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A

REFERENCE HANDBOOK

OF THE

MEDICAL SCIENCES

EMBRACING THE ENTIRE RANGE OF

SCIENTIFIC AND PRACTICAL MEDICINE

AND

ALLIED SCIENCE

BY VARIOUS WRITERS

ILLUSTRATED BY CHROMOLITHOGRAPHS AND FINE WOOD ENGRAVINGS

EDITED BY ALBERT H. BUCK, M.D.
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A REFERENCE HANDBOOK

OF THE

MEDICAL SCIENCES.

ICHTHYOL. This substance, recently introduced into medicine, is said to possess very marked antiphlogistic powers. It is a bituminous product, found in the Tyrol, and formed of the remains of fishes left there in former ages by the upheaval of this portion of the earth's crust. Ichthyol is of the consistence of vaseline, looks somewhat like tar, is slightly soluble in water, alcohol, and ether, and mixes readily in all proportions in oil and fatty substances. Its chemical constituents are carbon, hydrogen, oxygen, phosphorus, and sulphur. Unna, in 1883, recommended it in the treatment of rheumatism and various cutaneous affections, and since that time it has been used to a considerable extent, externally and internally, in many different inflammatory troubles, such as gastritis, frost-bite, acne, dental caries, etc. Externally it is applied in an ointment varying in strength from thirty to fifty per cent., and internally in solution in doses of two or three grains twice a day. As ichthyol is a remedy of so recent introduction, and is still on trial, it is not possible to indicate with any greater precision the affections in which it really may be useful.

T. L. S.

ICHTHYOSIS, commonly known as fish-skin disease, is a chronic, hypertrophic disease, characterized by dryness or scaliness of the skin, with a variable amount of papillary growth.

It usually occupies the whole surface, but is most marked upon the extensor surfaces of the arms and legs, especially at the elbows and knees. The face and scalp often remain free. It is usually first noticed in early childhood, and becomes progressively worse until adult age, after which time it is not uncommon for it to remain stationary, changing only with the season. It is seen in both sexes. Two varieties are usually described—ichthyosis simplex and ichthyosis hystrix, terms employed to designate the mild and severe forms respectively.

The milder form of the disease may be so slight as to give rise to simple dryness or harshness of the skin; but it may be, and commonly is, more developed, marked scaliness, in the form of thin epidermal plates, being observed. In slight cases the color of the scales is usually light and pearly; in the more marked examples it may be dark, olive-green, or black. The amount of scaling depends upon three factors—the severity of the disease, the age of the patient, and the frequency of ablutions. In the severe variety—ichthyosis hystrix—in addition to scaliness there is marked papillary hypertrophy, forming warty or spinous patches.

The general health of ichthyotic patients is usually noted to be good. Beyond the disfigurement the disease causes no inconvenience, except in those well-marked cases in which the scales become thick and more or less immovable; in these instances the natural mobility of the parts is compromised, and fissures may occur.

In all cases the disease is better in the warm months, and in the mild form may entirely disappear. This favorable change, as may be readily conjectured, is mechanical—due to the maceration which the increased activity of the glands gives rise to. The causes of the disease are not known. An hereditary influence is a positive factor. Although the affection is rarely noticed before the end of the first or second year, it is probable that it is born with the individual, but that during the first months it is so slight, and the skin is so frequently washed, that it readily escapes observation. In our own country the severe type of the disease is uncommon. Anatomically, the essential feature is epidermic hypertrophy, with usually varying degrees of papillary hypertrophy also. The diagnostic points are the harsh, dry skin, epidermic and papillary hypertrophy, scaliness, furfuraceous or plate-like; the greater development of the disease upon the extensor surfaces; and a history of the existence of the affection dating almost from birth. It is not an inflammatory disorder, and the absence of this character will serve to distinguish it from eczema, psoriasis, and the other inflammatory diseases in which scaliness is present.

The prognosis is unfavorable as regards the cure, but the process may be kept in abeyance by proper measures. Indeed, the good effects of persevering treatment over an extended period may persist for several weeks or months after the applications are discontinued. Constitutional remedies are practically powerless; occasionally some good is accomplished by the internal administration of linseed-oil and preparations of jaborandi. External applications constitute the most reliable measures of treatment. In mild cases frequent warm-water baths, simple or alkaline, will suffice. In others an application of an oil or fatty substance, such as the ordinary oils or ointments, made several hours or immediately before the bath, will be found necessary. In moderately developed cases the skin may be rubbed with sapo viridis and hot water, followed by a bath, and then may be made an oily application. In some of the more severe cases the following plan is often useful: The parts are first rubbed with an ointment consisting of precipitated sulphur one part, and sapo viridis seven parts; then a bath is taken, the skin rubbed dry, and an ointment (five to ten per cent.) of salicylic acid applied. Unna speaks well of a course of treatment consisting of the daily application of sulphur ointments (varying strength) and frequent bathing; several cases are mentioned in which the good results remained for months after active measures had been discontinued. Another ointment well indorsed is as follows: ℞. Potassii iodidi, ℈j.; glycerinæ, ʒj.; adipis benz., ol. bubuli, āā ℥ss. Glycerine lotions may be mentioned as often useful. In severe cases of ichthyosis hystrix it may be necessary also to employ caustics or the knife. Reference may also be made to salicylic-acid plasters. It is possible, also, that applications of ichthyol would have a favorable effect in this disease.

Henry W. Stelwagon.

IDAHO HOT SPRINGS. *Location and Post-office,* Idaho Springs, Clear Creek County, Col.

Access.—From Denver by the Union Pacific Railway, Colorado Division.

ANALYSIS (J. G. Dohle).—One pint contains :

	Grains.
Carbonate of soda	3.85
Carbonate of magnesia	0.36
Carbonate of lime	1.19
Carbonate of iron	0.52
Chloride of sodium	0.52
Chloride of magnesium	trace
Chloride of calcium	trace
Sulphate of soda	3.67
Sulphate of magnesia	2.34
Sulphate of lime	0.43
Silicate of soda	0.51
Total	13.39

Temperature, 85° to 120° F.

THERAPEUTIC PROPERTIES.—Dr. P. Brumund, a resident physician at Idaho, writes: "The hot baths have proved to be of considerable use in rheumatism, kidney affections, and chronic skin affections." . . . "As far as climate is concerned, I can truly say it surpasses anything I have ever seen either in the old world or this country." The flow of water is copious, and baths of various temperatures are provided. In addition there is a "steaming cavern," which is formed in an old mining tunnel. In prospecting for metal the miners struck a vein of hot mineral-water, which forms a pool and fills the cavern with steam, making an admirable hot vapor-bath. There are also cold mineral-springs in this group. The town of Idaho, with a population of about two thousand, is about forty miles from Denver, at an altitude of 7,500 feet, 2,500 feet higher than Denver. The journey on the railroad through the Clear Creek Cañon is most grand. Near by is Mt. Evans, one of the highest peaks of the Rocky Mountains. Within twelve miles are the famous Chicago Lakes, one of which, at an elevation of 11,500 feet, is said to be the highest body of water in North America. The accommodations are not first class, but there are several small hotels where visitors can be moderately comfortable. *Geo. B. Fowler.*

IDIOSYNCRASY (*ἰδιοσυγκρασία = ἴδιος, σὺν, κρᾶσις*). The word *κρᾶσις*, literally *a mixture* (from *κεράννυμι*, to mix), signifies that combination of attributes which makes up the peculiar (*ἴδιος*) disposition of the individual; hence by idiosyncrasy, or idiocrasy, its synonym, is meant "a peculiarity of constitution and susceptibility occasioning certain peculiarities of effect from the impress of extraneous influences or agencies" (Webster).

The temperature of an individual may be recognized by external signs, but idiosyncrasy cannot; it can only be known to the physician by imparted information, or by intimate acquaintance with the constitution of the patient. Various divisions of idiosyncrasies have been from time to time made. Thus, they have been classified as congenital and acquired, mental and physical, permanent or temporary. The subject will be considered here according to the effects observed, first, upon the system generally, and next, upon the special senses, though it is not possible to discriminate between the effects of sights, odors, and tastes upon the system generally and those exerted by the same agents upon each special sense.

Articles of ordinary diet may act upon individuals with effects widely different from those generally experienced. Examples of this sort are occasionally found with such common articles as sugar and honey, which have been known at times to have caused vomiting, while the urticaria resulting from the eating of lobsters and oysters is familiar to most practising physicians. Strawberries have long been observed to have been followed by strange effects, and cases have been reported in which febrile symptoms and convulsions have followed their use. In 1869 such a history was recorded in *The Lancet*, where it was stated that, on three distinct occasions, a patient experienced serious symptoms on merely tasting a strawberry. Once, after eating some trifle, in less than three minutes failure of the heart's action set in, and prolonged fainting ensued, while on another occasion similar alarming symptoms followed the tasting of strawberry-jam.

The violent actions of medicinal agents by idiosyncrasy is an important study. Of the purgatives, some act with greater violence on some persons than on others—rhubarb, or even manna, having been known to produce violent vomiting and purging, and similar symptoms have been noted as occurring after the use of mineral-waters. The balsams and turpentines occasionally produce urticaria.

Opium and belladonna act with great uncertainty in some cases, the latter producing a scarlatiniform rash with toxic symptoms, even after the administration of very small doses. The application of the belladonna-plaster, so generally used, has, in the experience of the writer, been followed by dilatation of the pupil and marked dryness of the throat. Chloral in some cases is highly dangerous, medicinal doses having produced alarming and even fatal results.

The action of chloroform as an anæsthetic is notoriously uncertain. Sudden death under its administration, occurring under so many different circumstances, leaves little room to doubt that idiosyncrasy is the main factor in such fatal accidents. A friend of the writer, a medical man, experiences a movement of the bowels each time he administers ether.

Ipecac produces a condition resembling asthma. It is not uncommon for cantharides-plaster to produce dysuria and hæmaturia. Many idiosyncrasies belong to the sense of smell. The characteristic scent of cats, rats, mice, and the like, is not only perceived by some persons with unusual acuteness, but it exercises upon them effects of various kinds, producing faintness, nausea, or vomiting. The physiologist Haller was made uncomfortable by the odor of old men, though others failed entirely to perceive it. He could, moreover, detect the presence of apples at great distances, and was made sick by the smell of cheese. The writings of the older authors abound in such instances. Again, the perception of certain odors may be absent, as in the case of an Englishman, mentioned by Blumenbach, who, though all his special senses were acute, nevertheless was unable to perceive or appreciate the smell of mignonette. Idiosyncrasies of taste are more common. In former days those who professed a liking for disgusting and repulsive articles of food were regarded with sympathy and interest. Pregnant women and hysterical girls were seized with "longings of so intense a kind that friends and relatives were obliged to secure their gratification at all risks." The prevailing scepticism of this part of the nineteenth century has abolished many of these fantastical beliefs. The practitioner hears little nowadays of the longings of the pregnant one, but the hysterical girl is to the fore with her fastings and depravities of taste. Instances may be cited of such patients eating chalk, ashes, earth, coal-dust; of their swallowing pins, hair, and other articles of convenient size. A step further in this direction and we come to the maniac who devours everything that comes to hand, no matter how disgusting.

Sounds vary in their effect on different individuals. Certain noises—the crackling of paper, the slamming of doors, etc.—are peculiarly distressing to some. The tones of certain musical instruments please some—annoy others. Scotchmen profess to enjoy the sound of the bagpipes, though effects the reverse of pleasant seem to be produced in others. Shakespeare's observation that incontinence of urine is, in some, produced by the screeching of these instruments is corroborated by J. J. Rousseau, and a similar unpleasant result has been recorded as the effect of the hurdy-gurdy.

Certain sights produce effects in human beings which cannot be explained upon any rational grounds. The sight of cats and dogs, as well as certain colors, are, to many, a source of discomfort; this is probably analogous to the condition of rage produced in animals by the exhibition of certain colors. Finally, it must be borne in mind that the actual number of real idiosyncrasies is very limited, and that the majority of them are assumed by the patient for the purpose of creating interest and sympathy. Patients who vow that morphia will kill them will sleep soundly on a dose of opium or codeia; cinchona may replace quinine, and Fowler's solution may be safely given to those who are convinced they cannot take arsenic. *R. L. MacDonnell.*

IMPETIGO. An acute inflammatory disease of the skin, characterized by the appearance of one or more discrete, rounded and elevated, firm pustules, of the size of a pea to a finger-nail, unattended, as a rule, by itching. The eruption is occasionally, but not often, attended by slight constitutional symptoms, as loss of appetite, constipation, and malaise. The pustules come out one or two at a time, and are discrete and scattered, never tending to coalesce. They are tense, raised, semiglobular, of a whitish-yellow color, and at first surrounded by an areola, but with little infiltration. In number they may vary from one to a dozen or more. They may occur upon any part of the body, but are common upon the face, hands and feet, toes, and lower extremities; also, upon the palms and soles. There is little or no itching or burning.

The disease may last several weeks, the lesions coming out rapidly, one after another at first, lasting a day or two in a typical condition, and then becoming darker or bloody, drying, crusting, and becoming absorbed. The fluid contents of the pustules, when these are ruptured by accident or design, are seen to be thinner than would appear from the firm aspect of the unruptured lesion. The crusts may be abundant, and of a yellowish or brownish color, or they may be insignificant, the pustule being absorbed. In no case does a permanent scar remain. The disease tends to a speedy recovery. Relapses are not common.

Impetigo occurs more commonly among children than among adults. Its exact cause is not known, but it does not seem to be connected with debility, want of proper nourishment, or derangement of the digestive system. It does not appear to be contagious.

Impetigo is to be distinguished from eczema by the superior size and development of the pustules, their small number, and separate arrangement. In addition, the pustules of impetigo do not incline to rupture, and there is rarely a crusted discharge. The opposite in all these respects is found to occur in eczema. In addition, eczema is almost invariably accompanied by infiltration and by itching, neither of which are present in impetigo. In impetigo contagiosa, which must not be looked upon as a variety of impetigo, but as a distinct disease, the affection begins by a vesicle, or vesico-pustule, like that of vaccinia; the crust is flat, sometimes umbilicated, without any infiltration about its base; and, above all, there is almost invariably a history of contagion. None of these characters is found in impetigo. Impetigo is often confounded with ecthyma, but in the latter affection the pustules are flat, and are surrounded by an extensive, inflammatory, hard base; in impetigo they are elevated and rounded, and have generally but a slight areola. In ecthyma the crusts are blackish or brownish in color, are large and flat, and are seated on a deep excoriation. Impetigo usually occurs in the strong and healthy; ecthyma in the weakly and cachectic.

The treatment of impetigo is simple. The pustules may be opened as they mature, and the contents allowed to escape. The part should be protected from rubbing and violence. The lesions may be dressed with simple oxide-of-zinc ointment, with the addition, in some cases, of calomel in the proportion of five to ten grains to the ounce. Or the following ointment may be employed: ℞. Pulv. bismuthi subnitrat., Gm. 2–4 (ʒ ss.–j.); ung. aqua rosæ, Gm. 32 (℥ j.). M. This ointment is to be spread on small pieces of patent lint, applied to the lesions, and covered with wax or paraffin paper. It is then to be bandaged on to the parts and retained in apposition, with occasional renewals, until the lesions have healed under the crusts. No internal or general treatment is required. *Arthur Van Harlingen.*

IMPETIGO CONTAGIOSA. An acute inflammatory contagious disease of the skin, characterized by the formation of one or more superficial, discrete, roundish or oval vesico-pustules or blebs, the size of a split pea or finger-nail, which pass into crusts. The eruption is commoner among infants and young children. Isolated, flat, or slightly raised vesicles are first seen, small in size at the beginning, but rapidly spreading on the periphery until they become like little blebs, with a thin, withered-looking collapsed wall. The lesions are few in number. Usually they are discrete, but sometimes two or more coalesce. They are most commonly found about the mouth, on the chin and nose, and on the hands.

Crusts form in a few days, usually yellowish or straw-colored, which, as they dry, often become loosened at the edges so as to look as if they had been stuck on the skin. The surface beneath is moist and excoriated. The mucous membranes of the mouth and conjunctiva are occasionally invaded. The disease may extend from place to place by auto-inoculation. It runs its course in about ten days, tending to a spontaneous recovery. Sometimes, however, it runs an anomalous course.

Impetigo contagiosa is ordinarily a disease of the lower classes, and its spread is favored by want of cleanliness. It is almost exclusively confined to children, though it sometimes occurs in adults who have the care of affected children. The disease is contagious and auto-inoculable. Occasionally it occurs as an epidemic of limited area. It is commoner in summer.

The affection has been supposed to be due to a vegetable parasite, and there are some features in the mode of its propagation which strongly favor this view. The evidence of observers is, however, conflicting. Stelwagon, who has made extensive observations on the disease, believes it to be an acute, contagious exanthem, with cutaneous manifestations, running a definite course, and in all probability due to a specific poison.

Impetigo contagiosa is to be distinguished from pustular eczema and from impetigo. The course and character of the lesions will suffice to establish the diagnosis. From varicella, pemphigus, and herpes iris (erythema multiforme), the appearance and distribution of the lesions will distinguish the affection.

The treatment of impetigo contagiosa is simple. An ointment of 0.65 Gm. (10 grs.) ammoniated mercury in 32 Gm. (1 oz.) of lard is as good an application as can be found, and this, with removal of the crusts and strict cleanliness, will suffice to bring about a rapid cure.

Arthur Van Harlingen.

IMPOTENCE. Inability on the part of the male to perform the act of copulation. This may be due to either physical or mental causes. Among the former are:

1. Absence or deformity of the penis. Deformity may consist: (*a*) of excessive brevity, either congenital or the result of accident or disease; (*b*) of inordinate bulk, as from carcinoma, syphilitic warts, retained calculus in the urethra or under the prepuce; (*c*) of a vicious direction of the penis, usually backward, as in hypospadias, and either backward or laterally, when following external violence or chordee.

2. Impotence may result from absence or defective conditions of the testicles. Atrophy of the testes may result from central lesions of the brain or spinal cord, from inflammatory disease of the testicles themselves, from the compression caused by hydrocele, varicocele, scrotal hernia, or any other tumor, or may follow excessive venery or onanism.

3. Virility is often impaired or destroyed by the prolonged and excessive use of certain drugs, as bromide of potassium, chloral, morphine, cannabis indica, and alcohol. The same is said to be true of iodide of potassium, and even of the milder diuretic salts, such as nitrate of potash and carbonate of soda. Lead-poisoning and chronic arsenical poisoning may have the same effect. Among the more familiar causes of impotence are injuries to the brain or spinal cord, myelitis, progressive locomotor ataxy, etc. In irritative dyspepsia, with deposits of earthy phosphates or oxalate of lime in the urine, there is generally some inability. In diabetes mellitus and albuminuria the reproductive organs are often weak, but may regain tone as the kidneys are restored to a healthy condition (Curling).

4. "Atonic impotence" is the name given by S. W. Gross, of Philadelphia ("A Practical Treatise on Impotence, Sterility, and Allied Disorders of the Male Sexual

Organs," Philadelphia, 1883), to that condition in which, independently of any of the preceding causes, "the lumbar reflex centre for erection fails wholly or partially to respond to the ordinary stimuli." This atony, he tells us, "depends either upon, or is maintained by, inflammation and hyperæsthesia of the prostatic portion of the urethra, or upon diminished or abolished reflex excitability of the genito-spinal centre without the intervention of those lesions. Of the 171 cases that have come under my observation, 159 were of the former, and only 12 of the latter, variety."

This inflammation and undue sensibility of the prostatic urethra has been recognized by other observers, ever since the day of Lallemand, as one of the results of masturbation, as well as of gonorrhœa, sexual excesses, and constant excitement of the sexual appetite without its gratification. It is frequently associated with stricture of the urethra, from whatever cause; and masturbation itself is the cause of the stricture, according to S. W. Gross in thirteen per cent., according to Otis ("On Stricture of the Male Urethra," pamphlet, New York, 1875) in nine per cent. of all cases.

It is of the utmost importance to determine whether, in any given case, stricture or hyperæsthesia of the urethra is the cause of the impotence. This is done, for stricture, by exploration with the bulbous or acorn-headed soft bougie; for hyperæsthesia, by the passage of the conical steel sound. "In the absence of proper instruments for exploring the urethra, the general practitioner may suspect inflammation and morbid sensibility if there be painful and frequent micturition, painful ejaculation, a feeling of weight in the ano-rectal region, a gleety discharge, prostatorrhœa, abnormal nocturnal emissions, and sensibility of the prostate on pressure with the finger in the rectum" (Gross, *loc. cit.*).

5. Impotence from mental causes, or "psychical impotence," may be of two general varieties. In the first, profound emotional disturbance—as sorrow, fear, personal dislike or distrust—may prevent erection, or make it so incomplete or short-lived as to forbid intercourse. The same thing may occur from great preoccupation of mind. In the second, the impotence is more purely imaginary, the individual fearing that he will not be able to accomplish the act and letting his mind dwell on this fear, instead of forgetting, watches himself, and so does actually fail. This is most likely to be true of masturbators, either the victims of abnormal seminal emissions or men who, without sufficient ground, have allowed themselves to be frightened into the idea that they have spermatorrhœa and are impotent. In dealing with persons who are thought to belong to this class the practitioner must never lose sight of the reality of atonic impotence dependent on urethral irritation, and must, by careful examination, eliminate that from his diagnostic problem.

TREATMENT.—Impotence dependent on deformity of the penis may sometimes be corrected by operative interference, and each case must be judged on its own merits in accordance with the general rules of surgery.

The same holds good with regard to some varieties of the second class. Where atrophy of the testicles results from pressure due to hydrocele, varicocele, scrotal hernia, or other tumor, these conditions should be removed, and if the atrophy be not too far advanced improvement may be expected.

In the third class the removal of the cause, when practicable—as, for instance, the withdrawal of drugs that cause sexual weakness—is indicated. The cure of the dyspepsia, diabetes, or other causal disease, will usually relieve the impotence. When dependent on inflammatory or other grave disturbances of the brain or spinal cord, the prospect is, of course, less favorable. After the subsidence of such disturbances, as well as after the removal of any of the other causes enumerated in the second and third classes, it may often be well to treat the remaining weakness by the administration of small doses of the phosphide of zinc, or of the tincture of cantharides, as well as by galvanization of the spinal cord and the testes.

The fourth class—the atonic impotence of S. W. Gross—embraces the larger number of cases of this trouble that will present themselves to the practitioner, and affords the most encouraging field for treatment. The methods given below are those recommended by Gross in the work cited. Their value has also been proven in the more limited experience of the writer.

Hyperæsthesia of the urethra having been shown to exist by the introduction of the conical steel sound or bougie, no better local treatment for the relief of this condition can be found than the habitual use of this very instrument. The size of the sound employed, where there is no stricture, will be gauged by that of the meatus, and its size should be gradually increased to that of the full capacity of the urethra, the meatus being laid open when required. At first the sound should only be introduced twice a week and immediately withdrawn. As the urethra becomes more tolerant it may be left in position longer, and finally used every day.

Where an irritable or resilient stricture is found to exist, it must be divided or divulsed before further successful treatment can be undertaken. The same rules apply to the performance of the operation and the subsequent treatment of the patient as would obtain in the case of stricture from any cause.

In some instances the urethral hyperæsthesia is so excessive that the patient cannot tolerate the introduction of the sound at all. Persistence in the attempt may cause him to faint or throw him into epileptiform convulsions. This extreme sensibility may be controlled by the injection, two or three times a day, of a solution of five grains of chloral and ten of bromide of potassium to the ounce of water; or, better yet, by the injection of a four-per-cent. solution of cocaine muriate a few minutes before the sound is passed.

After the general urethral hyperæsthesia has been relieved single sensitive spots may yet remain, requiring the local application of a few drops of a solution of nitrate of silver or the use of a small urethral suppository of the same.

For details as to the methods of conducting the above manipulations and the instruments to be used, the reader is referred to those sections of this work treating of urethral surgery.

The general treatment to be pursued in these cases is such as will prove tranquillizing and not irritating to the genital organs. Damiana, strychnine, phosphorus, cantharides, etc., are to be strictly avoided. Bromide of potassium may be given, in the more irritable cases, in doses of thirty grains three or four times a day, or in a single dose of sixty to eighty grains at bedtime. It can often be dispensed with. Small doses of quinine (one to three grains) with from twenty to thirty drops of tincture of iron, three times a day, are often indicated.

Gross says, "when the penis is cold and rigid, atropia is indicated to overcome the contraction of the muscular fibres of the trabeculæ of the erectile bodies, and to induce dilatation of the arterioles and an increased flow of blood through the organ. Its good effects are also evinced by the diminution of the number or the entire cessation of the nocturnal emissions and prostatic discharges which frequently complicate the affection." The one-sixtieth to the one-hundred-and-twentieth of a grain may be administered on retiring at night.

Other points in the physical and moral treatment of the patient will often suggest themselves to the practitioner, as the avoidance of indiscretions in diet and drink, abstinence from all that is calculated to arouse the sexual appetite, etc.

After strictures have been relieved and the hyperæsthesia of the urethra overcome—an undertaking which will occupy from two or three weeks to several months—it will usually be proved that the impotence has also been relieved or removed.

In those cases in which the result is still unsatisfactory something may yet be accomplished by the use of cold hip-baths, or cold sponging of the back and genitals, and the application of galvanism. In using the latter not more than fifteen cells need to be employed; the positive electrode is placed over the lumbar vertebræ, and

the negative is passed over the glans, dorsum of the penis, scrotum, and perineum. Tonic doses (one to two grains) of quinine and sulphate of iron, with the twentieth of a grain of phosphide of zinc, and the sixtieth of a grain of strychnia three times a day, should be continued for some time longer. Damiana may be tried. The moral effect of it is sometimes very good.

In the fifth class, or cases of supposed psychical impotence, it is, as before stated, of the first importance carefully to examine the patient, in order to determine whether some of the above-mentioned causes and conditions may not, after all, be responsible for a partial impotence which the alarm of the patient has then aggravated. Of course, in such a case the treatment appropriate to the condition must be undertaken. If, however, no cause is found, it will still not do to dismiss the patient with the assurance that he is mistaken. Something must be done for the body in order to treat the mind. The introduction of a sound once or twice a week, the administration of a tonic, and, in extreme cases, the use of the cold douche, or even of galvanization, may be demanded. Sometimes a mere placebo will do, but this is not the rule. The patient having been inspired with the confident hope of recovery, and having regulated his life in the wisest way practicable, it is important that he should not undo all that may have been accomplished by too early attempts to test his powers. If then, when he does come to the test, he is so sanguine of success as to forget himself, the end will have been accomplished. *Edward W. Schauffler.*

IMPREGNATION is the union of the male and female elements to form a single new cell, capable of initiating by its own division a rapid succession of generations of descendent cells. The new cell is called the impregnated or fertilized ovum. The production of cells from it is called its segmentation. For the theory of the relation of the elements to one another and to cells, see Sex; for accounts of the sexual bodies, see Ovum and Spermatozoa.

In all multicellular animals, impregnation is effected by three successive steps: 1, The bringing together of the male and female elements; 2, the entrance of the spermatozoa into the ovum, and formation of the male pronucleus; 3, fusion of the pronuclei to form the segmentation nucleus. We proceed to consider these steps in their order.

1. The Bringing Together of the Sexual Elements.—This is effected in a great variety of ways, which, however, fall into two groups, according as the impregnation is effected, *a*, outside the body of the mother, or, *b*, inside. The simplest manner is the discharge of the male and female elements at the same time into the water, leaving their actual contact to chance, the method of the osseous fishes for the most part, and of many invertebrates. An advance is the copulation of the anura (frogs, etc.), the male embraces the female, and as the latter discharges the ova, ejects the sperm upon them. In the higher vertebrates the seminal fluid is transferred from the male to the female passages during coitus. The physiology of this complicated function does not fall within the scope of this article.

For a long time it was not known how the semen fertilized the ova; the problem was long fruitful of fruitless speculation. The first step toward gaining actual knowledge was the discovery of the possibility of artificial fecundation by Jacobi, in 1764. Spallanzani was the first to take advantage of this, and to show that fecundation implied a material contact of the semen with the ova, and thus to set aside De Graaf's notion of the *aura seminalis.* But not until fifty years later did the memorable experiments of Prévost and Dumas (*Annales des Sciences Naturelles*, 1824) establish the fact that the spermatozoa are the essential factors of fertilization. Again, a little over fifty years later, Hertwig[10] and Fol[6] showed that one spermatozoon suffices to impregnate an ovum.

We have then to consider how the spermatozoa, after the semen has been transferred to the female, attain the ovum. They are found in mammals after copulation in the vagina and even in the uterus, but it is not clearly ascertained how they get beyond the vagina. It is probable that they travel through the female passages partly by the movements thereof, partly by their own locomotion, and enter the Fallopian tubes, though why or how is really unknown, and pass upward to meet the ovum. They are found in considerable numbers in the Fallopian tubes. The ovum meanwhile travels down the oviduct, it probably being impelled by peristaltic movements of the duct.

The meeting point, or site of impregnation in placental mammals, is about one-third, perhaps one-half way down from the fimbria to the uterus. It is remarkably constant for each species. Nothing positive is known as to the site of impregnation in man, but there is no reason to suppose, as is unfortunately often done, that the site is variable or different from that in other mammalia; compare vol. ii., p. 390.

2. The Entrance of the Spermatozoon into the Ovum and Formation of the Male Pronucleus.—With our present knowledge, the assumption appears unavoidable that the ovum exerts a specific attraction upon spermatozoa of the same animal species. We observe, in fact, when artificial fecundation is employed, the spermatozoa swarming around the ova as if held by an irresistible impulse. This phenomena occurs with every class of animals, even in mammals, whose freshly removed ova were examined on a warm stage under the microscope (Rein[15]). Stassano[22] has maintained that the eggs of echinoderms do exert such an attraction and also a similar but less strong attraction upon the spermatozoa of allied species. Since the brothers Hertwig[23] have found by their experiments with sea-urchins, that hybrid impregnation takes place more readily after the ova have been kept awhile, Stassano's view involves the further assumption that the specific nature of the attraction fades away during a few hours. Very suggestive in this connection is Pfeffer's[24] discovery that certain chemical substances may attract moving spores, etc., to definite spots. It is conceivable that the ovum may draw the spermatozoa toward itself by chemical influence, acting as an attracting stimulus.

Fig. 1810.—Ovum of a rabbit; taken from the middle of the oviduct about eighteen hours after coitus. The segmentation nucleus is already formed; the polar globules, *p.g.*, are shown; numerous spermatozoa lie both in and within the zona. (After Costa.)

There may be mechanical devices to facilitate the entrance of the spermatozoon; this is, perhaps, generally true of all ova with micropyles serving for the passage of the spermatozoa. A careful study of such devices in the cockroach has been made by Dewitz,[3] who found that the motions of the spermatozoa of this insect are peculiar, and adapted to increase the probability of their passing through one of the micropyles of the ovum. In ova without micropyles, among which those of mammals are included, the spermatozoa may, so far as we know, penetrate any part of the envelopes.

In the rabbit (Rein[15]) about ten hours after coitus the ovum is found nearly half way through the oviduct, and surrounded by many spermatozoa, perhaps a hundred, more or less. These are all, or nearly all, in active motion, for the most part pressing their heads against the zona radiata. Several of them make their way through into the interior of the ovum. According to Hensen,[9] only those spermatozoa which enter the zona along radial lines can make their way through; those which take oblique courses remain caught in the zona (Fig. 1810), and may still be seen there during segmentation. As the ovum at this time is already fully matured (see Ovum), there is a space between the contracted yolk and the zona. In this space, as well as in the zona itself, several spermatozoa may be observed at scattered points. The female pronucleus (see Ovum) is present, having been reformed since the expulsion of the second

polar globule from the ovum, while in the ovary. One spermatozoon gets into the yolk proper, and its entrance apparently prevents the penetration of other spermatozoa —*how* is undetermined. The tail of the spermatozoon soon disappears; while the head enlarges, probably by the imbibition of fluid from the surrounding yolk, and thus becomes a nucleus-like body, the male pronucleus.

The passage of the spermatozoa through the zona was first discovered by Martin Barry, in 1843, and although his statement was received with considerable hesitation by his contemporaries, it has since had competent confirmation repeatedly. Warneck [20] is said to have been the first (1850) to see the *two* pronuclei, but their significance was not perceived. The nature of the male pronucleus was first recognized by Oskar Hertwig,[10] who traced its genesis in the ova of echinoderms from the spermatozoon. The fact that the male pronucleus is the metamorphosed spermatozoon has since been confirmed by Selenka,[16] Éd. van Beneden,[19] Nussbaum,[13] Eberth,[4] Platner,[14] and others.

Although a number of the spermatozoa make their way into the perivitelline space, probably always one alone normally enters the yolk to there form a pronucleus. The best observers are agreed upon this point, and in all species, the observations upon which have covered the whole series of steps in the impregnation, there has been found in normal cases always a single male pronucleus. Schneider's statements to the contrary have been definitely corrected. Bambeke,[25] Kupffer,[7] and Kupffer and Benecke [8] have observed that several spermatozoa actually enter the yolk in batrachians and petromyzon. Hertwig, however, found only one male pronucleus in the frog, and there has as yet been no evidence adduced that several spermatozoa are concerned in the final phases of impregnation. Fol observed that star-fish eggs are normally impregnated by one spermatozoon; but if they are exposed to the action of carbonic acid they may, while so poisoned, be impregnated by several spermatozoa, but the subsequent development in this case is abnormal; apparently each pronucleus becomes a separate centre of development.

The term micropyle is applied to various structures, and does not in all cases designate a passage through

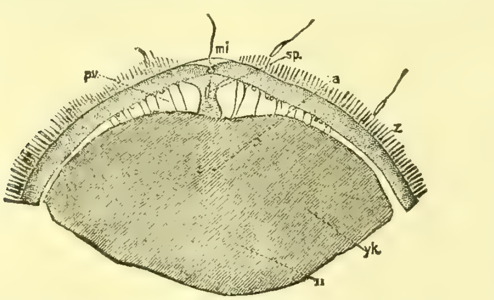

FIG. 1811.—Anterior Pole of the Ovum of the Petromyzon, with a Spermatozoon (*sp*)., entering the Micropyle (*mi*). (After Calberla.) *p.v.*, Perivitelline space; *z*, zona pellucida; *a*, pathway to female pronucleus, *n*; *yk*, yolk.

which spermatozoa enter—thus the micropyle of holothurians is merely a structure left in the envelopes in consequence of the way the egg is developed. A micropyle has been observed in the ova of teleosts and the lamprey, but it is doubtful whether it is, like the micropyles in the hard-shelled eggs of insects, intended for the passage of spermatozoa. Calberla [2] saw the micropyle thus used in the lamprey, and it is possible that the fructifying spermatozoon enters that way, although Kupffer and Benecke [8] state that spermatozoa may also pass directly through the zona. A good synopsis of the observations on the lamprey is given by Hensen (Hermann's "Handbuch," VI., ii., 120). We have only to notice that there is a special band of non-granular protoplasm leading from the micropyle to the egg nucleus (Fig. 1811), and serving as a path for the spermatozoon; a similar band has been observed in amphibian eggs by Hertwig and Bambeke; it serves perhaps as a mechanism to guide the male to the female pronucleus.

The manner in which additional spermatozoa are excluded, after the first has entered, is still under discussion. In cases where there is a single micropyle, which is used for entry, it is possible that a portion of the first spermatozoon may remain to close the passage, or that in going through it sets in action some mechanism by which the opening is automatically shut. Where there are several or many micropyles, as in some insects, or where the envelopes may be pierced at any point, as in mammals, there must of course be some other device. Fol has maintained that this is found in the starfish in the rapid formation of a membrane around the yolk, immediately after the entrance of the first spermatozoon; but Hertwig affirms that this membrane pre-exists. Selenka (*Biolog. Centralbl.*, v., 8) describes the fertilization of the ovum of a nemertean worm—several spermatozoa enter within the vitelline membrane; the yolk contracts slowly; after a time the two polar globules are expelled, and before they separate from the yolk one spermatozoon passes into the yolk between them; the globules then break off and are knocked about by the spermatozoa in the perivitelline space. In this case there seems to be a portal opened just long enough for one spermatozoon to enter. As the phenomena to be explained is common to all ova, its causation is presumably fundamentally identical in all cases. Beyond this surmise our present knowledge does not permit us to go. The hypothesis may be suggested that the attractive power of the ovum is annulled or weakened by the formation of the male pronucleus.

It is probable that the tail of the spermatozoon, when that appendage exists, disappears within the yolk. In a land-snail (arion), Platner [14] has traced this process very clearly. Only a portion of the tail enters the yolk; but the part within acquires the property of staining readily, and so may easily be observed. He reports that the head and tail separate; the head only conjugates with the female pronucleus, while the tail still remains distinct even after segmentation has been initiated (Fig. 1815, A). The disappearance of the tail has been recorded by most observers. As Hertwig says (*loc. cit.*,[11] p. 23), all these careful observations yield the assured conclusion that the head of the spermatozoon, and the head only becomes the male pronucleus.

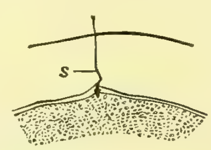

FIG. 1812.—Egg of Toxopneustes, with entering Spermatozoon (*s*), and a Protuberance of the Yolk rising toward it. (After Selenka.)

While the spermatozoon is passing through the ovic envelopes active changes occur in the yolk. Of these, the most constant, as well as the most obvious, is the formation of a slight protuberance on the surface of the yolk, rising up toward the spermatozoon. This protuberance (Fig. 1812) may remain, as in echinoderms, until the spermatozoon meets it, and by penetrating it enters the ovum; or it may retract before the spermatozoon passes through the envelopes, and even withdraw, as in petromyzon, so far from the advancing spermatozoon as to change into a depression (Fig. 1811). The protuberance lasts only a few minutes. In bufo, according to Kupffer,[7] several spermatozoa enter the yolk and a protuberance rises toward each one, as if the yolk were actively striving to reach the male element.

The relative size of the two pronuclei varies considerably in different species, and is probably a secondary and unimportant matter. Each pronucleus, when it first appears, is small, and gradually enlarges, apparently by the imbibition of fluids from the surrounding yolk. Now, the time when the spermatozoon enters the yolk may be either after or at some stage during the maturation of the ovum. If it enters early, as in limax (Mark), the male pronucleus enlarges equally with the female (compare Fig. 1813), but if late, as in the allied arion (Platner), then it appears (Fig. 1815) considerably smaller than the already swollen female pronucleus. Oskar Hertwig, in his third paper on maturation,[10] p. 171, first gave this explanation, and pointed out that in the starfish (asterias), if the

impregnation is prompt, the male pronucleus becomes as large as the female, but if impregnation is delayed for four hours, the male pronucleus remains much the smaller of the two. Again, in hirudinei (Fig. 1813), many mollusca, nematoidea, etc., impregnation usually takes place before the formation of the polar globules is completed, and the male pronucleus is accordingly as large as the female. In echinus, on the other hand, where the polar globules are found in the ovary, the male pronucleus is always small.

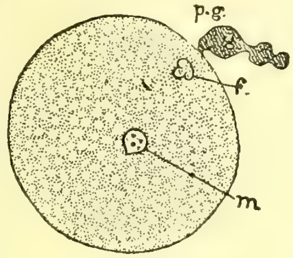

Fig. 1813.—Egg of Nephelis, three hours after laying. *m*, Male, and *f*, female, pronucleus; *p.g.*, polar globules. (After O. Hertwig.)

3. Fusion of the Pronuclei.—Each pronucleus is usually found surrounded by a space a little clearer than the rest of the yolk. Usually the yolk around this clear space presents a radiating appearance, which is known as the aster (Fig. 1814); but this appearance is not constant, nor is it known how it is caused. Mark [12] was unable to see it in limax, and Rein [15] could not detect it in the rabbit. In arion, apparently, only the male pronucleus has an aster (Fig. 1815, A). At one time it was assumed that the pronuclei acted as centres of attraction upon the yolk, and that the asters were due to their direct influence; but since, as in arion (Fig. 1815, B), the pronucleus may move away while the aster remains behind, it follows that the relations are more complex than this assumption indicates, since the aster exhibits a certain independence of the pronucleus. This is confirmed by Flemming's observations (*loc. cit.*,[5] p. 19), that when the asters *first* appear, in echinoderms, the centre of radiation is not the pronucleus itself, but a clear space just alongside. Some writers have considered the aster an expression of magnetic force within the ovum—a fanciful notion, without any evidence to support it.

In the rabbit (Rein [15]), both pronuclei lie at first eccentrically, but they move toward each other and toward the centre, meeting, however, before the central position is attained. As they near one another, both pronuclei perform active amœboid movements; after they meet they still continue their amœboid movements and move together to the centre of the ovum; one of the pronuclei assumes a crescent shape and embraces the other (Fig. 1816); at this time the yolk displays a radiate arrangement; from analogy with other animals, it must be assumed that the two pronuclei fuse into a single nucleus, which is therefore an hermaphrodite structure (see Sex), and which, after a certain period of repose, itself divides, and so begins the cleavage of the yolk (see Segmentation of the Ovum).

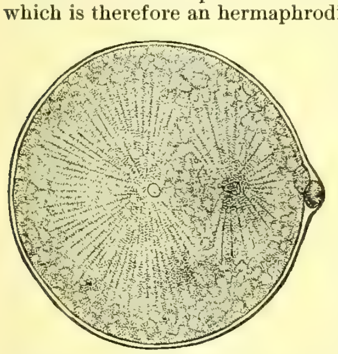
Fig. 1814.—Ovum of Sagitta, with two Pronuclei. (After O. Hertwig.) Around each pronucleus is shown the aster.

The place where the pronuclei meet varies; apparently the female pronucleus, of itself, moves to the centre or near the centre of the ovum; also the male pronucleus approaches the female as speedily as possible. If, now, impregnation occurs early, the two pronuclei meet peripherally; if late, they meet near the centre. In the former case they may move together, as in the rabbit (Rein), to a central position. The observations so far made indicate that after they meet the pronuclei both perform active amœboid movements, which continue for several minutes. Selenka maintains that the female pronucleus sends out processes which embrace the male pronucleus, but this has not been confirmed. Finally, the two pronuclei unite, but the process of union is very obscure, never having been satisfactorily observed. Apparently the membranes of the pronuclei, where the two are in contact, are dissolved away and the contents mix.

Now, since the head of the spermatozoon is developed chiefly out of the chromatin of the nucleus of a spermatoblast (see Spermato-genesis), it follows *that impregnation is essentially the addition of chromatin to the nucleus* (female pronucleus) *of the mature ovum.*

After the union of the pronuclei follows a period of repose, during which the yolk enlarges until it again fills, or nearly fills, the space within the zona; a little room is left, which is chiefly occupied by the polar globules. The significance of the contraction of the mature, and the expansion of the impregnated, yolk is unknown.

In certain cases the parts of the segmentation nucleus, which are derived from the male pronucleus remain distinguishable. This is notably the case with arion, according to Platner. The segmentation nucleus contains a number of nucleolus-like bodies (*Karyosomen* of Platner, Fig. 1815, A and B), with a distinct round outline, and a few granules of chromatin. These bodies are of

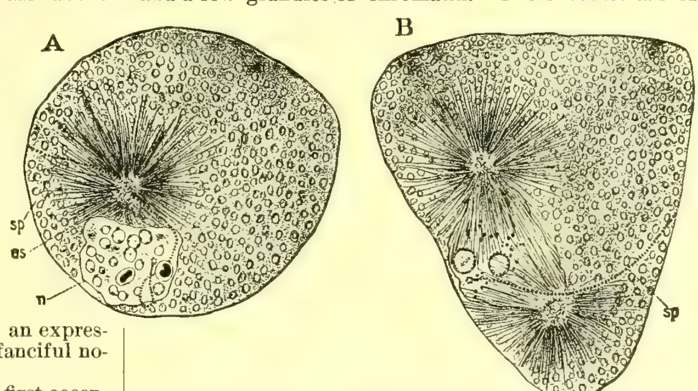

Fig. 1815.—Two Ova of a Land-snail, Arion. (After Platner.) The ova are irregular in shape, as at this stage they are still *in u ero* and mutually compressed. A, shows the segmentation nucleus, *n*, just formed; the two large "karyosomen" in it are derived from the male pronucleus; the male aster still remains, *as*. B, shows the commencing change of the segmentation nucleus into the first spindle. In both ova the tail, *sp*, of the spermatozoon is distinguishable.

two kinds (Fig. 1815, A)—the smaller and more numerous are produced by the female pronucleus, while the two larger ones arise from the division of the head of the spermatozoon. In the later stage, when the nucleus is changing into the first segmentation spindle (Fig. 1815, B), the two large male "Karyosomen" are still distinct, and have each their chromatin gathered in little particles around the periphery. Édouard van Beneden [19] goes even farther, stating that in ascaris the chromatin from the two pronuclei can be distinguished in the segmentation nucleus; and that when it divides, both the male and the female chromatin loops divide also, so that the resulting nuclei are truly hermaphroditic.*

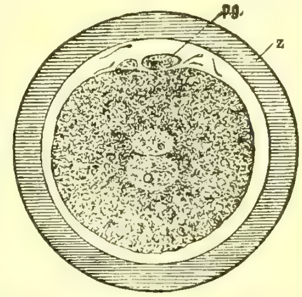

Fig. 1816.—Ovum of a Rabbit (seventeen hours after coitus), with the Pronuclei about to Conjugate. *p.g.*, polar globules; *z*, zona pellucida. (After Rein.)

Charles Sedgwick Minot.

* It must, however, be borne in mind that Van Beneden's work cannot be accepted without reserve. His previous investigations have been subjected not infrequently to very essential corrections by subsequent workers.

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INCOMPATIBILITY, MEDICINAL. The word *incompatible*, used in connection with the mutual relations of medicines, is one of very loose application. Thus, in a sweeping way, a medicine is said to be *chemically* "incompatible" with anything upon admixture with which a distinct chemical or physical change of condition in the medicinal substance results; and, similarly, a drug is classed as *physiologically* "incompatible" with anything that produces the reverse of its so-called physiological effects. Under these definitions, however, it is evident that in many cases so-called "incompatibility" may yet be perfectly compatible, in the ordinary sense of the word, with full medicinal power or purpose. Practically, under what is commonly referred to as the incompatibility of medicines, is embraced the topic of the chemical, physical, and physiological mutual relations of medicines that require consideration in the prescription of different medicinal substances in conjunction, and such topic it is that will be here considered.

As regards *chemical* and *physical* reactions there are. of course, many such which are special, between special medicines, and which must therefore be learned in connection with the individual medicines concerned. But, also, there are certain reactions that affect broad categories of medicines, and which, therefore, admit of general consideration. Such reactions and the practical bearings thereof in prescribing are as follows:

1. *Acids and bases tend to directly combine, to form salts.* This reaction may be utilized, if it be the object of the prescriber to obtain the salt that will result from the bringing together of an acid and base; but if the purpose of the prescription be to retain free acidity or alkalinity, acids and bases must not be conjoined in prescription.

2. *Stronger acids or bases tend to displace weaker bodies of those categories met with in solution, in saline combination.* Thus, if sodic carbonate in solution be treated with nitric acid, the nitric acid will displace the carbonic to the formation of sodic nitrate in solution and the evolution of carbon-dioxide gas. Strictly speaking, the statement of this reaction is a *circulus in definiendo*, since one acid is known to be "stronger" than another only by the fact of its supplanting such other acid in saline combination, in solution. The statement, however, as made, is convenient as a reminder to the prescriber of a set of reactions which are of common occurrence, and whose bearing upon prescribing is as important as it is obvious.

3. *Salts in solution tend to exchange radicles; or acids, or bases, to displace their respective brethren in saline combination, if thereby an insoluble compound will form.* If, as the cant phrase runs, nature "abhors a vacuum," she also, with equal uniformity of habit, *delights in precipitates;* for reactions, determined evidently by the fact that a precipitate will result, are among the commonest occurrences of chemistry. Concerning this reaction as it affects the prescriber, it must be remembered that while with some medicines the chemical change determining precipitation may profoundly affect medicinal potency, yet with others this may not be so, so that with certain medicines, so far as their medicinal usefulness is concerned, the occurrence of the precipitation is a matter of unimportance. Also, the purpose of a prescription may be for the very obtaining of a medicinal substance in precipitate, as in the case of the so-called *black* and *yellow* washes of mercury, under which circumstances, of course, the induction of the reaction is legitimate. Generally, however, the occurrence of a precipitate in a medicinal mixture is objectionable; for, even if medicinal virtue be not affected, the turbidity is unsightly, and, by the settling of the precipitate as the bottle stands, doses drawn, on the one hand, from the full or, on the other, from the nearly empty vial will vary enormously in strength of the precipitated ingredient, unless the bottle be thoroughly shaken at the taking of each dose. The following table of *notable* mutually precipitant solutions, taken from the writer's "Manual of Medicinal Technology," is convenient for reference. The reactions therein broadly stated as occurring with solutions of salts of the *alkaloids*, and of the *metals*, are true in the *generality* of instances only.

TABLE OF NOTABLE MUTUALLY PRECIPITANT SOLUTIONS.

	Solutions of Alkalies.	Carbonic acid and solutions of carbonates.	Sulphuric acid and solutions of sulphates.	Phosphoric acid and solutions of phosphates.	Boric acid and solutions of borates.	Hydrochloric acid and solutions of chlorides.	Hydrobromic acid and solutions of bromides.	Hydriodic acid and solutions of iodides.	Solutions of sulphides.	Tannic acid.	Arsenical solutions.	Albumen.
Alkaloidal solutions (generally)	prec.	prec.	.....	prec.	prec.	.....	.....	prec.	.....	prec.	.....	.....
Metallic solutions (generally)	prec.	prec.	....	prec.	prec.	....	.....	.....	prec.	prec.	prec.	prec.
Lead solutions	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.
Silver solutions	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.	prec.
Calcic solutions	prec.	prec.	prec.	prec.	.....	.....	.....	.....	.....	.....	.....	.....
Magnesic solutions	prec.	prec.	.....	prec.	.....	.....	.....	....	.....	.....	.....	.....
Albuminous solutions	.....	.....	.....	.....	.....	.....	.....	.....	.....	prec.	.....	.....
Gelatinous solutions	.....	....	.....	.....	....	.....	.....	.....	.....	prec.	.....	.....

4. *Things in solution precipitate on addition of an excess of a fluid in which they are respectively insoluble.* Here, as in the former instance, precipitation may not affect medicinal potency, but yet is to be generally avoided, because of the intrinsic objections to precipitates in medicinal mixtures, as set forth above. The two medicinal solvents most concerned in the present relation are *water* and *alcohol*, and the commonest instances of the reaction in question are afforded as follows: *albuminous, gelatinous, gummy, saccharine*, and many *saline* bodies that dissolve in water are yet commonly insoluble in alcohol, and so precipitate on addition of an excess of alcohol to their aqueous solution; while, *vice versa, alcoholic* solutions of *volatile oils, balsams, camphor*, and *resins*, precipitate on treatment with excess of water.

5. *Powerful oxidizing agents may determine explosions on concentrated admixture with readily oxidizable substances.* The exact conditions determining explosions with individual mixtures of this category will vary with the substances concerned, and must be learned, therefore, with each medicine. All that is appropriate to state in this place is that the medicinally used powerful oxidizers are *chromic* and strong *nitric* or *nitro-hydrochloric acids, potassic chlorate* and *potassic permanganate;* while the medicinal substances of easy combustibility are *oils, alcohols*, and *ethers* (including in the latter categories *glycerin* and *sugars*, bodies chemically belonging to the alcohols), dry *organic* substances generally, and the elementary bodies, *sulphur* and *phosphorus*.

Physiological incompatibility, as already stated, is alleged between medicines whose respective so-called "physiological" effects are mutually antagonistic. Such antagonisms are individual and peculiar, and are best discussed in connection with the individual medicines concerned. Two points alone are proper subject for mention in this place. The first is that *exact* antagonism in *all directions* of physiological action of drugs is very rare; and the second, that in practical prescribing, the fact of an antagonism need not preclude the proper conjunction of two antagonistic medicines in the same mixture. On the contrary, many of the happiest of medicinal combinations are of remedies more or less antagonistic in operation; this either because the antagonism is itself serviceable in mellowing a too intense action of the dominant antagonist, or because the drugs, though antagonistic in some lines, are synergic in others, and so together yield a resultant effect better for certain remedial purposes than the unmodified effect of either medicine used singly. An example of the former instance is the common combination of castor-oil and laudanum; and of the latter, the association of atropine with morphine. *Edward Curtis.*

INDIANAPOLIS. The accompanying chart, representing the climate of the City of Indianapolis, Ind., and obtained from the Chief Signal Office, in Washington, is here introduced for convenience of reference. A detailed explanation of this, and of the other similar charts published in this HANDBOOK, may be found in the article entitled Climate; where, also, the reader will find suggestions as to the method of using these charts. *H. R.*

Climate of Indianapolis, Ind.—Latitude 39° 46′, *Longitude* 86° 10′.—*Period of Observations, March* 1, 1871, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 703 *feet.*

	A			AA	B		C	D	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature.
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January....	26.2	34.1	29.6	29.9	45.9	20.0	36.5	21.4	69.0	44.0	20.0	−22.0	22	31
February...	28.8	38.6	33.8	33.7	42.2	21.2	43.3	26.8	72.0	55.0	20.0	−8.0	19	22
March......	35.4	45.8	39.7	40.3	49.9	35.0	49.9	33.6	77.0	62.0	24.0	9.0	27	25
April.......	47.4	59.3	51.3	52.6	58.6	45.8	61.4	43.7	85.3	71.0	35.0	19.0	17	23
May........	59.6	71.2	62.1	64.3	70.2	58.5	73.8	54.9	89.0	80.5	47.0	31.0	23	21
June........	68.8	79.1	70.1	72.6	76.7	69.6	80.1	62.5	96.0	89.0	62.0	45.0	20	19
July........	72.6	83.2	74.1	76.6	79.5	72.6	85.1	67.0	101.0	89.0	63.0	53.0	22	21
August.....	69.0	81.9	72.0	74.3	79.0	70.2	82.9	64.5	101.0	87.0	61.0	48.0	25	25
September..	59.3	73.4	63.5	65.4	73.5	61.7	74.7	56.7	94.5	80.0	48.0	35.0	25	18
October.....	49.5	62.2	54.1	55.2	62.3	49.8	65.3	49.1	86.0	75.0	39.0	23.0	21	19
November..	36.5	45.5	40.2	40.7	45.4	31.2	49.1	35.1	75.0	59.0	25.0	−5.0	21	21
December..	29.4	36.3	32.5	32.7	46.3	22.6	40.4	27.0	68.0	47.0	20.0	−15.0	21	26
Spring......	......	......	......	52.4	56.9	49.7	......	......	......	......	......	......	......	......
Summer....	......	......	......	74.5	77.1	72.2	......	......	......	......	......	......	......	......
Autumn....	......	......	......	53.7	58.8	49.4	......	......	......	......	......	......	......	......
Winter......	......	......	......	32.1	39.9	25.5	......	......	......	......	......	......	......	......
Year........	......	......	......	53.2	55.0	50.2	......	......	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind, in miles, per hour.
						Inches.	From	Miles.
January...	91.0	73.6	10.5	5.3	15.8	2.94	W.	6.4
February..	80.0	69.7	9.4	6.5	15.9	3.70	N.W.	6.5
March.....	68.0	67.0	10.6	6.5	17.1	4.22	N.W.	7.3
April......	66.3	59.4	13.0	7.2	20.2	3.49	N.W.	7.0
May.......	58.0	60.3	12.5	9.5	22.0	4.26	S.E.	5.7
June.......	51.0	67.6	13.8	6.6	20.4	5.56	S.W.	5.1
July.......	48.0	67.8	14.2	9.3	23.5	5.78	S.W	4.3
August....	53.0	68.5	14.1	11.0	25.1	3.31	S.	4.5
September.	59.5	68.6	11.3	12.0	23.3	2.59	S.	4.6
October....	63.0	67.3	12.7	9.6	22.3	3.47	S.	5 1
November.	80.0	69.9	10.2	6.1	16.3	3.89	N.W.	5.8
December..	83.0	73.2	10.1	5.2	15.3	3.33	W.	6.2
Spring.....	80.0	62.2	36.1	23.2	59.3	11 97	N.W.	6.7
Summer...	56.0	68.0	42 1	26.9	69.0	14.65	S.W.	4.6
Autumn...	99.5	68.6	34.2	27.7	61.9	9.95	S.	5.2
Winter....	94.0	72.2	30 0	17.0	47.0	9.97	W.	6.4
Year......	123.0	67.7	142.4	94.8	237.2	46.54	N.W.	5 7

INDIAN SPRINGS, GA. *Location and Post-office,* Indian Springs, Butts County, Ga.

ACCESS.—By railroad from either Macon or Atlanta.

ANALYSIS (J. R. Colting).—One pint contains:

	Grains.
Carbonate of magnesia	1.982
Sulphate of potassa	3.415
Sulphate of magnesia	71.528
Sulphate of lime	7.152
Total	84.077
Gases.	**Cub. in.**
Carbonic acid	1.000
Sulphuretted hydrogen	3.005
Nitrogen	0.156

Therapeutic Properties.—These are very valuable purgative sulphur waters, and enjoy a deservedly high reputation. *G. B. F.*

INDIAN SPRINGS, IND. *Location and Post-office,* Trinity Springs, Martin County, Ind.

Access.—By Ohio & Mississippi Railway to Shoals, thence nine miles by stage ; or by Louisville, New Albany & Chicago Railroad to Bedford, thence by stage.

Analysis (E. T. Cox).—One pint contains :

	Grains.
Carbonate of lime	4.138
Carbonate of soda	0.452
Carbonate of potassa	0.315
Carbonate of magnesia	2.368
Chloride of sodium	4.921
Chloride of magnesium	0.007
Sulphate of lime	2.529
Sulphate of soda	1.478
Sulphate of potassa	0.300
Sulphate of magnesia	3.799
Sulphate of alumina	0.104
Oxide of iron	trace
Iodides and bromides	trace
Silicic acid	0.056
Total	20.467
Gases.	Cub. in.
Carbonic acid	0.77
Sulphuretted hydrogen	0.25
Nitrogen	0.17

Therapeutic Properties.—This is a mild saline-sulphur water. The springs, five in number, discharge about four hundred gallons per minute, giving an abundant supply for bathing.

The hotel accommodates two hundred. *G. B. F.*

INDIGO, WILD (*Baptisia tinctoria*, R. Br. ; Order, *Leguminosæ*), a bushy perennial herb, with an upright branching stem about half a meter high, trifoliate leaves with obovate leaflets, and few-flowered racemes of yellow papilionaceous flowers. It grows abundantly in dry woods and pastures in the United States and Canada, and, when dried, the leaves and flowers blacken as the gerardias, Indian pipes, and other root-parasites do.

Wild indigo has a knotty woody root, ten to twenty centimetres long, with long, straight branches five or six millimetres in diameter ; root-bark dark brown, fibrous, easily separating ; odor none ; taste bitterish and slightly acrid ; the activity resides in the bark, the wood itself being tasteless.

Constituents.—*Resin*, and a not very well known *alkaloid*, whose chloride is crystalline, separated by Dr. F. V. Greene.

Action and Use.—This is another of the disagreeably violent or uncertain emetics and cathartics of which our native Materia Medica seems to be so prolific, and of which scarcely any have taken general hold of medical favor. It has had some vogue in fevers, in dysentery, and as a wash for ulcers, sore mouth, etc. It may be given, if desired, in decoction ; there is also a resinoid, "baptisin," in the market. Dose of the decoction ($\frac{1}{10}$), ten or fifteen cubic centimeters.

Allied Plants.—See Senna. *W. P. Bolles.*

INFANCY. The period of life comprised under the term infancy has been variously limited by different writers. Some include under it the first year only ; while a few have extended it to the end of the fourth or fifth. Probably the best limitation is that which includes under it the period from birth to the end of the first dentition, when early childhood may be said to commence. It is the period of life especially characterized by extreme frailty, rapid growth, and commencing development. Life at this time, therefore, possesses features of much interest. It is a period especially liable to disease, some of the manifestations of which are peculiar to it, such as rickets and laryngismus stridulus ; others, though similar to what we meet with in the adult, are more or less modified by the infant constitution. The mortality of this period is many fold what it is in later years.

Anatomical and Physiological Characteristics.—The first act of the *new-born* is to inspire. With that act the whole circulation is altered. For the first time a full current of blood distends the pulmonary arteries to meet air in the newly opened vesicles of the expanding lungs ; the thorax is enlarged, and the diaphragm and abdominal viscera depressed—all probably conspiring to assist the alteration of circulation. Thrombi immediately form in the venous and arterial ducts, and in the umbilical veins and arteries ; at the same time contraction of their muscular coat takes place, greatly reducing their calibre. In an infant thirty-six hours old, Vogel found the ductus arteriosus scarcely large enough to admit a probe. In time the vessels shrivel, and become converted into fibrous cords ; the gradual retraction of the umbilical arteries gives to the navel its peculiar shape. The foramen ovale closes more slowly. The border of the valve usually remains free for some months (Vogel), but the foramen is so completely covered that no detriment to the circulation ensues. As soon as respiration is established, the more or less livid hue of the skin, due to interference by parturition with the fœtal circulation, is exchanged for the deep red of the new-born infant. This fades in a few days, when the skin frequently assumes the yellowish hue spoken of as icteric. As to the true cause of this we are still in doubt. Apart from the yellow color of the skin, there are no other symptoms. It gradually disappears of itself, so that by the third week the skin should assume the rosy tint of healthy infancy. The fine, soft hairs which at birth cover almost the whole body generally fall out by this time, and are not renewed ; but feeble infants retain them longer. The long, strong hairs on the scalp, with which many infants are born, fall out at a later period, and are replaced by finer and generally lighter-colored hair.

For the first few months the *lachrymal* and *sudoriparous* glands have little functional activity ; it is almost impossible to produce sensible perspiration in an infant a few weeks old. After three months the secretion becomes freer, and in rachitic infants is often very profuse. The *sebaceous glands* in the earlier half of infancy are very active. The secretion of those in the scalp begins about the second month, to form the incrustation known as seborrhœa capillitii. It is developed gradually. At first the scalp over the vertex has the appearance of having been smeared with wax ; afterward a more distinct scab forms, of a yellowish-brown color. Portions can be easily removed by the finger-nail, when the subjacent skin will be found in a healthy state, not even congested. About the end of the first year the excessive secretion ceases spontaneously, and the scabs dry and crumble away. In healthy infants *fat* is abundant in the subcutaneous tissues, but generally absent from the interior of the body. The *muscles* in the new-born are small and soft ; not till after the sixth month are they felt firm and resisting. The *bones* contain a large percentage of organic matter.

The *secretions* from all the mucous membranes commence shortly after birth. The mouth and nasal cavities become moist, though sometimes imperfectly so. *Saliva* is also secreted, but apparently from the parotid glands alone (Jacobi), and the amount for the first two or three weeks is but one-tenth of what it becomes about the third or fourth month. Not till this time do the submaxillary glands begin to be active. The gastric follicles at birth secrete a fluid capable of digesting the casein of the mother's milk. The *intestinal villi* are abundant and large, even surpassing in size the corresponding structures in the adult (Berg), and contain large capillaries. The glands of Lieberkühn are present, but few in number and poorly developed. The same is true of Peyer's glands, which do not reach their development till after the early months of infancy are past. The secretion of mucus in the infantile intestines is copious. It readily ferments and becomes sour, neutralizing easily the feebly alkaline intestinal juices and the secretions of the pancreas and the liver (Jacobi). The secretion of the *pancreas* is for the first few months very deficient. The *liver* at birth is very large, occupying the greater half of the abdominal cavity, and early secretes a light-brown bile which gives to the fæces an orange-yellow color. The *meconium* is no longer considered to be simply an admixture

of bile with intestinal mucus, but is found to contain flat epithelial cells, which could not have originated in the intestinal canal, with fine hairs and fat-globules evidently cutaneous. The latter ingredients are supposed to be derived from the amniotic fluid containing some of the vernix caseosa in suspension. It is inferred that the fœtus has, from time to time, swallowed quantities of this fluid, the water of which is absorbed by the stomach, while the other ingredients pass through as indigestible substances.

Occasionally, in young infants, a very imperfect development of the muscular coat of the intestines is met with. This becomes a frequent source of colic and constipation (Jacobi). We note, also, considerable difference in the relative size of the several parts of the *alimentary canal*, as compared with those of the adult. The *stomach* at birth is small, less elongated, and situated more vertically. Thus emesis is much more readily produced. Digestion and peristaltic action are also much more rapid. Both *small and large intestines* are comparatively long. Treves gives the average length of the small intestine at birth at 9 feet 5 inches, and of the large at 1 foot 10 inches, and says that there is remarkably little deviation from these figures. During the first two months he reckons that the small intestine will grow about two feet per month, but after that period the development proceeds in a most irregular manner—depending upon the nature of the food, the vigor of the digestive process, and the activity of the abdominal nervous centres. It bears no relation to the general growth of the body, nor to the weight of the child. Of the large intestine, both ascending and transverse colon at birth are short, leaving the descending colon, and especially the sigmoid flexure, of great comparative length. For the first four months the growth in length is very slight; but a certain amount of readjustment appears to take place, by which the ascending and transverse portions increase at the expense of the sigmoid flexure. After four months it grows regularly and steadily. In a subject a year old, it measured 2 feet 6 inches (Treves). Occasionally this great length of the sigmoid flexure persists throughout infancy, seriously impeding the passage of the fæces and giving rise to constipation (Jacobi). At birth *the kidneys* are distinctly lobulated, but gradually change their form; so that, toward the close of infancy, they have the same shape as in adult life, although they are comparatively larger. The *renal secretion* commences early, even before birth. Occasionally it happens that during the first few weeks of life crystals of uric acid and urates, the result of the rapid metamorphosis of the tissues, are found in the urine. They excite more or less fretfulness in the infant, through their elimination, and stain the diaper, on which they appear as a pinkish-red powder. Not infrequently they are arrested in the tubules of the pyramids, where they are seen as pinkish-red spots or lines (uric-acid infarction). Pathological consequences are rarely attributed to them. Virchow, however, thinks that, in the fœtus, they may produce obstruction and inflammation of the renal tubes, and ascribes to them some instances of congenital cystic degeneration. During infancy the kidneys seldom undergo degenerative changes as in the adult, but they are liable to congestion and inflammation (Smith).

Circulatory System.—The blood of the new-born contains a large amount of hæmoglobulin (twenty-two per cent. of the whole solid constituents), but the amount of fibrin is small, and the comparative amount of blood in the body is said to be much less than it is in the adult. These conditions, however, soon change. The amount of hæmoglobulin at once begins to decrease, reaching its minimum about the sixth month, when the amount remains stationary until after the sixth year (Leichtenstern); after that it begins to increase again. The fibrin rapidly increases in amount. The infant, after the first few months, has more blood, in proportion to its weight, than the adult; but the blood is of low specific gravity (1.045 to 1.049), has less fibrin, less salts, less hæmoglobulin, less soluble albumen, and more white blood-corpuscles than that of more adult life. The large arteries in the newly born and infant are wide, but they do not grow equally, nor do they exhibit the same relative proportions that we meet with in the normal development of the adult. The subclavian and carotid, during the early months, are comparatively large in the infant, corresponding with the more rapid development of the head and upper extremities. The pulmonary artery is from two to four centimetres larger than the descending aorta—implying active work for the lungs. Although the arteries are large, the heart itself remains proportionately small. Especially is this the case in the first year; so that in the infant it would appear that growth and physiologically low blood-pressure go hand in hand (Jacobi).

The *pulse* of an infant is naturally quicker than that of an adult. Slight causes disturb and greatly accelerate it. Occasionally slight irregularity of rhythm is noticed. Owing to its extreme feebleness, observers have varied much in their statements as to its frequency during the first few weeks of life. The following table of statistics, by Dr. J. Lewis Smith, in which sources of error at the wrist were avoided by auscultation or palpation of the præcordial region, is apparently reliable:

TABLE OF INFANTILE PULSE IN HEALTH.

Age.	First week.			End of first week to end of first month.			End of first month to end of third month.			End of third month to end of sixth month.			End of sixth month to end of first year.		
State.	Asleep.	Awake.	Excited.	Asleep.	Awake.	Excited.	Asleep.	Awake.	Excited.	Asleep.	Awake.	Excited.	Asleep.	Awake.	Excited.
Number of observations ...	16	22	4	10	10	4	17	15	6	6	25	6	3	20	6
Extremes	108 140	104 152	140 160	104 144	124 160	146 162	104 132	112 148	144 180	104 116	112 146	132 156	....	112 144	132 198
Means	122	126	148	118	139	152	118	132	160	108	129	147	109	127	156

After the end of the first year the frequency of the pulse decreases rapidly. Toward the close of the period of infancy its average, in infants awake and not excited, is 95 to 105, in infants asleep, 90 to 95.

On account of the circular shape of the chest, *respiration* in the young infant is carried on almost wholly by the diaphragm, and is therefore described as abdominal.

Under the age of six months, respiration is apt to be irregular. Slight muscular efforts, and causes sometimes not appreciable by us, will suspend the breathing for comparatively long intervals. In the new-born, sighing is occasionally noticed.

M. Rogers, as quoted by Meigs and Pepper, gives 39 as the average number of respirations during the first week of life, and 35 as the average for infants between two months and two years.

Eustace Smith gives "40, or perhaps more," as the number of respirations in the new-born, but adds that they soon become less rapid. In reference to this quickened action of both heart and lungs, attention is drawn by Jacobi to the greater labor required of these organs in the infant as compared with the adult. Not only must their own development go on, but this increased action is demanded of them. Hence fatigue is more easily experi-

enced, and the greater necessity of sleep is readily explained.

Dr. Smith gives the following table as the result of his own observations on children under one year :

TABLE OF INFANTILE RESPIRATION IN HEALTH.

Age.	First half-hour.	First half-hour to close of first week.		End of first week to end of first month.		End of first month to end of third month.		End of third month to end of sixth month.		End of sixth month to end of first year.	
State.		Awake.	Asleep.	Awake.	Asleep.	Awake.	Asleep.	Awake.	Asleep.	Awake.	Asleep.
Number of observations	29	28	14	13	13	16	10	25	7	19	6
Extremes	25 104	32 64	40 64	40 96	28 60	32 68	28 52	36 88	24 40	28 64	24 36
Means	48.5	52	52	59	45	51	39	54	33	41	29

The *lymphatic* system in the infant is pre-eminently developed. The glands are numerous and large in size, and the intercommunication between them and the general system is more marked than at any other period of life. Brief mention may here be made of the thymus gland. At birth its weight and size are said to bear a proportion to the weight of the infant. It increases in size till about the close of the second year, when it ceases to develop ; then remains stationary, and after the eighth year rapidly decreases. Its functions are not yet ascertained.

Nervous System.—At birth the cerebral matter is soft in consistence and uniform in color ; not till after the close of the first month does the gray matter make its appearance on the convolutions. The centres in the medulla and spinal cord are in a much more forward state of development than those in the cerebrum, and throughout infancy maintain their functional superiority. In the spinal cord the centres of motion and circulation in the anterior cornua predominate over those of sensation in the posterior. Hence the greater reflex excitability of the nervous system in infants. So much is this the case that Virchow has termed them "spinal-system men."

WEIGHT AND GROWTH.—The average weight of the new-born babe, as ascertained by Dr. Kate Parker at the New York Infant Asylum, is found to be : Average male weight, 7 lbs. 11 oz.; average female weight, 7 lbs. 4 oz. Some enormous weights have been recorded. One recent case is mentioned in England, where the infant weighed 23¾ lbs on the day of birth. More interesting, perhaps, than actual weight at birth is the condition of gain or loss afterward. It is found that in a large number of infants, owing doubtless to delay in the supply of the mother's milk, there is more or less loss in weight during the first few days. Ingerslev, as quoted by Jacobi, states that, of 50 children raised at the breast, 47 lost in weight until the third day, and 33 did not begin to gain until the fifth. Children fed on cow's milk did not regain their original weight until the tenth day. Large children suffer less loss of weight and recover more quickly than small ones. In contrast to this, it is found that in the young of mammals which commence to take the dug immediately after birth increase of weight is immediate and uninterrupted.

The following are the results of the observations made at the New York Infant Asylum by Dr. K. Parker :

In 50 infants who were wet-nursed and well taken care of there was at the end of the week :

Increase of weight in 32 cases ; average gain, $4^8/_{10}$ oz.
Loss of weight in 13 cases ; average loss, 3⅓ oz.
Greatest gain, 12 oz. ; greatest loss, 6 oz

Average gain.

From birth to 4 months old (25 cases)...4 lbs. 8¾ oz., or 4½ oz. per week.
From 3 to 6 months (6 cases)...........3 lbs. $3^1/_6$ oz., or 4 oz. per week.
From 6 to 9 months (6 cases).........2 lbs. $7^1/_6$ oz., or 3 oz. per week.
From 9 to 12 months (6 cases)..........1 lb. 15½ oz., or 2½ oz. per week.

The infant grows most rapidly in the first few weeks of life. The increase for the first year amounts generally to from six or seven inches (Vogel) to ten (Schadow). Afterward the growth is less rapid. When about six or eight weeks old, the child begins to raise its head and turn it voluntarily toward a bright object. Not till about the seventh month does it learn to sit, and it is still later, toward the close of the first year, before the lower extremities are sufficiently developed to enable the infant to make some efforts to stand. Two or three months later it should begin to attempt to walk. Imperfect nutrition and diseases associated with it hinder growth, but the acute exanthemata sometimes appear to accelerate it. Growth does not always take place uniformly ; the head often increases more rapidly in size, but sometimes the extremities. When growth is too rapid, failure of strength, with more or less emaciation, may ensue.

About the sixth month *dentition* generally commences, with the eruption of the first pair of temporary incisors ; the remainder following in successive groups. The date of their appearance varies considerably in different children. Rapid dentition is generally accepted as the index of progressive, and delayed dentition as the evidence of retarded, development, but we cannot invariably draw this inference. Merei and Whitehead state that in seventy-nine per cent. of the well-developed the first teeth appeared before the eighth month had passed, while in sixty per cent. of those with unfavorable development the first were cut at eight months and upward. The following is the general formula for their appearance, as given by Routh : Anterior incisors, seventh month ; lateral incisors, ninth month ; anterior molars, twelfth month ; canines, eighteenth month ; posterior molars, twenty-fourth to thirtieth months (see article Dentition).

During the earlier months of infancy the *anterior fontanelle* remains open, and affords a fair indication : *first*, by its size, of the state of development in the cranial bones, and, so far, of the state of ossification in the body generally ; and *second*, by its condition, whether bulging or depressed, of the condition of the brain, whether congested or anæmic. It is said to be smallest in the newborn, gradually increasing in size up to the ninth month, when it remains stationary for two or three months, and then rapidly begins to close (Vogel). Between the fifteenth and eighteenth months, in healthy, well-developed children, it should become completely ossified.

The DEVELOPMENT OF THE SENSES AND MENTAL FACULTIES in the infant is an interesting study, to which comparatively little attention has been directed. For the following facts I am principally indebted to an article on the subject by Professor Preyer, of Jena (see *American Journal of Obstetrics*, April, 1881). The first movements of the new-born infant are either purely reflex, like its crying, or impulsive, and due to the unloading, in an objectless manner, of its "inherited provision of motor impulses." Sucking, however, is not a purely reflex act, but is instinctive ; otherwise the child would continue sucking even after its hunger was satisfied. Toward the close of the third month we get the first indications of an awakened will, in the holding erect of the head. Before that time, if the child be held upright, its head will fall to one or other side. This can scarcely be due to mere weakness of the muscles, for movements requiring more strength are made earlier. After it has succeeded in

balancing its head it will shortly attempt to sit, then to stand, and, later on, to walk. Voluntary grasping is not generally noticed till after the fourth month, and with it comes the knowledge of things apart from itself.

Sensation, both general and special, is at first very defective. The senses of taste and smell appear to be the first to make distinct and clear impressions on the mind. The new-born can distinguish between bitter and sweet, and the taste and smell of the milk first received remains firm, so that another is often tried only to be put away. Thus memory and judgment appear to arise first in the domain of these senses.

Hearing and sight are very deficient at first, but become afterward of much importance in development. All children are born deaf. Even the strongest do not notice a sharp sound earlier than six hours after birth. More frequently it is some days before we notice the sudden start at a noise. This deafness is explained by the fact that the Eustachian tube is closed until opened by the acts of breathing and swallowing; the middle ear contains no air, and the tympanum stands too obliquely. After the ear is complete, no organ of sense contributes so much toward mental development. Deaf children are much more backward than are the blind. The eye appears to be able to distinguish light from darkness almost from the first, but that is all, for the movements of the lids and balls are unsymmetrical. After the sixth week a bright light, if moved slowly, is followed with the eyes, which begin now to move symmetrically. It is only after the third month that we observe the quick closing of the lids on the approach of an object. After the sixth month the estimation of size, distance, and color becomes gradually developed. Not till after the third year are all the colors distinguished.

Speech is not inborn, but the tendency to it is inherited. At first only vowels are uttered, but after the first few weeks we can determine the mental state of the child from the different sounds that it makes. Gradually the voice becomes more modulated to suit the mood, and toward the end of the first year the child begins its first imitations of sound. The progress is more rapid after this, but for a long time the expression and gestures are the most important means of communication, and the words are merely accompaniments. Then one word is used to signify several thoughts, showing the growth of reasoning power. Two or three words are next joined together, and finally complete sentences are formulated.

All kinds of disturbances of speech in the adult have their counterpart in the child. In the one the functions are disturbed by disease, in the other they are not yet sufficiently developed.

Infant Mortality.—The high rate of mortality in infancy has been referred to and deplored by all writers on the subject. In England, out of 1,000 infants under one year, there die annually 141.8; in France, 223.2; in Italy, 273.3 (Farr). These are the mean rates for rural and urban districts. In large cities the rates are higher. In Paris, during the four years 1863–66, the mean annual death-rate of infants under one year was 290 per 1,000 living. In Berlin, in 1873, it reached 320 per 1,000, or forty-two per cent. of the total number of deaths; the general death-rate for the same year being 28.29 (Virchow). In Boston, with a general death-rate not exceeding 24.5 per 1,000, the mean death-rate of infants under one year, determined in the four census years 1855, 1865, 1870, and 1875, was 272.7 per 1,000 infants living, while for children under five it was 95.6. The same rates are more or less true at present for all our large North American cities. Curtis says that out of every hundred children born alive, about twenty-five die before the end of the first year, and from forty to fifty before reaching the close of the fifth year. This appears to be a somewhat high estimate for most of our cities, yet it is doubtless true in a few. In smaller towns, and in the country, the rates are very much lower, but even there the percentage of deaths occurring in infancy forms a large proportion. With each year's advance in age the liability to sickness and death rapidly diminishes. More than half of those who die under five years of age die in the first year (Jacobi).

Such high rates force themselves on our attention, and demand our earnest consideration of the causes that give rise to them. Can they be reduced? is the practical question with which we have to deal.

At the outset we notice that a certain small percentage of infants are born with vices of formation more or less interfering with life; cyanosis, spina bifida, hydrocephalus, meningocele, and some of the more important defects of the alimentary canal generally terminate life within the first few months. Even when no such defect presents itself, we must recognize the fact that life in the infant is of necessity very frail. The great and important changes which take place in the organism with the completion of birth and the rapid development which afterward ensues are both fraught with special dangers, even to those naturally healthy. In many, however, we have the added weakness involved in a hereditary disease. Syphilitic, scrofulous, and tuberculous taint in the parent most surely entail an enfeebled offspring, unless powerful preventive measures be taken. Even where we have no distinct diathetic disease to grapple with, general debility and many chronic affections in the mother affect the vitality of the offspring unfavorably, and render it more liable to succumb to disease. When we inquire into the special diseases that are most fatal in early life, we find that the great number of them may be referred to one of the following classes: 1. Acute zymotic diseases, among which the most important, on account of their frequency and great mortality, are measles, scarlatina, diphtheria, and pertussis. Of these, pertussis has its maximum fatality during the first year, measles in the second, and scarlet fever in the third and fourth (Farr). Unfavorable hygienic surroundings increase largely the mortality of these diseases by weakening the vitality of the infant, and, perhaps also, by increasing the virulence of the poison itself. Strict isolation and thorough disinfection must be demanded by the physician in all such cases. Anything less becomes culpable. 2. Diseases connected with a hereditary diathesis, such as the syphilitic, the scrofulous, and the tuberculous. Dr. Curtis estimates that from ten to fifteen per cent. of all deaths under five years must be assigned to this class. In many of these the physician may, by timely therapeutic or hygienic measures, avert the mischief, and it is his duty, as far as it is in his power, to insist that such measures shall be taken by the parent. 3. Inflammation of the respiratory organs, principally bronchitis and pneumonia, affecting chiefly children over one and under five years. Dr. Farr says that this class is the cause of nearly one-sixth of all the deaths under five. Dr. Jacobi estimates that 21 per cent. of all the deaths in the first year of life are due to this cause, and 36.5 per cent. of the deaths in the second year. In a majority of these cases the cause must undoubtedly be found in undue exposure to wet and cold, with insufficient covering to chest and extremities; the result of ignorance or vanity on the part of the parent. In a few poverty entails defective clothing, fuel, and house-shelter. 4. The diseases of the digestive system, including the diarrhœas. These, by reason of their frequency and fatality, are the most important of all the ailments of early life. Their common symptom is denutrition. Their common causation is a faulty dietary and bad hygienic surroundings. In the first year of life the deaths from this cause alone have been estimated by Jacobi at 40.89 per cent. of the total number occurring during that period. In the second year the mortality, though large, is not so great.

If, however, instead of considering the special diseases which lead to this black-list, we go deeper still into their etiology, the principal factors will be found to be as follows:

1. *Improper Dietary.*—From its earliest days the young infant should be nursed at its own mother's breast. Should that for any reason fail us, we have no perfect substitute. Maternal lactation furnishes fewer victims than either wet-nursing or artificial lactation (Busey). This is a fact that should be impressed deeply on the

mind of every mother. With wet-nursing, however, the results, as a rule, are good , but the difficulties connected with it appall many, or the expense quite places it beyond their reach. Practically, when maternal lactation fails, the only resort for the greater number is artificial feeding, with results that are in general the more disastrous the earlier recourse is had to it. Too often, through ignorance or carelessness, the infant is fed with food which the yet undeveloped or only developing glands in the intestines are unable to digest perfectly. Chronic inflammation, imperfect absorption, and defective nutrition are the result ; marasmus, diarrhœa, or cholera infantum the end. The great mortality arising from this source is well shown in the following figures, given by Professor Kehrer in his lectures on infant food : Of 8,329 infants, of six months of age and under, that died in Munich between 1868–70, 1,231, or nearly fifteen per cent., had been suckled, and 7,098, or over 85 per cent., had been brought up by hand.

2. *Impure Air.*—This is another source of deficient vitality and development in the young infant. The crowded tenement-house in the dark and filthy street, where the heavy atmosphere never gets thoroughly changed, the heated room in winter, with its vitiated and deoxidized air, are important factors in the production of disease in the adult, but much more in the frail system of the infant. Especially are the results disastrous when, in addition to general vitiation, the air is loaded with germs of decaying animal and vegetable material, as is so often the case during the summer months. These are absorbed, not only through the respiratory tract, but in the artificial food of the infant, and are a fruitful source of diarrhœas of all kinds. Milk and liquid farinaceous foods exposed to air containing these germs rapidly absorb them and become putrescent. Even where the milk or food is apparently fresh to the taste when taken, the introduction into the stomach of these low fungoid organisms in any amount initiates changes which completely arrest digestion. Still more disastrous are the effects when the germs are the result of defective drainage or sewerage. The imbibition of such is frequently followed by virulent inflammatory affections of the bowels, with, occasionally, symptoms of blood-poisoning.

3. *Extremes of heat and cold* raise the mortality tables. Routh, in his treatise on "Infant Feeding," says that among the most pernicious influences to young children we may include *cold*. An extreme fall in the temperature produces a decided increase of mortality, principally by disease of the respiratory organs. The same is, no doubt, more or less true with us, although our houses are better provided against an extreme cold than are the English ones. Here it is the extreme of *heat* which proves so disastrous. A very hot summer month will triple, or even quadruple with us the mortality of infants under one year although that of infants from one to five may be barely doubled. The increased prevalence of diarrhœal diseases during the summer will be in direct ratio to the intensity and duration of the heat-waves (Davis). This fatal influence of extreme heat and cold is well illustrated in the following tables, quoted by Dr. Busey for the City of Baltimore .

[Prevailing direction of winds in summer months, S., S.E., S.W. In report of deaths under one year of age, still-born not included.]

TEMPERATURE.

	Highest and lowest.								Mean monthly.			
	1875.		1876.		1877.		1878.		1875.	1876.	1877.	1878.
January	52	1	71	17	54	1	57	6	30.1	41.5	32.1	35.7
February	59	3	65	12	63	18	63	20	29.3	37.8	40 5	47.6
March	63	19	69	12	65	9	72	21	39.5	39 8	41.4	49.3
April	74	23	75	30	80	32	79	42	49.4	52.1	53.6	58.7
May	88	42	88	34	92	41	85	43	64.1	64.2	62.7	63.5
June	97	54	95	51	95	55	92	51	73.7	75.9	73.7	70.1
July	96	61	99	59	93	64	98	65	78 0	80.4	78.7	80.8
August	88	58	90	55	94	63	92	59	73.4	75.9	77.6	76.0
September	92	43	88	45	88	48	87	47	65.9	65.6	67.9	69.3
October	77	34	77	30	80	41	80	35	55.5	52.4	59.7	58.7
November	65	16	76	25	68	25	61	33	42.9	47.1	48.4	47.3
December	67	12	56	1	67	22	61	15	38.3	28.7	43.5	35.4

DEATHS.

	1875.			1876.			1877.			1878.		
	Under 1 year.	Bet. 1 and 2 yrs.	Bet. 2 and 5 yrs.	Under 1 year.	Bet. 1 and 2 yrs.	Bet. 2 and 5 yrs.	Under 1 year.	Bet. 1 and 2 yrs.	Bet. 2 and 5 yrs.	Under 1 year.	Bet. 1 and 2 yrs.	Bet. 2 and 5 yrs.
January	133	39	78	116	74	35	121	85	41	104	58	29
February	153	66	70	131	62	45	122	112	35	120	44	32
March	141	54	54	152	99	45	144	155	65	151	63	41
April	113	42	38	101	56	41	135	109	42	103	44	32
May	119	29	53	105	63	28	121	88	44	161	43	38
June	236	43	36	549	88	20	382	176	43	270	58	37
July	489	66	49	418	105	20	423	140	34	257	53	34
August	259	91	25	261	119	31	248	163	35	203	65	35
September	174	90	28	164	70	34	167	109	44	125	67	34
October	165	71	22	104	49	22	98	59	57	117	42	33
November	101	46	25	89	45	25	96	63	35	116	34	46
December	133	68	30	137	95	52	125	80	43	107	33	53
Total	2,216	705	508	2,317	925	398	2,182	1,329	518	1,834	604	444

INFANT HYGIENE.—For a few hours after the birth the mother requires rest, but after that the infant should be applied to the breast. Although the full supply of milk is not established until the second or third day, yet, in many instances, sufficient will be obtained to satisfy the infant, and artificial feeding of any fashion should then be discouraged. The frequency of application should be decided by the strength of the mother and the urgency of the infant. In most cases at this early period the infant does not require much, and three or four times a day seems to satisfy it. Should the influx be delayed a few days, and the infant be fretful, it would seem advisable to have it fed with a little cow's milk, mixed with three times its quantity of warm water and sweetened. For the first month it is difficult to obtain regularity in nursing, but care should be taken to let the mother know the importance of regular feeding, and that crying and fretfulness during the intervals are not due to hunger, but to colic, which will be aggravated in time by irregular nursing. After the second month an interval of at least two hours between each nursing should be insisted on for the day. During the night this should be lengthened to three or four. As the child grows older its stomach becomes capable of taking larger quantities at a time, and the intervals should be correspondingly lengthened to nearly four hours. But while regularity is required to insure good digestion and nutrition, mathematical exactness, as M. Douné has said, would be ridiculous. Quiet, natural sleep in a well-nourished infant should not be interrupted, unless it be very protracted. On the other hand, should the infant be ill-nourished and very wakeful during the night, too prolonged a sleep might be indicative of some passive congestion of the brain, and the need of increased nutrition, or even of stimulants. In such cases it will generally be found that the milk is deficient either in quantity or quality. The infant must, under such circumstances, be fed regularly at shorter intervals, and the character of its food must be improved. No fixed rule can be stated as to the proper time to allow artificial food in connection with breast-milk. While robust mothers, with an abundant supply of milk, can easily satisfy their infants up to the age of twelve or fifteen months, many begin to feel the drain upon them by the second or third. In others, the milk, though abundant, fails to satisfy and sufficiently nourish the child, and must be early supplemented by artificial food.

Bathing.—The first bath of the infant should be given in a warm room, free from draughts, and in water the temperature of 96°. The infant should be dried beneath some warm flannel covering. In general, nurses are not sufficiently alive to the necessity of preventing undue chilling of the surface. From the fifth to the ninth day the navel-string becomes detached, and not till that occurs is a general bath advisable. After that a daily bath, in water 92° (F), should be given. The temperature of the water, after the age of eight or nine months, may be lowered carefully to 90°, or 85°, according to the strength of

Infancy.

the infant and the vigor of its reaction. Too prolonged chilling of the surface during bathing and dressing is the frequent beginning of catarrhs of all sorts.

Clothing.—In the dressing of the new-born, care should be taken that there is no injurious dragging on the navel, that the usual band is not applied so tightly as to interfere with respiration or digestion, and that sufficient warmth be secured for the extremities. Later on the mother should be cautioned that none of the clothing press unduly on either chest or abdomen. All should hang loosely from the shoulders ; no compression of the vessels of the neck should be permitted, and the extremities should always be efficiently and warmly covered. No sudden changes in the amount or character of the clothing is, on any account, to be permitted. Special care is also to be given to the shoes. The leather should be pliable and the shoes made broad and loose about the toes, so as to allow freedom for movement and growth.

Sleeping.—For the first few weeks of its life an infant should sleep eighteen hours out of the twenty-four. As it grows older, it gradually requires less. A fretful and wakeful baby is ailing in some way, and the cause of its fretfulness should be found out and remedied. When possible, the nursery should be large and well ventilated. For the first few days of infant life it may be desirable that the room in which it is kept should be somewhat darkened, but after that, fresh air and sunlight should never be excluded. At the same time draughts and rapid changes of temperature are fraught with much danger.

Exercise is important, but the manner of it is equally so. No infant should be carried about upright until it is able to raise its head and rotate it easily ; nor should it be encouraged to walk or stand till nearly a year old, and if there be any tendency to rachitis this must be postponed still later. After an infant is three months old—a little later, in the winter season—it should be "short-coated," and the fullest liberty given to its arms and legs. It should be encouraged to lie on its back in its crib with loose clothes and enjoy, as it will do, the liberty of kicking. Every day it should be taken out regularly during the more suitable portion of the day, unless the weather be blustery. When it is sufficiently old, walking forms a pleasant exercise, but it should never be carried to the extent of much fatigue.

Weaning should, if possible, be effected gradually, and the digestive organs should be accustomed to some suitable artificial food before lactation is altogether stopped. Abrupt changes in its food try an infant's digestion, and frequently upset it. In selecting the time to make the alteration, attention should be given to the following points: 1. An interval between the eruption of the several sets of teeth should, if possible, be chosen, as we sometimes notice at these times irritation of the nervous system with hyperæmia and increased peristalsis of the alimentary canal. 2. It is never desirable to take the breast from an infant while it is sick, or recovering from sickness, unless it is manifest that the milk of the mother is injurious. Even an inadequate supply will often be all-important for the nourishment of such an one (Busey). 3. Regard must be paid to the season of the year. Any change during the hot months is very undesirable, and may be followed by a diarrhœa which may terminate fatally.

Artificial Feeding.—The problem how we can best supply nourishment to the young infant deprived, from whatever cause, of its natural and best food, the mother's milk, is one continually coming before us for solution. In the new-born the question is particularly difficult. The digestive glands at this time are only very imperfectly developed, and their secretion defective, both in quantity and quality ; so that all our imperfect substitutes for maternal milk are liable to irritate and disagree. Especially is this the case in warm weather and in unsanitary districts; most of all in the crowded wards of large cities, where the high death-rate from marasmus and diarrhœas of all kinds sufficiently attests our unsuccess. Even when we do succeed in rearing such, they are very apt to be delicate, tardy in dentition, and prone to manifest signs of rachitis or scrofula. As the infant becomes older and its glands are better developed, the power of accommodating itself to our artificial nutriment is much increased, so that the chances of an infant over three months thriving well on artificial food, given with care, may be considered good. The following table places these facts in a strong light. It is quoted by Dr. Busey as the results of the observations of Drs. Merei and Whitehead on 1,041 infants

1. Infants having had breast-milk *alone* to ninth month or longer.	Well developed, 62.6 per cent. Medium developed, 23.3 per cent. Badly developed, 14 per cent.
2. Infants who have had a *moderately abundant* supply of breast-milk with other food from birth or early age.	Well developed, 51 per cent. Medium developed, 25 per cent. Badly developed, 24 per cent.
3. Infants who have had a *scanty supply* of breast-milk with other food from birth or early age.	Well developed, 26.5 per cent. Medium developed, 26.3 per cent. Badly developed, 47.9 per cent.
4. Infants fed entirely by hand, with *no* breast-milk at all.	Well developed, 10 per cent. Medium developed, 26 per cent. Badly developed, 64 per cent.

These facts should be placed strongly before every mother. No effort should be spared to obtain an abundant and wholesome secretion of breast-milk, and every additional day we secure that for the infant is so much to its gain. Our task is not so difficult when we have merely to supplement the breast-milk in older infants, but even here care in the selection of its food, and regularity and cleanliness in its feeding are necessary.

In 1882 a special conference of the leading German pædiatricars was held in Salzburg, to discuss this problem of artificial feeding in infancy, and all the members agreed that some modification of animal milk formed the best substitute that we could have. In this opinion most of our best American authorities concur. The animals whose milk has been employed in this country are the cow and the goat. Goat's milk has the advantage, and that an important one, that in large cities, among the poorer classes, it can be obtained fresh night and morning ; even oftener if desired. It is also said to differ less in its composition from human milk than does that of the cow. Cow's milk, however, is much more abundant, more easily obtained, and is freer from any disagreeable odor, and is, therefore, the one in general use. Experience teaches us, however, that the milk of these animals must be modified to agree with the infant's stomach. Given pure, in most instances they early produce symptoms of indigestion, colic, vomiting, and curded motions, which, if continued, end in fatal diarrhœa or marasmus. The problem is, therefore, how we can best modify it that it may most closely approximate to this normal standard of mother's milk—*a*, in digestibility ; *b*, in nutritive qualities. Human milk has an average specific gravity of 1034.7, and is always alkaline. Cow's milk has a specific gravity of 1029, and is generally of a slightly acid reaction. The analyses of both are given variously by different writers. The following are the results of the latest researches of Leeds, and of König as quoted by him :

	Mean.		Minimum.		Maximum.	
	Leeds.	König.	Leeds.	König.	Leeds.	König.
Woman's Milk.						
Water	86.76	87.09	83.34	83.69	89.09	90.90
Fat...............	4.01	3.90	2.11	1.71	6.89	7.60
Milk-sugar........	7.00	6.04	5.40	4.11	7.92	7.80
Albuminoids.....	2.06	3.88	0.85	1.14	4.86	8.50
Ash	0.21	0.49	0.13	0.14	0.35	(?)
Cow's Milk.						
Water	87.70	87.41	....	80.32	....	91.50
Fat..............	3.75	3.66	. ..	1.15	....	7.09
Milk-sugar.......	4.42	4.92	....	3.20	....	5.67
Albumen	3.42	4.52	....	2.76	....	12.44
Ash	0.64	0.70	....	0.50	....	0.87

We notice, on comparing these two tables, no very great divergence between the two milks ; in both there is a good deal of variation in the albuminoids and fat, and much constancy in the amount of milk-sugar, and yet, supposing the albuminoids, fats, and salts represent the

same substances in both, not so much difference but that one might be substituted for the other without great harm resulting. But just there our knowledge is at fault, and our difficulty comes in, for, practically, we find that the two milks present entirely different results on the addition of coagulating acids—cow's milk, when so treated, yielding up four-fifths of its albuminoids as a rapidly forming and firm coagulum, very slowly dissolved by the gastric juice; while human milk yields hardly one-fourth of its albuminoids, in the form of a slowly forming and flaky coagulum, easily acted on by the ferments of the stomach, the other three-fourths remaining uncoagulated. In what does this difference in these albuminoids consist? Lehmann thinks there is little but what may be caused by the more or less alkaline state of the fluid. He says: "I have found woman's milk when acid yield a much thicker coagulum than when alkaline; and cow's milk when alkaline a much looser coagulum than when acid—facts which are of the greatest interest and value in relation to dietetics." But Biedert goes farther, and insists on a more radical difference. Besides this difference in the albuminoids, which must rank as the most important, we note also that cow's milk contains considerably less sugar of milk and a little less fat, so that, when diluted, this deficiency becomes very notable.

With these facts before us, we must endeavor to make the necessary modifications. Two ways have been proposed: The first is the chemical or digestive method; the second may be called the mechanical. By the first, recognizing that the important difference between cow's milk and human milk lies in the different reactions of the albumen, this ingredient is partially or entirely digested, and thus prevented from forming hard and indigestible coagula. One of the preparations of pancreatin, with the addition of an alkali, is probably the best method of accomplishing this. The following are Leeds' directions, as given by Lewis Smith: 1 gill of cow's milk, 1 gill of water, 2 tablespoonfuls of rich cream, 200 grains of milk-sugar, 1¼ grain of extractum pancreatis, and 4 grains of sodium bicarbonate. Put the above into a nursing-bottle, and place the bottle in water of a temperature of 115° to 125° F., and allow it to stand just twenty minutes, when it is ready to be given to the child. It should be prepared just before using. If allowed to remain too long it becomes bitter, and may on that account be refused. The mechanical method of altering the albumen is to dilute the milk with some bland and easily digested fluid, generally farinaceous, which, by mechanically separating the caseous particles, prevents the formation of large masses and enables the digestive fluids to act more readily upon them. This method was given to us many years ago by the late Dr. Meigs, with his emphatic recommendation, in the well-known formula of a weak solution of gelatine and arrow-root added to the milk, with the further addition of a little sugar and cream. This was altered by Jacobi, who substituted barley- or oatmeal-water for the gelatine and arrow-root, and with him it still remains a favorite formula. Though the albuminoid constituents in cow's milk form the chief difficulty in its assimilation by the child, the amount of the other constituents in the milk should not be overlooked, or the infant's nutrition will surely suffer. And as nature insists on keeping the sugar-supply a constant quantity, it will be inadvisable on our part to let it fail. In our directions cane-sugar is generally ordered, but it may well be doubted whether it is wise that it should be so, and, where practicable, sugar of milk should be used. To increase the quantity of the fats, which are also deficient, cream may be used in place of a portion of the milk. The whole fluid should be kept strictly alkaline by the addition of either lime-water or soda. Very recently Dr. Keating has been urging that a certain amount of a soluble salt of lime should always be added to an infant's food, to counteract the great tendency to rickets which exists in bottle-fed children; the lime-water frequently added is not, in his opinion, sufficient. He has therefore had some compressed tablets (*milk-food tablets*) made, each containing: Sugar of milk, 26 grains; calcis lactophos., $\frac{1}{6}$ grain; calcis carb., $\frac{1}{12}$ grain; sodii bicarb., $\frac{1}{2}$ grain; potass. bicarb., $\frac{1}{12}$ grain; sodii chloridi, $\frac{1}{6}$ grain. These are to be used as follows: To prepare the bottle for a child of a few weeks, take three ounces of boiling water and stir in one ounce of milk. To this add three tablets and dissolve thoroughly. Place the mixture in a nursing-bottle, and add two teaspoonfuls of cream. Shake well, and feed to the infant at about the temperature of the body. For an infant of a few months, two ounces of milk and four tablets are used in the above formula. Condensed milk is used largely in the feeding of infants, and has sometimes appeared to be of service in cool weather during the early months of infancy. One part of condensed milk must be reduced by fifteen of water at first, and gradually increased to one in ten. Jacobi recommends barley- or oatmeal-water for the purpose. The large amount of cane-sugar it contains is, however, very apt to disagree; producing acid fermentation and diarrhœa (Smith). The question here arises, Can we not obtain the same results without trouble by ordering some of the many proprietary preparations, especially such as are termed milk-foods? The fact that they are proprietary, and, therefore, secret preparations; that analyses by many able chemists have given very variable and not altogether flattering results; that they are liable to be old and musty, and that they are very expensive for the poorer classes, should, I think, make us resort to them with hesitation.

The *amount of nourishment* required by a healthy infant is a subject of interest, but cannot be made a matter of rule; some infants require much more than others to satisfy them. The danger in most cases is of overfeeding. To avoid that the infant should be fed regularly; allowed to satisfy itself at the time, and then allowed no more until the next feeding-time comes round. With care in this way overfeeding at any one time is avoided. Dr. Lewis Smith had some observations made at the New York Infant Asylum in reference to the amount of nourishment taken by healthy infants. It was found that the average daily amount for infants under four weeks was 13 ounces, with a maximum of 22.2 ounces for a child of five days and a minimum of 5.4 ounces for another of similar age. In another series, where the infants were from one to ten months old, the daily average was nearly 24 ounces for each child, with a maximum of 36.8 ounces for an infant of four months and a minimum of 12.2 ounces for one of six months. Biedert, also, has published some very interesting facts in a long article entitled "Weight Studies." In this he gives the conclusions arrived at from the systematic weighing of infants, as to how much food a child should have to thrive on. He asserts that a bottle-fed infant thrives best when the minimum amount of food necessary for development is given to it; and his studies were principally directed as to how much such required. His weighing showed that an infant of one month, 6 to 7½ pounds weight, requires only 5¼ to 6¼ ounces of cow's milk during the twenty-four hours; second month, 8 pounds weight, 10 to 22 ounces; in the third month, 3 ounces for every kilogramme the child weighs. The principal conclusions Biedert has arrived at are as follows: 1. Remarkably small amounts of nourishment, especially in the first few weeks, are sufficient for the good development of infants. 2. An increase in the amount of fat, considerably above what is contained in dilute cow's milk, spares albumen, makes digestion easier, and increases growth of child. 3. Sickly children must be fed with weaker preparations of milk, such as are suitable for infants of younger weeks. 4. Careful regulation is necessary, as the child has no instinct which guards against indigestible food or overfeeding. In the first months this regulation is of importance. Even breast-fed children are apt to drink too much then.

As the infant grows older, and its digestive glands become developed, a larger amount of farinaceous food may be allowed. A pap may be made of stale bread or biscuit boiled in water sufficient to cover it, and afterward mixed with fresh milk and sweetened. Better still is the food prepared from flour partially converted into glucose. This can be accomplished by boiling a few

pounds of dry wheat flour, tied up tightly in a linen bag, for three or four days, in water sufficient to cover it. Afterward the hard mass inside the coating of dough should be grated down and made into food in the ordinary way with milk and sugar. If a little malt extract be added, it is probably still more readily assimilated. Beef-tea and chicken or veal broth, with rice or barley in it, may be allowed toward the close of the first year for the midday meal. After the first set of molars are cut, well-mashed potatoes, with gravy juice or beef-tea, may be given, and a little variety allowed in the meals, but the full diet of the table should not be permitted till the close of dentition proclaims the full development of the digestive functions.

In the EXAMINATION of infants much tact and observation are necessary. All appearance of abruptness is to be avoided ; no harshness in voice or manner is allowable ; the physician's hands must be warm ; and a full supply of patience must ever be ready to be exercised if demanded. If the infant be asleep on the physician's arrival, it should on no account be awakened until he has seen its decubitus, counted its pulse and respirations, and noted their character, and made such other superficial examinations as are possible without disturbing it. The pulse and respirations in an infant just awakened are always extremely rapid. With regard to its decubitus, a healthy young infant in sleeping generally assumes the position he is supposed to have had in utero. An older infant, even if lying on its back, should incline its head to one side or the other, so that its cheek comes in contact with the pillow. If it be found with closed eyes and face directed straight upward, it is probably suffering from serious disease. If it be lying with its head retracted, cranial disease should be thought of. If it sleep on its belly, or resting on elbows and knees, it is probably suffering from abdominal discomfort. Healthy children should sleep quietly. Much tossing, any twitching of the muscles, or screaming and talking in sleep, indicate feverishness or digestive derangement.

Much may be learned from the character of the child's cry. Unappeasable screaming, without any other symptom, often results from earache. The temperature should always be taken with a sensitive thermometer ; preferably in the rectum, if not convenient there, in the groin. The armpit is not so good, as infants object to the necessary restraint of the arm. In many abdominal troubles the skin and extremities may be quite cool, yet the thermometer in the rectum show a temperature of 104° or 105°. The respirations, if practicable, should always be counted. At the first examination we should always insist on having the infant stripped, otherwise no thorough examination can be made. Care should, at the same time, be taken that the infant be not chilled by a too prolonged examination. Passing downward, we note : 1, Shape of child's head and state of fontanelle ; 2, shape of chest, character of the breathing, whether there be any retraction of chest-walls or intercostal spaces. With warm hands palpation should be made, and the expansion, and also the presence, if any, of rhonchal fremitus should be noted ; 3, shape of abdomen, whether protuberant or retracted, whether the walls are tense or lax. Gentle pressure may be made by the hand, and any tenderness of the abdomen or enlargement of liver or spleen detected.

In addition, the color and elasticity of the skin and the general nourishment of the tissues should be observed at this time. In auscultating the chest, the infant should be placed on the left arm of the nurse, leaning over her left shoulder, with its arms around her neck. In this way only are the muscles of the back equally relaxed and correct results obtained. Percussion should always be gentle. Immediate auscultation never gives the exact results obtained by the use of the stethoscope, but any painful pressure by the instrument must be carefully avoided. In infants, symptoms of disease are more frequently found at the back than at the front, and at the base rather than at the apex. Nevertheless, no part should be omitted in the examination. Inspection of the mouth and fauces should always be left to the last, as giving rise to more or less resistance. To effect this the infant should be seated on the nurse's lap before a bright window Sometimes with a little gentle pressure on the chin the mouth is opened and the tongue seen. To examine the fauces requires the use of a depressor, for which nothing is better than the smooth handle of a spoon. This can always be slipped in behind the teeth and over the tongue to its base. When the pharynx is reached the mouth involuntarily opens, and, if the physician be on the alert, a good view of the fauces is obtained. Lastly, the secretions should be examined, if in any way at fault. Trouble is sometimes experienced in obtaining the urine. If necessary, a small silver catheter may be passed and a sample drawn off.

In making our diagnosis and prognosis in infancy, the following points must always be remembered as modifying disease at this period :

1. The wide diffusion of symptoms met with at the outset of an acute attack.
2. The severity of the initial symptoms often bear no proportion to the gravity of the local lesion.
3. The extremely rapid rise and fall in the temperature of the body frequently observed.
4. The rapidity with which functional mischief may pass into organic.
5. The extent to which local disease is modified by certain diatheses.

For an account of the special diseases to which the infant and new-born are liable, the reader is referred to the separate articles on these diseases, and also to the article on Childhood, vol. ii.

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A. D. Blackader.

INFECTIOUS TUMORS. Klebs first proposed this name to designate a class of new-formations which have a certain agreement with each other in their histological structure, and are distinguished from other tumors not only by their close relation to inflammatory products, but also by their etiology. They comprise the tumor-like productions of syphilis (gumma) and tuberculosis (tubercle), farcy, actinomycosis, rhinoscleroma, lupus, leprosy, and, most probably, some forms of lymphoma. Virchow separated most of the members of this group from the other tumors, and gave them the name of granulation tumors. This name had especial reference to the tissue of which they were composed, which he very aptly compared to the granulations of wounds, with the difference that the cells did not advance far enough to form complete tissue, but their progressive metamorphosis was very early arrested and they underwent various degenerations.

Certainly not all the pathological products of syphilis, nor of tuberculosis, can with right be included with the tumors. The gumma has all the attributes of a true new-formation, and so has the nodular tubercle ; but most of the pathological changes produced by syphilis do not result in the formation of gummata, and the tubercle represents but a part of the pathological products of tuberculosis. All of these stand in very close relation to inflammatory

products. Most of the changes produced by both syphilis and tuberculosis are certainly inflammatory in character, and even the tubercle and gumma are always associated with inflammation. But this does not justify us in considering the gumma and tubercle as due to inflammation; we cannot attribute their formation to those vascular changes which Cohnheim has taught us to regard as pathognomonic of inflammation, nor can we trace the elements composing them to the white corpuscles of the blood. Then, too, those cardinal symptoms which, from the time of Celsus, we have always associated with inflammation are wanting in them, and we are unacquainted with any inflammatory changes which lead to the production of new-formations which are circumscribed and tend to a certain definiteness of structure. We find also, in the same diseases, changes which are undoubtedly inflammatory in character and where we have not the formation of tumors, and it is better to consider both the inflammations and the tumors simply as coeffects of the same cause.

In speaking of the tumors in general, we saw that many of them were in a certain sense infectious, in that they acted as foci of infection for the bearer. From one tumor a general infection of the body, leading to the production of similar tumors, could take place. They are, however, infectious only in this narrow sense; there is no example of a surgeon having infected himself with carcinoma while engaged in the removal of such a tumor, nor have they been communicated from person to person in any other way. The new-formations which we include under "infectious tumors" are infectious not only in the narrow sense in which the carcinoma is infectious, but they are inoculable. They can be transferred from person to person; and from a single case a whole family, or even a community, can be infected.

We are justified in believing that there exists, as a condition for their development, a virus, a true contagium vivum, and it is only by means of the transferrence of such a virus from person to person that the disease is produced. We find associated with most of these formations certain vegetable parasites, which are not only constantly present here, but which can be grown in suitable media outside of the body and the disease produced by inoculating with the parasite itself unassociated with the cells of the growth. Such parasites have been shown to exist in tuberculosis, leprosy, actinomycosis, farcy, and rhinoscleroma. In syphilis it is probable that the parasite has yet to be discovered, in spite of the assertions of various investigators, each of whom has his own special bacillus. There is, however, no reasonable doubt that the disease is caused in this way. We have placed lupus among the infectious tumors, although most dermatologists hold that it is non-infectious. We have done this because it agrees in its general histological character with the others, and its prevalence in certain regions points to the existence of a virus which may be miasmatic in character. Recently, however, almost undoubted proof has been brought forward showing that lupus is not a disease *sui generis*, but is a form of tuberculosis, differing from the ordinary tuberculosis in its little tendency to infect the general system. The proof of its tubercular nature is found not only in the similarity of its histological structure to that of tubercle, but also in finding the tubercle bacillus and in producing true artificial tuberculosis in animals by inoculations with its tissue.

All these tumors have a general agreement in their histological character. They are composed of small round cells, similar to those of granulation tissue; of large, pale, swollen cells, similar to the epithelium, and of very large protoplasmic masses containing numerous nuclei. The latter are most often found in tubercle, and, at one time, were supposed to be pathognomonic of this, but we know now that they may be found in any of the group. The large, pale cells are found in the greatest number in the leprosy nodules, and are always filled with the parasites which produce the disease.

There are, of course, differences in the various tumors both in size and appearance, and in the arrangement of their histological elements, their general size, relation to staining reagents, etc.; still it would be a difficult matter to give in a short definition the chief characteristics of each.

Degenerations are more commonly met with here than in any other tumors. They are chiefly fatty degeneration and necrosis; we find here, however, certain degenerations which seem to be specific. The tubercle undergoes a transformation into a dry, yellowish substance having a similarity to old cheese; hence the name which has been given it, "caseous degeneration." We meet in the gummata a product which is somewhat similar. It may be due, in part, to the occlusion of blood-vessels, thus cutting off all nourishment from the centre of the tumor, but, in part, it seems also to be the result of the action of the specific virus on the cells themselves.

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INFLAMMATION. It would be impossible to give any clear, simple definition which will embrace all of the pathological processes that are grouped under the head of inflammation. We have not to deal here with one single pathological process which always follows the same course, manifests itself by the same group of symptoms, and leads to the same results, but with a whole group of phenomena which might be separately arranged under other heads. The various pathological conditions which arise during or as the result of inflammation might be considered under the new-formations, under regeneration and degeneration of tissue, but especially under the circulatory disturbances. We shall see, as we go along, that the latter form the most important part of the process. Some authors, notably Perls, have thought it best to include each of the prominent processes involved under a separate heading, and thus to exclude the word inflammation entirely from medical nomenclature. But still the manner in which these various phenomena are grouped together, although individually differing in duration and intensity, lends to the whole inflammatory process such a distinct character that it will in the future, as it has done in the past, hold a distinct place in medical literature. In writing this article, we have thought it best not to attempt any general review of the literature, but to give some account of the various processes which constitute inflammation, together with the most prominent theories that have been advanced to account for them. Special attention will be given to those steps of the process which it is possible to follow directly under the microscope, as they are the most important for a general understanding of the whole subject, and by their study the most important results have been obtained.

When we observe a loop of the mesentery of a curarized frog under the microscope, taking pains not to put the membrane too much on the stretch, we see the arteries, veins, and capillaries of the part, with the blood flowing through them. With a power of sixty to one hundred diameters all the details are easily made out, the individual corpuscles are seen, and the white easily distinguished from the red by their difference in shape and color. The difference which the circulation presents in the different varieties of vessels is seen. In the arteries the flow is not constant, but proceeds in a series of pulsations, and is so swift that the individual corpuscles can only be distinguished in the intervals between any two succeeding pulsations. In the capillaries this pulsation is entirely lost, and the blood flows with a steady stream into the veins. The venous flow is constant, and not so swift as the arterial flow, even in the intervals between the pulsations. One feature is especially well seen in the veins, and to a slight extent also in the arteries. The blood-corpuscles are divided, the red being packed together in a solid red column in the centre of the vessel, while between this central column and the walls of the vessel there is a clear layer of serum in which the white corpuscles roll along with a motion that is much slower than that of the red. It is actually a rolling motion; they can be seen to roll over and over, like a ball rolled along the floor. The red corpuscles in the middle form what is called the *axial stream*, and the space between this and the wall of the vessel is known as the *plasma layer*. In

the capillaries there is no separation of the corpuscles, the width of the capillary being not much more than the diameter of the corpuscles.

In opening the peritoneal cavity, and exposing the mesentery, we have placed the membrane under abnormal conditions, and the effect of this soon becomes apparent on the blood-vessels. The first change that is noted is an increase in their calibre, which principally affects the arteries, the veins in less degree, and least of all the capillaries. This widening is at first associated with an increased rapidity of the blood-current, which becomes so swift that even in the veins the single corpuscles cannot be distinguished. This quickening of the blood-current is but temporary, rarely lasting more than half an hour; then it gradually becomes slower, much slower indeed, than the normal flow. This slowing of the current makes the pulsation of the arteries much more perceptible than it was at first; it extends to the finest arterial ramifications, and sometimes to the capillaries and through these to the veins. While these changes have been taking place, a special phenomenon becomes apparent in the veins. The plasma layer becomes crowded with white blood-corpuscles, which are so numerous that the vessel appears to be paved with them. The circulation in the vessel is slower than normal, and this slowness seems especially to be felt by these corpuscles; they roll slowly along, at times lying motionless along the wall, then again swept on by the current. In the capillaries, also, there seems to be a good deal of difficulty in the movement of the white corpuscles. One may become adherent to the wall for a considerable time and completely block up the vessel, producing stagnation, then it is torn loose and carried farther. Even the red corpuscles seem to have more attraction for the walls of the capillaries than they formerly had.

This condition lasts for a variable length of time, when it gives place to another, and one much more remarkable. *The white corpuscles pass through the walls of the vessels.* Though Cohnheim cannot be considered as the discoverer of this fact, yet he was the first to fully appreciate its importance, and through him it has served as a lever to overthrow most of the former theories of inflammation. The steps of the process can be easily followed. First, a small, colorless projection is seen on the outside of the wall of a vein opposite the point on the internal surface where a white corpuscle has remained clinging; this point, or bud, increases in size, processes of greater or less length are given off from it, the corpuscle inside the vessel becomes smaller and smaller until it totally disappears, and we see an irregular, colorless mass of protoplasm, containing one or several nuclei, in the tissue outside of the vessel. While we have been tracing the various steps of this process in one place, it has been going on all over the area; from both the veins and the capillaries there has been a constant exit of these corpuscles, until the tissue just outside of the vessels becomes filled with them. If we now inject the vascular system of the animal with a blue injection mass and stain the tissue red with carmine, we shall find the vessels represented as blue lines surrounded by a zone of cells which are stained a bright red. This escape of the white blood-corpuscles is only seen in the capillaries and veins; it never takes place in the arteries. In the capillaries another change is noticed which was not seen in the veins: not only do the white corpuscles escape, but at the same time a greater or less number of *red corpuscles* pass from the vessel into the tissue. The various steps of this process cannot be followed with the same ease as the escape of the white corpuscles, and it takes place later—when the capillary circulation is very slow, or when there is complete stagnation of the blood-current in these vessels. Many of the white corpuscles remain alongside of the vessels at the point where they have escaped; others, by means of their power of voluntary motion, wander farther into the tissue, or even through the endothelial layer to the free surface, where they may be seen still undergoing active amœboid movements. The red corpuscles, not having the power of voluntary motion, remain, for the most part, alongside the vessels.

Not only do the corpuscles thus escape from the vessels, but the fluid portions of the blood as well, and there is a decided increase in the transudation stream. By means of this the red corpuscles are often carried to a distance from the vessels and even on the free surface of the mesentery, which membrane is thicker and more voluminous than normal. Its tissue is infiltrated with fluid, and even with the naked eye we see that the serous surface is covered with a thick, white, fibrinous layer which can easily be scraped off.

This is the end of the process; the vascular changes which result in an acute fibrinous peritonitis have been described. The same changes are seen here which we find in the acute fibrinous peritonitis of the human subject—thickening, exudation, and cloudiness. The cloudiness is more perceptible macroscopically than microscopically, and can easily be shown to be due to the number of white corpuscles in the tissue. All these changes which we have described take a varying length of time for their full accomplishment, depending mostly on the care which we take in arranging the membrane for microscopical examination. When care is taken to keep the membrane in as natural condition as possible, and to protect it from drying by frequent irrigation with salt solution, it takes ten to fourteen hours before there is anything of an exudation on the surface. The membrane may be so much stretched or otherwise injured that in place of seeing, in turn, all these vascular changes—the increase in the diameter of the vessels, the quickening and then slowing of the current—a dilatation will be quickly set up which soon gives place, not to a slowing, but to a stagnation of the blood-current in the part. The escape of the red blood-corpuscles from the vessels is one of the latest events in the typical chain of inflammatory processes, and takes place better the nearer the blood-current in them comes to actual stagnation. The same series of phenomena may be studied in a much shorter time by touching the exposed mesentery with a crystal of nitrate of silver, but the effect of cauterization can be best studied on the tongue of the animal. The tongue may be stretched out by tying a thread to each of its posterior cornua, and then it should be lightly brushed with a solution of croton- in olive-oil (1 to 40). The changes which have been described in the mesentery will also be seen here. This irritating solution must only remain for a short time in contact with the mucous membrane, and then be washed off, or its action will be so intense that thrombi will at once form in the vessels of the part and all circulation cease. When the irritation only reaches the proper degree of intensity, we see almost at once an enormous dilatation of the vessels with a very much quickened blood-stream, which soon gives place to a slower current with the typical arrangement of the white corpuscles along the sides of the vessels. The escape of the white corpuscles from the vessels soon begins; and, as we have seen in the mesentery, the white corpuscles escape from the veins, and both white and red corpuscles from the capillaries. The tongue is red, swollen, and not so transparent as normal, and we see large quantities of both white and red corpuscles in its tissue.

All these changes can be studied better when the caustic is applied, not to the whole surface of the tongue, but to a small area. Here, of course, the most marked changes will be seen in the immediate area that was touched by the caustic, and as its action is slowly diffused we can see all the described changes, not successively, but all taking place at the same time. Three well-marked zones can be made out, the inner of which will be the place exposed to the most concentrated action of the caustic. In this there takes place at once an intense dilatation with quickened blood-stream, which soon gives place to a slower stream with an abundant escape of corpuscles. As the effect of the caustic increases, the slowing of the stream is succeeded by stagnation in a number of vessels, and the escape of red corpuscles is very rapid. Immediately outside of this area there is a zone where the circulation was normal for some time after the application of the caustic; then, as its action extended, there appeared, first, dilatation with increased rapidity of current, then slowing with

escape of corpuscles. Here the action of the caustic is so mild that stagnation of the blood is never produced, and the white corpuscles escape in greater numbers than do the red. Outside of this zone, again, there is another in which the action of the caustic has only been sufficient to produce in the vessels the first step in the inflammatory process, viz., dilatation with quickening of the current.

The cause of these disturbances in the circulation must be sought in some alteration of the vascular walls. These changes are of such a nature that they are only appreciable by their effects. There can be changes in the tissues, of a chemical or molecular nature, whose existence we can discover in no other way. The application of a concentrated mineral acid to the tissues will produce necrosis of all the parts with which it comes in contact; a weak solution of the same acid will have no effect. By constantly increasing the strength of the dilute acid, a point of concentration will be reached which will always produce a necrosis. It must be supposed that various changes are produced in the tissues by each application, and yet the changes which result in necrosis are the only ones which can be recognized. Cohnheim has shown that, by the application of various degrees of heat and cold to the ear of a rabbit, disturbances of various degrees of intensity can be brought about which chiefly affect the vessels. If the ear is exposed to certain degrees of heat or cold by immersing it in warm water or in a freezing mixture, the effect of this is shown only by a temporary acute congestion. By increasing the degree of cold or heat, or by prolonging the time of exposure to its influence, various other changes, even up to complete necrosis of the ear, can be produced. Beginning with the acute temporary congestion, we can have continued congestion, œdema, abundant extravasation, and hæmorrhage. In various other ways the blood-vessels may be more directly influenced. By the application of a ligature to the frog's tongue, and letting it remain a variable length of time, all the changes which we have described as making up the inflammatory process will be produced. Cohnheim ascribes the whole cause of inflammation to some alteration of the vessels, which is probably of a chemical or molecular character. If the alteration produced be but a slight one, it only shows itself in a temporary dilatation; if more severe, in a dilatation with slowing of the current and increased serous exudation; the next degree allows of the exit, first of white corpuscles, then of red; and, if the alteration is very pronounced, stagnation and coagulation of the blood. There is now little doubt that the non-coagulation of the blood during life is due to its continued contact with the living endothelium of the vessels. So soon as the vitality of the endothelium is destroyed the blood coagulates, and this necrosis of the endothelium represents the greatest injury that can be inflicted on the vessels. It will be well to consider more in detail the various changes which we have described.

The hyperæmia which is the first effect of abnormal conditions is well known. Any direct influence whatever on the vessels of a part is always answered by dilatation. This dilatation, though at first sight very similar to that produced by the effect of nervous influence on the vessels, can be shown not to be dependent on the nerves, and, indeed, it differs in many respects from that so produced. In the first place, it is more marked than the dilatation produced either by paralysis of the vaso-constrictors or excitation of the dilators. If the ear of a rabbit is inflamed by the application of croton-oil after the vessels have been dilated by section of the cervical sympathetic, the vessels will go on to a much greater degree of dilatation. This difference is well shown by cutting the sympathetic on one side, and exciting inflammation in the other ear; the difference between the two ears will be marked. When a part is removed from all nervous connection with the body, all the phenomena of inflammation can be produced, and will not vary in any degree from that in uninjured parts. This is the case when the rabbit's ear is ligatured or even cut through, leaving intact only the median artery and vein; and the same changes are seen in the frog's mesentery or tongue when the entire central nervous system has been destroyed. Possibly the great slowness with which inflammatory processes develop speaks more against their being the result of nervous influence than does anything else.

The separation of the white corpuscles from the red in the blood-current, the formation of the axial stream, and of the plasma layer, can be explained on mere physical grounds. The white corpuscles have a different specific gravity from the red, they are lighter, are of different shape, and cannot pack so closely together. Schlarewsky has shown that a separation takes place when wholly indifferent substances, of different specific gravity, are suspended in a fluid and caused to circulate in narrow tubes. He used oil-globules and carmine, or carmine and powdered graphite, which differed in gravity as the heavier red globules and the lighter white. By varying the quickness of the stream flowing through the tubes, a layer on the outside which contains only the lighter particles is produced. The slower the stream, up to a certain point, the clearer and more definite becomes this outside layer. When the same force is exerted on two bodies, one of which is heavier than the other, the heavier body takes up most of the force, as is well seen when a bullet is fired out of a gun and its flight compared with that of the wad which follows it. The red corpuscles travel faster than the white, and the resistance to their motion in the vessel, which comes principally from the attraction of the walls, is exerted less on them than on the slower-moving white corpuscles. As the stream becomes slower this attraction of the walls makes itself felt more and more, and the fact that the motion of the white corpuscles becomes constantly slower than that of the red would account for their excessive numbers in those vessels in which the circulation is slowest. The same number are constantly being brought to the locality, but the same number, in the same space of time, do not leave it.

The cause of the slowness of the blood-current in the inflamed area is due to some local opposition given by the vessels. They are dilated, and the pressure behind them, so far from being diminished, is, if anything, increased, and the opposition can only be found in an increased friction. The walls possibly lose their smoothness. That the friction is increased in these vessels is shown by the fact that it is much more difficult to inject fluids through inflamed vessels, and when the fluids contain suspended particles the difficulty is rendered even more evident.

The escape of white corpuscles from the vessels seems first to have been discovered by Waller, in 1849. He thought that the wall of the vessel disappeared before the cell that was pressing against it, and in this way a hole was made through which the corpuscles escaped and which afterward closed up. These observations of Waller seem to have excited but little attention at the time, even in England, where they were made, and only came to general knowledge after Cohnheim's publication on the same subject. The cause of this emigration is still in doubt. The amœboid movements of the corpuscles may have some effect, and it may be an active emigration; that substances which inhibit these movements have some effect in checking their passage, as has been claimed by some authors, would lend weight to this idea. Arnold has shown that the stomata which are present in the cement substance between the endothelial cells, in the normal capillaries, become larger in inflammation, and he supposes that it is through these openings that the corpuscles escape. Cohnheim thinks that their escape is nothing but a filtering process; that the vascular filter which ordinarily lets only the plasma pass is so altered by inflammation that the corpuscles pass through as well. That it is not the amœboid movements alone is shown by the fact that, under some conditions not connected with inflammation, we have the most vigorous amœboid movements in the white corpuscles in the vessels, and yet none will pass through the walls. This explanation would not hold at all in the case of the red corpuscles, which pass through the unbroken walls of the capillaries in greater numbers than the white, and which have no power of making amœboid movements. One element that is necessary for their passage is pressure in the vessels. If the blood-pressure is completely removed

from the vessels of an inflamed part, there will be no emigration. This would seem to be in favor of Cohnheim's idea of filtration.

In an acute inflammation of an external part nearly all of the changes which are produced will be included in the four symptoms described by Celsus—*tumor*, *calor*, *dolor*, *rubor*. The part will be swollen and elevated above the surrounding skin; the patient will complain of a sense of heat in the part, and if the hand is passed over it an increase of heat, as compared with surrounding parts, will be felt. The inflamed part will be painful and redder than normal. A fifth symptom has been added to the four described by Celsus, viz., a disturbance of the function of the part. It will be best to examine into each one of these symptoms more closely.

Calor.—John Hunter appears to have been the first to make any exact experiments in reference to the heat of inflamed parts. After drawing off the water of a hydrocele, he placed a thermometer in the empty sac, and found a temperature of 93° F. The next day, after an acute inflammation had been set up, he again introduced the thermometer, and found a temperature of 98.7° F. This was not at all in accordance with the views that were then held. It had been supposed that the heat of an inflamed part exceeded by a great deal the normal body temperature. These results of Hunter have since continued to be a matter of dispute; they were confirmed by some observers and denied by others. Baerensprung and Gierse made thermometric measurements of the inflamed skin, and they obtained results which seemed to show that the temperature of the part was above that of the general body temperature. Numerous other thermometric experiments have been made, but this comparatively coarse method of measurement has been superseded by measurements made with thermo-electric apparatus, and the results are in the main confirmatory of those of Hunter. The special advantages of this method over the thermometer are that, by passing the needles into the tissue, the temperature of deeply seated organs can be measured without any extensive operations being necessary, and without any exposure to the air, which must exert a disturbing influence. By passing one needle into the inflamed part, and the other into the corresponding normal part, exact comparisons can be made. Breschet and Becquerel, who first used this method of measurement, found in some scrofulous lymph-glands in the neck of a young woman 104° F., in the biceps of the same case 99.05° F., and in the mouth 99.5° F. Simon, and after him Weber, found that when the femur of a dog was broken, or when a deep-seated inflammation of the leg was produced by the injection of croton oil, there was a local increase of heat. Weber also obtained, in kidneys which were inflamed by the subcutaneous injection of cantharides, a temperature in excess of that in the spleen and in the deep-seated muscles. These experimenters went farther, and compared the temperature of the arterial and venous blood of the inflamed leg with the temperature of the inflamed area. Both reached the same results, and found that neither the arterial nor the venous blood is so warm as the tissue of the inflamed area, but that the venous blood flowing from it was warmer than the arterial blood. From this Weber concluded that the blood which passed through an inflamed part was warmed in its passage, and that we must regard the inflamed area as a source of heat. These results of Weber and Simon are not free from objections. Recent careful experiments have shown that there is no absolute constancy in the temperature of arterial blood.

In the small mammalia especially, very slight disturbances of the animal may alter the temperature very decidedly. It is possible to suppose that the inflamed part could have been raised to the temperature of internal parts by the more rapid circulation of the blood, and then, in consequence of tying the animal down, there was a sudden fall in the body temperature which was not so soon felt in the inflamed part. Whatever be the explanation of these results of Weber and Simon, experiments made by Jacobson and Landieu, with more exact and perfect methods, have shown that Weber's are erroneous. They found that, although there was often a difference of from 7° to 9° between the temperature of the inflamed and that of the normal ear of a rabbit, there was only a difference of three-fourths of a degree between the inflamed and normal part when the inflammation was seated in the deep muscles of the thigh. It was found that this difference in temperature existed only in the acute stage of inflammation, and that in extensive purulent inflammations in open wounds and ulcerations, so far from there being an increase of heat in the inflamed area, the sound side was actually warmer. Even when the inflamed part was at a distance from the surface, its temperature never reached the temperature of internal organs. Further experiments by Jacobson and Bernhardt have shown that the temperature of the inflamed pleura is never so much as that of the heart-cavities, and in most cases is even less than that of the corresponding healthy pleura. The truth of Hunter's law, that "in inflammation the heat of the part is increased above the normal temperature of the part, but not beyond the temperature of internal organs," has not been overthrown.

The increase of temperature in inflammation agrees entirely with the increase of temperature which is caused by variations in the movement and amount of blood in a part. Bernard has shown that the active congestion in a rabbit's ear caused by cutting the sympathetic raises the temperature 5° to 7°. No measurements of inflamed parts have given much greater values than this, and we cannot doubt but that the increase of temperature in an inflamed part is due wholly, or for the most part, to the increase in the rapidity of the blood-current. It is merely a matter of more heat being brought to the part, and the temperature of the venous blood coming from an inflamed area will be above that of the corresponding normal part because, owing to this same rapidity of flow, less heat is given off by conduction and radiation.

Rubor.—An inflamed part is redder than normal. The cause of this can only lie in the increased quantity of the blood—*i.e.*, red blood-corpuscles—in the part. The redness is much more perceptible in some parts of the body than in others. The idea was formerly held that this redness was too intense to be due merely to the dilatation of the normal vessels of the part, and that vasa serosa existed, which only became filled with blood in inflammation. We know that the capillaries occasionally do contract so much that the blood-corpuscles cannot pass into them, but this is only temporary; observation has shown that there are no vasa serosa, and the redness is due, certainly in the early stage of inflammation, simply to the dilatation of the arteries, veins, and capillaries. The intensity of the redness is, in general, directly proportional to the degree of vascular dilatation and injection. For the degree of color it does not matter whether the stream of blood in the dilated vessels is rapid or slow, since the color is determined by the number of red corpuscles in one place. The character of the circulation does, however, influence the quality of the redness. In some parts the dilated vessels can be seen with the naked eye; then the redness is spoken of as an injection. In the conjunctiva, where normally but a few scattered vessels are apparent, in inflammation numbers of large, tortuous vessels are seen; not only those normally visible are much larger and prominent, but many formerly invisible, when dilated, are large enough to be made out. In other parts, as in the skin, where the single vessels cannot be seen through the epidermis, the color is a diffuse red. The character of the color varies very much. In the beginning of an inflammation, when there is a rapid flow of blood through the dilated vessels, the color is a bright scarlet. When the circulation is much slower, and the blood remains in the part until it has been almost entirely deprived of its oxygen, the color may be almost cyanotic. Besides the vascular dilatation, there is another movement of importance in determining the color. There is nearly always in inflammation—always, if it be intense enough—an escape of red blood-corpuscles into the tissue. The greater the number of these the greater the degree of redness, but it is different with the increased transudation of serum and escape of white corpuscles.

The serum dilutes the color and the white corpuscles mask it, and the greater the amount of serum and white corpuscles the less intense will be the color. In a typical inflammation of the skin, as in a furuncle, the color is at first a bright red, then, as slowness of the blood-current takes place, the color becomes cyanotic, and this gives place to a grayish-red, from the heaping up of white corpuscles in the tissue. In an abscess the color of the red corpuscles is masked entirely by the white, and we find only a red zone in the periphery of the abscess. This inflammatory redness cannot appear in non-vascular parts, as in the cornea, in cartilage, etc., and may vanish entirely after death, especially from the outer surface of the body. After death from scarlet fever, or even erysipelas, the redness which was so distinguishing a feature during life may almost entirely vanish, only the few punctiform hæmorrhages being left.

Tumor.—This is, perhaps, the most marked of all the inflammatory symptoms. In the production of the *calor* and *rubor* the dilatation of the vessels played the principal rôle. Here it is of but minor importance. That it cannot be entirely overlooked in reviewing the causes of the swelling is shown by the beautiful experiments which have been made with the plethysmograph. The swelling is due principally to the increased transudation. From the direct observation of the inflamed mesentery and tongue, we could only follow with the microscope the escape of the corpuscular elements of the blood, and we concluded that there must also be an increase in the transudation, because the amount of swelling of the parts was greater than would be occasioned by the corpuscles. This amount of fluid in the tissues might be accounted for in two ways—either there must be an increase in the transudation stream, or it does not exceed the normal limit and from some impediment in the lymph-stream it is not carried away. A very simple experiment suffices to show that this latter is not the case. If a cannula be placed in one of the chief lymph-vessels of the leg of a dog, and then an acute inflammation be excited in the foot by the injection of croton-oil, or by placing the foot in hot water, it will be found that the flow of lymph is enormously increased; not only is the lymphatic circulation not impeded, but even double or threefold the normal amount is carried off, and still we have the swelling showing how great the transudation has become. How the exudation (the corpuscular elements with the fluid) is situated in the tissues depends upon the anatomical structure of the part. The so-called parenchymatous organs—muscle, liver, kidneys, etc.—become diffusely swollen, and the extent of this swelling depends on the amount of exudation. It is situated in the meshes of the interstitial connective tissue, because this carries the vessels and is more easily distended. In such organs the swelling is also in part due to the increase in size of the proper tissue-cells, a circumstance which will be considered later. In tissues which are entirely composed of connective tissue, the exudation simply collects in the lymph-spaces and distends them. In all cases it collects where the least resistance is offered to its presence. If the superficial vessels of the skin are affected, the fluid collects beneath the epidermis, which it raises up, forming a blister; it can do this more easily than it can distend the dense tissue of the true skin. If the deeper vessels are affected, the exudation collects in the subcutaneous areolar tissue.

On mucous surfaces the epithelium does not offer the same resistance to the passage of the fluid parts of the exudation that the skin does, and here it comes on the surface. The same is true of serous surfaces. In inflammations of the pleura and peritoneum the membrane is distended by the fluid, but the greater part collects in the cavities which the serous surface lines. In a pneumonia, though the walls of the alveoli are distended, still the bulk of the exudation is found in the air-vesicles of the lung. In the earlier stages of an inflammation the exudation is very poor in corpuscular elements, and has great similarity to the ordinary transudation which we find in dropsy. When it has accumulated in loose connective tissue, as in the skin, it can be removed from one place to another by pressure. Chemically, it differs from the serous exudation. Lassar has made numerous chemical analyses of the lymph obtained from the lymphatics of the leg after an acute inflammation of the foot has been excited. In all of his experiments he found the amount of solids enormously increased. In human inflammatory lymph a solid residue of six to seven per cent. has been found. This increase in the solids is due almost entirely to the increase in the albumen, the salts being in about the normal proportion. The increase in the solids forms the chief difference between the inflammatory lymph and the dropsical, the former being very rich and the latter very poor in solid matter; the normal lymph standing about midway between the two. In no way is the difference so clearly shown as in the little tendency that the dropsical lymph has to coagulate, while the inflammatory coagulates in a short time to a hard, firm jelly. The causes which bring about the dropsical accumulations in the tissues and those which bring about the inflammatory are totally different. In an ordinary dropsy, not dependent at all on changes in the quality of the blood, the accumulation of fluid in the tissues is due to increased venous pressure. There must be some re-

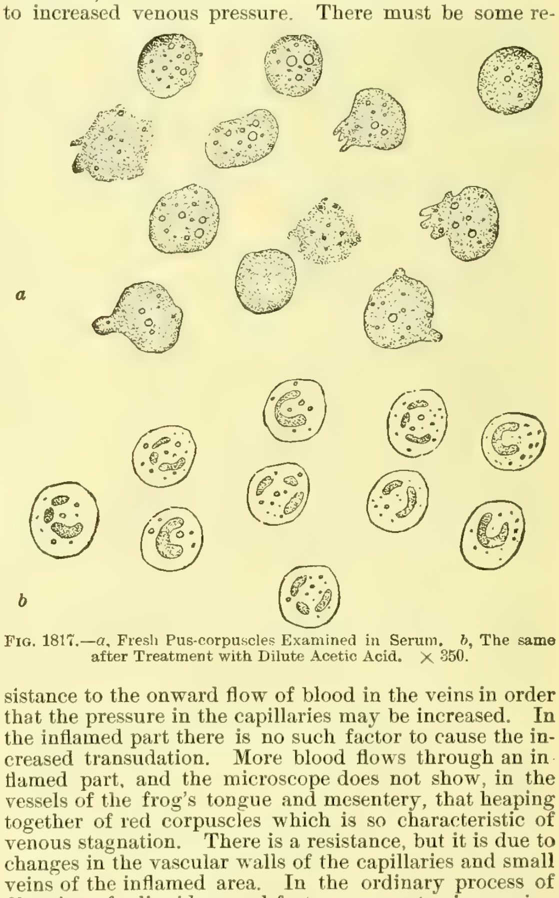

FIG. 1817.—*a*, Fresh Pus-corpuscles Examined in Serum. *b*, The same after Treatment with Dilute Acetic Acid. × 350.

sistance to the onward flow of blood in the veins in order that the pressure in the capillaries may be increased. In the inflamed part there is no such factor to cause the increased transudation. More blood flows through an inflamed part, and the microscope does not show, in the vessels of the frog's tongue and mesentery, that heaping together of red corpuscles which is so characteristic of venous stagnation. There is a resistance, but it is due to changes in the vascular walls of the capillaries and small veins of the inflamed area. In the ordinary process of filtration of a liquid several factors may enter in causing a difference in the filtrate obtained. It will vary with slight changes in the character of the liquid; its quantity will be raised or lowered with differences in pressure, and, most important of all, with differences in the character of the filter. We can have dropsies from a change in the character of the blood, as in profound anæmia, from increased pressure in the capillaries; and since in inflammation we do not have either of these, the increase in quantity and in chemical composition of the filtrate must be due to changes in the filter, *i.e.*, the vascular walls of the capillaries. Microscopically, the inflammatory exudation differs markedly from the ordinary transudations. In inflammations of different character and in-

tensity the character of the exudation also differs, and it is on these differences in the character of the exudation that the best classification of inflammation rests. The corpuscular elements are always increased, sometimes to such a degree that the exudation has a thick creamy consistency. The chief cellular elements which are found in the inflammatory exudation are the so-called pus-cells. In a fresh exudation they appear as round or irregularly shaped cells of the size and general appearance of white blood-corpuscles. In the perfectly fresh state, examined in a medium normal to them, their protoplasm is finely granular, with here and there a well-marked oil-globule. They may differ considerably in size, form, and composition—some are finely granular, others contain coarse granules and numerous fat-drops, others again foreign matter with which they may have come in contact. On staining them with almost any reagent their nuclei are brought plainly into view. The nucleus presents many peculiarities which serve to distinguish the pus-cell from all other cells, except the white blood-corpuscle. It is sometimes single, more often multiple, two or three being found in a single cell. When the nucleus is single it is elongated and doubled up in the cell, something in the shape of a horse-shoe. When multiple, the single nuclei are grouped so as to form the same sort of a figure. They always stain more brightly than do the nuclei of the tissue-cells. When the cells are treated with dilute acetic acid the protoplasm is made clear and transparent, bringing the bright, sharply refractive nuclei into view. In all these particulars they agree exactly with white blood-corpuscles ; they are of the same size, of the same general shape, and the arrangement of the nuclei is the same in both. When the exudation is fresh it contains quantities of such cells, later they undergo certain changes which will be considered further on.

The fourth symptom of Celsus is *dolor*, pain. This is very easily accounted for. It is due to influences exerted on the sensitive nerves by the exudation. It may be pressure on them, or tearing and stretching. It varies much in character, may be dull, burning, or throbbing. It is always most severe in acute inflammations, and in parts richly supplied with nerves. When the exudation collects beneath a dense membrane and forces this up, as is the case with inflammations of the periosteum, the pain is often most intense. It is one of the most constant of the symptoms of inflammation, and one whose cause is apparent.

The fifth symptom, one which has been added to the four of Celsus, is the lesion of function. When the other four symptoms are present, it can be readily seen that the function of the part must be interfered with. Any of the series of processes which make up inflammation must, of necessity, exert more or less influence on the function of the inflamed part. This interference with its function will affect the general system in proportion to the importance of the part. An interference with the function of the lungs or heart will, of course, have more effect than an interference with the functions of the eye.

In any inflammation some of these symptoms that Celsus has described must be present, though it by no means follows that all must be, and a review of what takes place in inflammation will show when these symptoms will be present and when absent. In parts where the distribution of sensitive nerves is very poor, or where the anatomical structure of the part is such that they are not compressed or stretched by the exudation, an inflammation may be attended with little or no pain. In inflammations of internal organs no increase of heat can be brought about by rapidity of the circulation. In parts where there are no vessels the inflammatory redness will be wanting, and in parts where a free way is given for the removal of the exudation as soon as it is formed, even the swelling will not appear.

The presence of the pus-cells gives to the inflammatory exudation a character differing from all other fluid accumulations in the body, and most of the literature on inflammation in recent years has been taken up with the question of their origin. This question has, indeed, overshadowed other and, for the most part, more important questions. Rokitansky was one of the first to enter this field of literature. He, in accordance with the cell-theory that was held at his time (the theory of free-cell formation), supposed that the first step in their formation consisted in the sweating out of a fluid from the blood-vessels. This fluid was the blastema, or mother-fluid, and in it the cells were formed. He describes in full their formation, by the aggregation of small particles which appeared in the fluid ; the nucleus was first formed, and by collection of the granules around this, the protoplasm of the cell. Virchow overthrew this idea of their formation in the general overthrow of the free-cell formation, and substituted for it another theory. But this theory of Virchow, although better than that of Rokitansky, cannot be regarded as correct. According to Virchow, the pus-cells are derivatives of the normal cells of the tissue in which the inflammation has its seat, but not all of the cells of the tissue take an equal part in their formation. He regarded the connective tissue as the mother-tissue in all new-formations, and said that in inflammation the connective-tissue cells, under the influence of the stimulus which was given by the inflammatory irritant, proliferated, and as the result of this proliferation the pus-cells appeared in the tissues. Virchow was the first, also, to call attention to the similarity between the pus-cells and the white blood-corpuscles. The vascular changes in inflammation were regarded by him as secondary to the tissue-change, and were of such a nature as to bring more nutritive material to the inflamed parts.

Of late Stricker has become the most strenuous advocate of the view of Virchow, and this theory has undergone some modifications at Stricker's hands. He says that the tissue-cells, under the influence of the inflammatory irritant, return to their former undifferentiated embryonic condition, and then rapidly proliferate, forming similar cells. Not only do the cells thus proliferate, but young cells are also formed from the non-cellular portions of the tissue. He refuses to regard the cells of a tissue as the only active part, and does not make the distinction between the cells and the non-cellular tissue, the result of the formative activity of the cells. This is opposed to the cell-theory of Virchow and to Beale's theory of bioplasm, and comes nearer the old theory of free-cell formation. The only difference between this theory and that of Schwann and Rokitansky is that in the old theory cells were formed from an exuded mother-liquid. A great deal of work has been done by Stricker and his pupils in support of his peculiar views relative to inflammation. He claims that every tissue—even one so highly differentiated for a particular purpose as the central nervous system—can return to its embryonic condition and proliferate, under the influence of the inflammatory stimulus. The distinction between so highly differentiated a mass of protoplasm as the cells of the central nervous system and the cells in the first few days of embryonic life is greater than the difference between so complicated a unicellular organism as a vorticellum and a simple amœba. In the nerve-cell we have a structure which differs from the embryonic cell not only morphologically, but chemically and functionally. It seems almost absurd to suppose that a structure which has been the result of modifications carried up through countless generations of cells could in a moment be lost. He regards embryonic formative activity as a force stored up in every cell, just as force is stored up in the bent bow. The mysterious inflammatory stimulus, the irritant, the "Reiz," acts as unloosing the string of the bow sets the arrow free. From the undifferentiated protoplasm into which not only cells change, but tissue as well, repair can take place, and any sort of tissue be formed when the inflammation subsides. It seems to us that it would be almost as absurd to suppose that the vorticellum, under the influence of a stimulus of any kind—chemical, mechanical, or thermal—could return to the condition of the amœba, as that the central ganglion-cell could return to its embryonic condition. One is the result of a differentiation of protoplasm which has taken we know not how many centu-

ries for its accomplishment, while the other has taken months, and in the case of man years, for its completion.

All this is assuming that the pus-cell and white blood-corpuscle are purely undifferentiated embryonic cells. But in the case of both, if we can rely at all on morphological differences, there has been a differentiation. The white corpuscle has a nucleus that is characteristic; in no embryonic cell, at any period, do we find this horse-shoe nucleus. There is no analogy for this return of cells to their embryonic condition, this rejuvenation of the tissues, given in any process, whether physiological or pathological, that we are acquainted with. According to Stricker, the vascular changes were also a part of this rejuvenation process. He was probably the first one to show that the capillaries were composed of protoplasm, and he supposes that they also return to their embryonic condition, that their cells become amœboid and rapidly proliferate. Stricker does not deny the emigration of the white corpuscles from the vessels, but says this is of but little importance in the inflammatory condition. We have given some space to this theory of Stricker, for his ideas have gained considerable credence, especially in this country.

The theory of Cohnheim is exactly opposed to the theory of Virchow and Stricker. According to Cohnheim, the vascular changes, the dilatation of the vessels, the slowing of the blood-current, and the escape of white and red corpuscles, *these* form the essential inflammatory phenomena.

These various theories being held, the non-vascular tissues were taken up and the inflammatory processes studied on them. For it was argued that, as there were no vessels in these tissues, all the changes produced by inflammation must result from the action of the tissue itself. The cornea was the tissue most generally selected for study, and there is no question in pathology which has been so generally discussed, and on which so much experimental work has been done, as that of the origin of the pus-cells in an acute keratitis.

It was found that after the application of an irritant (nitrate of silver was the one most generally used) to the cornea, the tissue became cloudy and opaque, and on microscopic examination it was seen to be full of pus-cells. It was argued that these cells could only result from the change of the connective-tissue corpuscles into pus, for there were no vessels in the cornea from which the cells could come. Cohnheim then showed that when the irritant was applied to the centre of the cornea, the cellular infiltration did not begin here, but was first observed around the scleral edge. At the point of irritation there was at first no infiltration, and no change in the corneal corpuscles. He sought the explanation of this in the fact that the influence of the irritant extended to the vessels in the sclera and conjunctiva, and produced in these the vascular changes which we have described. There was an emigration of white corpuscles here, and they afterward made their way by passage along the lymph-spaces into the cornea.

It would perhaps be well to say here a word about the peculiarities of corneal structure. The cornea is composed of dense connective tissue arranged in parallel layers, between which are irregular spaces in which the connective-tissue corpuscles lie. The spaces have the general shape of a hand with the fingers extended, and vary much in different animals. In some they have very broad communications with each other, in others the communications are very narrow. They can easily be shown in any animal by staining the tissue with nitrate of silver, which acts only on the tissue between the spaces, staining it brown. The spaces are visible because left uncolored. These spaces connect with the lymphatics in the tissue outside of the cornea. In addition to these lymph-spaces, the larger of the nerve-bundles which enter the cornea are surrounded by a lymph-sheath which commmunicates with the lymph-spaces.

It is a well-known fact that the white corpuscles have the power of taking up into their substance small insoluble particles of various kinds, such as carmine and vermilion, when these are injected into the circulation. Cohnheim found that when an inflammation of the cornea was produced after vermilion had been injected into the blood, the pus-cells in the cornea contained this pigment, and it could only have gotten into them by being taken up by some cells which were circulating in the vessels, for the insoluble granules could not of themselves have gotten out of the vessels. Hoffman found that, when the cornea was inflamed, if the head was immediately cut off and preserved in a moist chamber, under as natural conditions as possible, changes were found in the cornea in every way similar to those found in the living animal. Of course, in such a case there could be no question of white corpuscles escaping from the vessels and wandering into the tissue. These results of Hoffman have never been confirmed, and it is difficult to see how there could have been growth and reproduction of cells in a tissue from which all the nutrition had been cut off. Various observers have described numerous changes in the connective-tissue corpuscles, which terminated in the production of pus-cells. According to most of these observers the corpuscles draw in their processes, and become changed into round protoplasmic masses which then divide up. Böttcher has succeeded, by the use of mild caustics, such as chloride of zinc, in producing a central

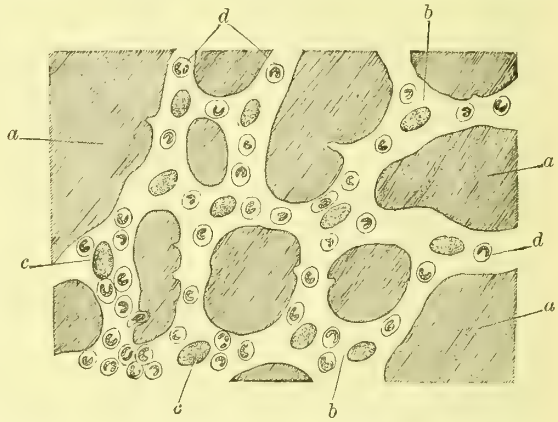

FIG. 1818.—Scleral Edge of Cornea Fifteen Hours after Central Cauterization. *a*, Ground substance of cornea, staining brown with nitrate of silver; *b*, cell-spaces in the tissue which have become dilated; *c*, nuclei of corneal corpuscles; *d*, *Wander zellen*, pus-corpuscles, lying in the cell-spaces with the unchanged corneal corpuscles. Silver and carmine preparation. × 250.

keratitis, with an infiltration of cells around the centre, without any involvement of the scleral edge.

Stricker finds in keratitis strong grounds in favor of his views. He says that when the cornea is treated with nitrate of silver, forty-eight hours after central cauterization the tissue around the eschar is divided up into small areas by narrow silver lines, not unlike the lines between endothelial cells. These, he supposes, arise from the formation of these cells from connective-tissue corpuscles and the corneal substance. The whole subject of keratitis can best be studied, and the changes most easily understood, by staining the tissue with nitrate of silver and carmine. In this way both the spaces and the cells which occupy them are rendered visible. Fifteen hours after an acute inflammation has been set up, three distinct zones can be recognized. First, a central one, where the tissue has been totally destroyed by the caustic. No structure can be seen here, nothing but a black eschar. Outside of this will be found a zone, more or less wide, where some traces of the cell-spaces will be seen, but no cellular elements, neither pus-cells nor fixed connective-tissue cells. Outside of this again comes the uninjured corneal structure. At this early period we find the cell spaces near the scleral edge widened and filled with cells. Each nucleus of the pus-cells is distinct and easily recognized from its shape. The cell-spaces also contain the fixed connective-tissue corpuscles, in which no change can be made out. The picture is different when forty-

eight hours have elapsed. At this time the whole of the normal corneal tissue is filled with cells. They are found here in various situations. Not only are the cell-spaces very much enlarged and filled with them, but they are also found in the lymph-sheaths of the nerves. They occupy various positions in the spaces—sometimes lying alongside of the fixed cell, or even enclosed in its substance, or they may be seen in the narrow communications between adjoining cells, as though fixed in the act of passing from one cell-space into another. Some also are found in the corneal tissue outside of the cell-spaces, where they appear as long, thin rods between the fibres. The most cells will, however, be found in the area just outside of the central eschar, in the place where, as we have seen, there were no living corneal corpuscles. Stricker saw these cells here, and concluded that they were formed from the fixed corpuscles. With regard to the central inflammation without involvement of the scleral edge, Senftleben has found that such appearances were only produced when the epithelium was removed and the corneal tissue injured. Even these cells do not arise in the centre, but wander into the tissue from the conjunctival sac. This always contains a certain number of white corpuscles, and the number of these is much increased by the slight conjunctivitis caused by the cauterization of the cornea.

One experiment which was made by Senftleben seems to set at rest any idea of the participation of the fixed

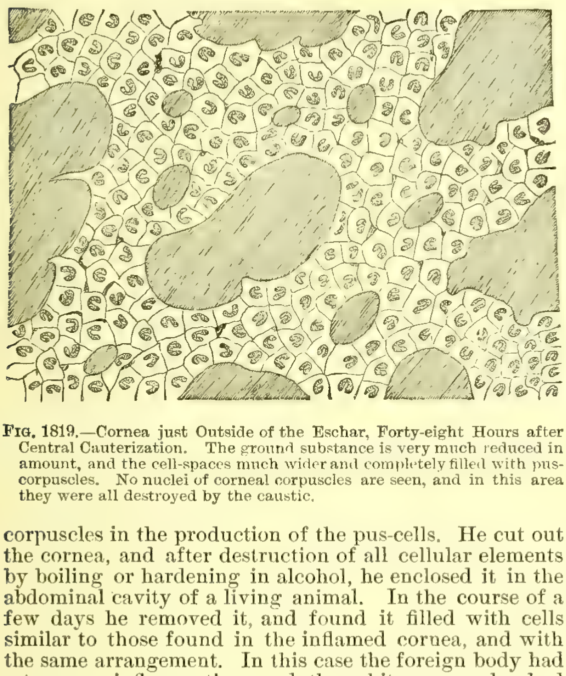

Fig. 1819.—Cornea just Outside of the Eschar, Forty-eight Hours after Central Cauterization. The ground substance is very much reduced in amount, and the cell-spaces much wider and completely filled with pus-corpuscles. No nuclei of corneal corpuscles are seen, and in this area they were all destroyed by the caustic.

corpuscles in the production of the pus-cells. He cut out the cornea, and after destruction of all cellular elements by boiling or hardening in alcohol, he enclosed it in the abdominal cavity of a living animal. In the course of a few days he removed it, and found it filled with cells similar to those found in the inflamed cornea, and with the same arrangement. In this case the foreign body had set up an inflammation, and the white corpuscles had wandered into the cornea from the peritoneal cavity. The same thing happens when pieces of pith or sponge are enclosed in this cavity.

There seems to be no perfectly established fact in favor of the production of pus-cells from the fixed cells of the tissue. One of the arguments used against the theory of Cohnheim is that it is not possible for the great number of cells which we find in a purulent pleuritis, or in a phlegmonous inflammation of the subcutaneous tissue, to be derived from the blood. It is possible that the number of white corpuscles in the blood under normal conditions is rather underestimated. Anyone watching the capillary circulation under the microscope must be struck with the fact that the white corpuscles appear more numerous than they do when the blood is examined on a slide. It must be recollected that the corpuscles are not taken from the inflamed area alone, but from the whole body, and that, too, not at once, but in the course of hours and days. Under normal conditions there is, no doubt, a continual new-formation of white corpuscles, and this process is probably much more active in inflammation. The fact that the blood is richer in fibrin when there is some acute inflammatory process going on shows that the number of white corpuscles is increased. In our present state of knowledge we are unable to say definitely how and in what organs this increased production takes place, but many things point to the probability that the lymph-glands and the spleen play an active part in this. An increase in the size of the spleen and lymph-glands is almost a constant accompaniment of severe inflammations. In addition to this it is probable that not all the white corpuscles found in the inflammatory area have gotten there through the vessels. They are active living cells, and, like other cells, have the property of dividing and forming new cells. They have been seen to divide by some observers, and it is probable that a considerable proportion of the cells found in an exudation have arisen in this way.

Although it may be shown that the tissue-cells do not take any active part in the production of pus, it would be a mistake to suppose that they play an entirely passive rôle in the whole inflammatory process. It must be supposed that any cause which is capable of exerting so marked an effect on the walls of the vessels must in some degree, possibly even in a much greater degree, affect the cells of the tissue. What the effect is of various irritants on the tissue-cells is a subject about which we know very little. The fixed connective-tissue cells in the cornea and the tadpole's tail may undergo some changes of form after the application of various reagents. In some cases the long cell-processes are drawn in and the branched corpuscle changed into a round mass. Sometimes the processes become club-shaped, and the cell may even be broken up into a number of smaller masses. There must also be various chemical changes produced in the cell which we cannot recognize. These changes, however, do not denote any formative activity, but are degenerative. Most of them are accompanied by the disappearance of the cell-nucleus, the change which Weigert has taught us to recognize as the first step in coagulation necrosis.

There are, however, other changes which take place in the tissue-cells which are of a distinctly formative character, and which do not result in the production of *pus-cells*, but cells of the same type as themselves are produced to take the place of those which were destroyed by the inflammation. These changes are called regenerative. About three days after cauterization of the cornea such changes can be seen in the corneal corpuscles, just outside of the area where the tissue was destroyed. The first change seen in the cell is that it stains more brightly with the various reagents. Then long processes are given off from the body of the cell which shoot up into the necrotic area. These processes may be many times longer than the body of the cell. The protoplasm of the cell flows up into these, and collects near the end of the process. From this new branches are given off, the connection with the parent-cell is severed, and a new cell is thus produced; not a *pus-cell*, however, but a new connective-tissue corpuscle. By the use of appropriate reagents we can destroy the cells in a limited area of the cornea without setting up any inflammation. The tissue will then be regenerated, and the process may be studied without the complications which the presence of pus-cells in the tissue causes.

This process of regeneration can be best studied in some of the lower animals, in whom the power exists in a marked degree. If the end of the tail of a young tadpole is cut off, in a short time the part removed will be replaced. As the tissue is very thin and transparent, all changes in the cells can be seen without the disturbing influence which most microscopic manipulations make necessary. The first regenerative changes are seen in the epithelium, which proliferates very rapidly and covers the cut end with a layer of newly formed epithelial cells. Beneath this protective layer the new-formation of con-

nective tissue rapidly proceeds. It is very similar to the same process in the cornea. Some inflammatory changes are produced in the blood-vessels, and a number of white corpuscles escape into the tissue. They often collect in considerable quantities in the part where the new-formation is going on, but they can be seen to take no part in this.

Virchow was the first to make the special division of inflammation into the parenchymatous and interstitial. In the latter the connective tissue of the organ and the vessels are affected. In the parenchymatous the whole weight of the process falls on the special cells of the tissue. This sort of inflammation occurs in the so-called parenchymatous organs, which are composed of elements endowed with special functions, held together by a connective tissue which carries the blood-vessels. In inflammation of such organs the first change consists in a swelling and greater opacity of the cells. From this opacity of the cells the whole organ presents a cloudy, opaque appearance on section. Virchow aptly compares this to the appearance of tissue after being boiled. After the cells become swollen and granular, they rapidly proliferate. These changes which Virchow describes are produced in organs from a number of causes, but they are *degenerative* changes, and probably represent the first stage of fatty degeneration. They are found in the liver and

FIG. 1820.—Rapidly Proliferating Connective-tissue Corpuscles from the Tadpole's Tail. *a*, *b*, White blood-corpuscles which have been figured rather too small. × 250.

kidneys in nearly all acute diseases, especially in those which are accompanied by high fever.

There is no doubt that in every inflammation of a parenchymatous organ changes are produced both in the connective tissue and in the proper cells of the organ. The changes in the gland-cells can be divided into two classes: degenerative changes leading to cell-destruction, and regenerative changes leading to cell-renewal. In an acute nephritis we have vast quantities of kidney-epithelium cast off and passed out with the urine. These are not cells which have been newly formed as a result of irritation, but cells which have been destroyed either by the cause which produced the inflammation or by the subsequent vascular changes. On microscopic examination of such a kidney these changes will appear very evident. The epithelial cells will be found opaque, granular, and fatty-degenerated, the interstitial tissue filled with white blood-corpuscles, and the vessels very hyperæmic. We cannot have a catarrh of the mucous membranes or an analogous inflammation of the skin in which the changes are limited to the epithelium alone. Under some circumstances we can have the exudation mixed with cells which are newly formed. The regenerative changes may pass beyond the degree necessary for the supply of cells which have been destroyed, and the over-supply help to swell the exudation. In an acute inflammation of a mucous membrane the exudation contains numbers of such cells. It is by no means uncommon in such exudations to find large epithelial cells which enclose one or more well-formed pus-cells in their interior. For a long time it was supposed that this was an undoubted example of pus-formation by the epithelial cells, an endogenous cell-formation. It is known now that this is merely an invagination of the pus-cells in the epithelial cells. After the injection of carmine or vermilion into the blood such invaginated cells are found to be filled with the granules.

It has been proposed to classify inflammations by the causes producing them. Any cause which exerts influence of sufficient intensity on the vessels may produce inflammation; and the number of causes which may act in this way must be infinite. Such a classification has little to offer for its acceptance.

The most rational classification is the one based on the character of the exudation, for it is the exudation which distinguishes inflammatory from other pathological processes and gives to each inflammation its distinguishing character. A division which is often made, of sthenic and of asthenic inflammations, may be retained, if nothing more is meant than to distinguish different degrees of intensity of the symptoms. The sthenic inflammations are best seen in young, strong, well-nourished individuals. In these all the phenomena of inflammation—the heat, redness, swelling, and pain—appear with greater intensity than in old, weak individuals. The fact that the symptoms are more severe than in the asthenic is more than counterbalanced by the greater tendency which the well-nourished vessels have to return to the normal condition, and the slower and more imperfect regeneration of tissue in the old and weak. The best examples of asthenic inflammation are given in the hypostatic inflammations. Here inflammations develop in the most dependent part of the body in individuals who are weakened by a long spell of sickness. The vessels in the inflamed organ are dilated by passive congestion, the circulation is feeble, and the nutrition of the walls of the vessels, as well as that of the tissues, is at a low standard. Such parts are very easily inflamed, and the inflammation is accompanied by such slight symptoms that it easily escapes the attention of the patient and is only evident on a careful examination.

The exudation may be thin and transparent, very similar to the ordinary serous transudation. The inflammation giving rise to such an exudation is known as the serous inflammation. The quantity of albumen in this exudation is reduced to a very small amount. Such inflammations are very often seen in individuals whose blood-serum has become very thin in consequence of long malnutrition. It is best seen in cases of chronic nephritis. In such cases inflammations are very common, and may appear in consequence of slight injuries, probably because the vascular walls as well as the other tissues are badly nourished and undergo extensive alterations from causes which would not be felt in vessels whose nutrition was good. The quantity of the exudation is usually very large and not concentrated. A very slight experiment suffices to show that the exudation varies with the character of the blood. If an inflammation is set up in the foot of a dog, and the lymph is collected by a cannula placed in one of the chief lymphatics of the leg, it will be found much more abundant and less concentrated if hydræmia is caused by the injection of salt solution into the circulation. The intensity of the inflammation also influences the character of the exudation. It is only in the later stages of inflammation that the white corpuscles escape from the vessels, and we may have changes produced in the vessels of so slight a character that the early condition of increased transudation is not passed. In any inflammation there is not the same degree of vascular alteration in all parts of the inflamed area. An acute pneumonia always begins with a serous exudation, a congestion, and œdema of the lungs. Every wound first exudes a clear, transparent fluid, which contains but few formed elements. In an inflammation of the skin so severe as variola, the first exudation that appears in the vesicles that are raised is a thin, transparent fluid. Apart from inflammation in hydræmic individuals, a pure serous exudation which does not pass beyond this is rare.

Inflammations of the serous surfaces sometimes have this sort of an exudation. It is proper to consider the

common affection of the skin known as urticaria as an inflammation, and here the changes in the vessels never go beyond the stage of simple increased transudation. The changes are due to a chemical irritant acting on the vessels of this part. In the frog's tongue, after the application of croton-oil, there are several well-marked zones of inflammation around the central eschar. In the outermost zone the vessels are dilated, the blood-current slow, but no corpuscular elements escape. The same thing is seen in an acute pneumonia. Outside of the area of consolidation, where the alveoli are filled with the fibrinous exudation, there is an area where the changes are limited to a hyperæmia of the vessels with serous exudation. It is not an uncommon thing to find in an acute pleurisy an extensive œdema of the subcutaneous cellular tissue over the inflamed pleura. This œdema has been known as collateral œdema, and was supposed to be due to venous congestion in the tissue brought about by circulatory disturbances. It is not a collateral œdema, but is an inflammatory œdema, and represents the last wave of the process extending from the inflamed area. It corresponds to the outermost zone on the inflamed tongue. Serous inflammations may arise very quickly and be very transitory. The changes in the vessels are so slight that they quickly can return to the normal condition, the exudation is absorbed, and a few hours may include the beginning and end of the process.

Uncomplicated serous inflammations are relatively rare. Most often we find more or less fibrinous coagula mixed with the exudation. When this fibrin is in the exudation in large amount, or deposited on the surface of the inflamed membrane, a fibrinous inflammation is spoken of. There is no sharp line separating the serous from the fibrinous inflammation. The most typical examples of fibrinous inflammation are found on serous surfaces and in the lungs. The serous surfaces are covered by a thick, grayish-white membrane, which is sometimes so tough that it can be stripped in great flakes from the surface. On microscopic examination of the membrane it is found to be composed of fine transparent fibrin filaments, woven together in a sort of meshwork which contains in its meshes a greater or less number of white blood-corpuscles, cast-off epithelial cells, and generally a few red corpuscles. The fibrinous exudation may be almost pure, or it may be associated with a large exudation of serum. In a fibrinous pericarditis both the visceral and parietal layers of the pericardium may be covered with a dense fibrinous membrane, with no more than the normal amount of serum in the sac, or the collection of serum may be so extensive that the lungs are compressed by it, and between these two extremes every gradation is found.

On epithelial surfaces the membrane is either seated directly on the basal membrane or it reaches deeply into the tissues beneath. In any case it is not seated directly *on* the epithelium. The epithelium always forms a part of the membrane. The epithelial cells are changed in various ways—they become irregular in form, sharply refractive, and their nucleus disappears. In case the membrane is seated on the basal membrane beneath the epithelium, it can easily be removed, and is termed a *croupous* membrane. On epithelial surfaces which have not a firm, dense basal membrane the fibrinous exudation extends deeper into the tissues, and is so firmly adherent that on its forcible removal a loss of substance in the tissue is perceptible. In this case the exudation is called *diphtheritic.* So far as the pathological condition is concerned, there is no difference in the two processes. The same etiological factor will produce a croupous inflammation in an epithelial surface backed by a dense basal membrane and a diphtheritic inflammation where this basal membrane is wanting. It is the most common thing to find a diphtheritic inflammation in the pharynx, and when the process extends into the larynx or trachea, to find a distinctly croupous exudation. It will be readily seen that the fibrinous inflammation is a more severe process than the serous. For the formation of fibrin it is necessary to have the white corpuscles escape from the vessels in considerable quantity, and then to break down, setting free the fibrin ferment. At first sight it seems a little strange that the fibrin formation should not be present in all inflammations of sufficient intensity. In inflammations of the parenchymatous organs, as the liver and kidney, the white corpuscles make their way into the interstitial tissue in great numbers, but they find there the conditions sufficiently favorable to provide them with nutrition and they do not break down. These conditions are not so favorable in the spleen and lymphatic glands, and in most inflammations of these organs there is a quantity of fibrin found in the interstices of the tissue. On epithelial surfaces we only find a fibrinous inflammation when the epithelial surface is wanting, or has been destroyed. It seems that the breaking-up of the white corpuscles and the setting free of the fibrin ferment is in some way hindered by the living epithelium. Most probably they find in the interspaces between the cells sufficient nutriment.

In some exudations there is so large a number of corpuscles present that the transparency of the material is lost, and it appears as a milky or a thick creamy fluid. There is either no fibrin in this fluid, or at best only a few flakes. The cellular elements present in the fluid are principally white blood-corpuscles, though at times so many red corpuscles may be mixed with them that the exudation has a yellowish, or even a reddish, tint. This is the purulent exudation, and the inflammation which gives rise to it, the purulent inflammation, is sharply separated from all others. In the serous exudation there is only an infiltration of the tissues ; the exudation is contained in the dilated lymph-spaces. The purulent exudation very rarely takes the form of infiltration, but collects in a mass in the tissues. It cannot be that it is only formed in this small area, for the amount of it is often very large. The exudation seems to exert some solvent action on the tissues, which give way and allow of its collection. Such a collection of pus in a small circumscribed area is called an abscess. When the pus collects in a natural cavity it is termed a purulent exudation. The anatomical arrangement of a part has nothing to do with determining this character of the exudation. In many cases, especially well shown in inflammations of serous surfaces, the exudation is fibrinous at first and afterward becomes purulent. Nothing is more common than to have, in pleurisy, first a well-marked fibrinous inflammation, which afterward becomes purulent. The purulent inflammation denotes a later stage and a more severe form than the serous or fibrinous, but it would be an error to say that it is nothing *more* than a more intense form. It is a totally *different* form of inflammation, and its most remarkable feature is that, in spite of its intensity, there is no formation of fibrin. The colorless corpuscles in the exudation do not give rise to the formation of fibrin. They are so numerous that a great deal of the fibrin ferment must be present, but still the fibrin is not formed. Not only is there no formation of fibrin in the pus, but this seems to exert a solvent action on that which was present before the exudation assumed a purulent character. When a purulent pleuritis supervenes on the fibrinous, only a few flakes of the fibrin will be found in the exudation—all the rest has disappeared. When the pus collects in the form of an abscess, it exerts a solvent action on the tissues, most probably on the cement substance between the cells. On microscopic examination of the pus from an abscess some trace of this action will be seen in the shape of broken-down tissue-cells and remains of tissue, as elastic fibres, etc., mixed with the pus-corpuscles.

There must be some chemical substance in the pus which exerts this solvent action and which antagonizes the fibrin ferment. At present we do not know anything definite as to the nature of this substance. Ewald has sought to find it in the increased amount of CO_2 which is found in tissues in which there is a purulent inflammation. Although CO_2 has some effect in hindering the formation of fibrin, it has no dissolving action on that already formed. Peptone has been found in considerable quantity in purulent exudation ; and after it had been shown, in Ludwig's laboratory, that this substance hindered the formation of fibrin, it was thought that peptone might be this chemical substance. It was necessary to

give up this idea when it was found that a watery extract from a lung solidified by croupous pneumonia, in which there is most abundant formation of fibrin, contained a large amount of peptone. The most severe inflammations can be induced without assuming a purulent character. The strong mineral acids and caustic alkalies can be injected under the skin, and an inflammation with the most extensive necrosis set up, but there will be no pus. The purulent inflammation is due always to the presence of this chemical compound we have spoken of, and which Weigert has aptly designated the pus-poison (*Eitergift*).

It has long been known that an inflammation was most apt to become purulent when the air had access to the inflamed part. A simple fracture of a bone never produced a purulent inflammation ; but if a spicula of bone projected through the skin, and the fracture was compound, then the pus was formed. A serous inflammation of the pleura too often becomes purulent after the puncture of the trocar. It was soon shown, however, that it was not the entry of the air alone which gave rise to such inflammations. Air was injected into the subcutaneous cellular tissues of rabbits until they were blown up like balloons, without any inflammation, much less a purulent one, being set up. Everyone knows the risk attending the exposure of serous membranes to the air, yet it was shown that, with certain precautions, air might be passed through the peritoneal cavity for days without any unfavorable results. Other experiments showed that without doubt it was not the air itself, but the lower organisms which it contained, that did the damage, and when these were excluded no harm resulted from the action of the air. In the great majority of cases a purulent inflammation is the result of the action of certain lower organisms, and the pus-poison most probably is a chemical substance produced by them. It is possible, however, to have purulent inflammation entirely independent of lower organisms ; the pus-poison may have another source. So much as this fact has been denied, it may be regarded to-day as certain. By the injection of petroleum, turpentine, and especially croton-oil, it is always possible to cause a purulent inflammation. Also, if metallic mercury is injected into the knee-joints of rabbits, a purulent inflammation is caused. Most of these experiments were made by injecting the various substances into the tissues by means of the hypodermic syringe. It was claimed by the bacteria believers that, even though the needle and substance injected were thoroughly disinfected, still a way was left open for the entry of organisms by the canal which the needle made. The opponents of the bacteria theory claimed that suppuration could also be produced by the injection of the most varied substances, such as milk, olive-oil, etc. It needed but a little care and cleanliness in operating to show that these last-named substances had no such action. Some experiments have been made by the writer with a view to the

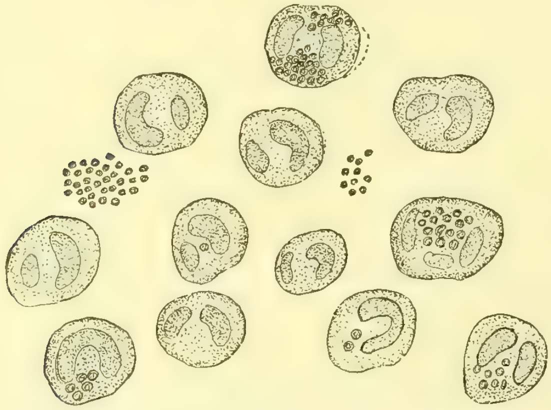

FIG. 1821.—Pus from a Small Abscess. Micrococci are seen both enclosed in pus-corpuscles and lying free. Cover-slip preparation stained with fuchsin. × 600.

absolute exclusion of lower organisms in the suppuration caused by croton-oil. The oil was boiled and enclosed, while still hot, in glass capsules which had previously been heated red-hot. A small opening was made in the skin, and the capsule pushed along a director for some distance into the subcutaneous cellular tissue. After several days had elapsed, and after the skin wound and canal were perfectly healed, the capsules were broken by pinching them, and the result was in every case a suppuration. Control experiments were made in which the capsules were filled with various other substances, and the result was always negative. Nothing could have shown better the inertness of mechanical irritants to produce inflammation than some experiments made by Dr. Sternberg and the writer in regard to tuberculosis. Large quantities of finely broken glass and Prussian blue were injected, with antiseptic precautions, into the abdominal cavity of rabbits, and a purulent inflammation was never produced. As regards croton-oil, apart from all experimental evidence, we know that its application to the skin of man produces a purulent inflammation. A vesicular inflammation is produced, and the vesicles soon change into pustules. As the inflammation takes place beneath the epidermis, the influence of lower organisms in this case also can be excluded.

Apart from such cases as have been mentioned, we can always regard purulent inflammation as due to bacteria. In most cases there is but little difficulty found in tracing their entry into the body, and often they enter the tissue at some distance from the point where the abscess has formed. Still there are cases in which there is an abscess formed as the result of violence, and, so far as can be seen, there is no injury to the skin, no way by which bacteria could have entered.

Abscesses of the brain in consequence of a blow on the head, or of the subcutaneous cellular tissue in consequence of a blow or injury of any sort, are not very uncommon in man. On microscopic examination bacteria are found. How do these organisms get there ? Ordinarily the tissues and blood do not contain any bacteria. Moreover, these injuries are followed by suppuration in but a very small percentage of the cases, probably less than one per cent. Experimentally, such suppurations cannot be produced in the lower animals when all chances of infection by bacteria are excluded. It is useless to deny, as has been done, that such cases are seen in man, nor can they be used as proof of the existence of suppuration without the presence of bacteria. Though we know that ordinarily no bacteria are in the normal blood and tissues, still there is the possibility, or even probability, that they may continually enter the blood from the alimentary canal, or in some other manner, and be destroyed or removed from the blood. It may be, in these cases, that the organisms find in the injured and inflamed area a place of minor resistance, a suitable nidus for their growth ; they develop here and produce a suppuration. In these abscesses bacteria are found, but there are certain abscesses which arise without apparent cause, do not, as a rule, give rise to much constitutional trouble, and in which the ordinary bacteria which are found in acute abscesses are never seen. These are the so-called cold abscesses. Since the discovery of the tubercle-bacillus by Koch, it has been found that in most cases these abscesses are tubercular in character, and connected with tubercular caries in bone. The pus is rarely formed at the place where the abscess appears ; in most cases it comes from a distance, travelling along the sheaths of muscles or fasciæ. The best example of this is the abscess which forms in the groin in consequence of tubercular caries of the vertebræ. The most careful search of the pus in these cases often fails to show the presence of the tubercle-bacillus, but the proof of their tubercular character is found in the fact that the injection of such pus into rabbits or guinea-pigs produces tuberculosis. If the pus is cultivated in suitable media, tubercle-bacilli will develop. It may be that the organisms are present in such small numbers that they elude our search, or they may be present in some form which we cannot recognize. Such abscesses are also found in connection with syphilis, farcy, and actinomycosis. Lately,

numerous cases have been recorded, in which a suppurative inflammation has been found as the result of an echinococcus cyst.

Not every bacterium is capable of producing suppuration. The ordinary bacterium termo, the hay bacillus, and a score of other forms, can be injected into the tissues with impunity. Others, when injected, will cause inflammations varying in character and intensity, but never becoming purulent. Other forms do not ordinarily produce suppuration, but may, under certain circumstances, do so. It seems certain that suppuration may be produced by the tubercle-bacillus, especially when caries of bone is a consequence of its presence. We know of only a few varieties which, under all circumstances, give rise to suppuration when they are injected into the tissues. These all belong to the order of micrococci; they are round or slightly oval bodies of minute size, which multiply by simple division and do not produce spores. Rosenbach, who has done by far the most careful and exact work in investigating the lower organisms of pus, found one of three forms in every acute abscess. In some abscesses only a single species was found, in others all three of the forms together. These organisms, though of different species, are yet so much alike that they can scarcely be distinguished from each other, even under the highest powers of the microscope. Rosenbach was only able to differentiate them from each other, and to obtain each species for study and experiment, by making cultivations on suitable solid culture media. By this proceeding he found that, although the individuals of the several species could not well be distinguished by a comparison of size and shape, yet, when growing in a colony the colonies differed macroscopically from each other. One species produced a yellowish color, another dissolved the gelatine, etc. The four species which always produced suppuration, and one of which was always found in acute abscesses, were: 1, Staphylococcus pyogenes aureus; 2, staphylococcus pyogenes albus; 3, micrococcus pyogenes tenuis; 4, streptococcus pyogenes.

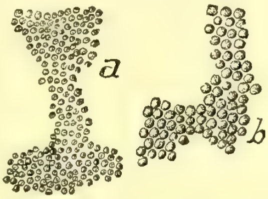

FIG. 1822.—Staphylococcus Pyogenes Aureus, or Albus, which two forms have the same size and shape. *a*, is from a young cultivation on gelatine; *b*, from an older.


FIG. 1823.—Micrococcus Erysip. Fehleisen.

The exudation may contain so many red blood-corpuscles that it has a red color, and is spoken of as the hæmorrhagic exudation. In order to understand the nature of the inflammation which gives rise to this exudation, it is necessary again to refer to the inflammation produced in the frog's tongue by the application of croton-oil. In this we have seen that the red corpuscles escaped from the vessels chiefly in the central area, where the influence of the irritant was most potent. Here there was almost complete stagnation in the capillaries, and the nearer the blood-current comes to stagnation in these vessels, the more red corpuscles escape from them. Even when the blood-current is at a complete standstill, as happens in the hæmorrhagic infarction, there is a great escape of red corpuscles. This signifies nothing more than that the alteration in the walls of the vessels must be very great, and that the inflammation which gives rise to a hæmorrhagic exudation is a more severe form than any of the others which we have considered. Those inflammations which terminate in gangrene of a part are most often of a hæmorrhagic character. In the production of such exudations a great deal depends upon the condition of the blood and tissues. A purely serous exudation is met with most often in cases of marked hydræmia, and we meet with the hæmorrhagic in persons who have been exposed to great hardship and have had insufficient food for a long time. Prolonged deprivation of vegetables and the use of salt meat, give rise to a condition of the system in which such inflammations are common. The slightest causes which, in ordinary conditions, would give rise to no inflammation at all, or at most to a very mild form, are apt in such persons to produce this most severe form. The cause lies both in changes in the blood and in malnutrition of the vessels, which allows in them extensive alterations from very slight causes. Hæmorrhagic inflammations are also frequently seen in persons affected with some severe constitutional disease, especially tuberculosis, and with the inflammation there is an abundant eruption of miliary tubercles. This is so well known that in a hæmorrhagic pericarditis or peritonitis, the pathologist always searches for tubercles beneath the exudation, and rarely fails to find them. In most cases there is a great amount of fibrin mixed with the red corpuscles, and the exudation on serous surfaces often forms a membrane one-half inch or more in thickness. An inflammation associated with an abundant eruption of carcinoma nodules, a miliary carcinosis, is very often of a hæmorrhagic character. In addition to these cases, there is a great tendency to a hæmorrhagic exudation in persons of a marked hæmorrhagic diathesis, cases of hæmophilia.


FIG. 1824.—Micrococcus Pyogenes Tenuis. The single micrococci here are more oval than in No. 1, and shaded on the ends. After Rosenbach. × 500.

We have now considered the principal types of inflammation—the serous, the fibrinous, the purulent, and the hæmorrhagic. We have seen that the serous, the fibrinous, and the hæmorrhagic can depend merely on the intensity of the vascular alterations, but that the purulent did not depend on this. It would be a mistake to suppose that in every case these different forms appear sharp and clear. None of the pathological processes are of such a nature as to admit of a perfect classification. Most often we have mixed forms of inflammation, and the most dominant process must determine to which sort it shall belong. This can best be expressed by a compound term. The exudation has a sero-fibrinous, or sero-purulent character. In the early stages of purulent inflammations some flakes of fibrin are often found, giving to the exudation a fibro-purulent character.

It will not be necessary to dwell long on the causes of inflammation. Any influence, be it chemical, thermal, or mechanical, which can so affect the blood-vessels as to allow the phenomena which we have described to take place, may act as a cause of inflammation. The lower organisms deserve special mention as a cause. We have seen the influence which they exerted in producing purulent inflammation, but this is only one of the forms which they produce. The bacteria may cause almost any form of inflammation. Croupous pneumonia is almost the most typical form of fibrinous inflammation which we know of, and this seems in certain cases to be produced by a specific micrococcus. In erysipelas we have an inflammation of the skin with great congestion of the vessels and a considerable exudation, and this seems certainly to be caused by a certain micrococcus. If no other organisms are present an erysipelatous inflammation does not end in suppuration. The catarrhal inflammations of mucous surfaces, and many inflammations of the skin, are produced by various organisms. These organisms do not all belong to the bacteria. The various fungi play an important part, especially in inflammations of the skin. A number of the bacteria produce pathological conditions which are very similar to inflammation, but there are sufficient reasons for not considering them as simple inflammation. The tubercle, the gumma, and the nodules which are produced in actinomycosis, approach the inflammatory formations very closely. They are always accompanied by inflammation which may or may not be purulent in character. It is not certain whether these inflammations are caused directly by the action of the organisms on the vessels, or by the effect which the

nodules, the tubercle, the gumma, etc.; exert on the tissues. In syphilis it is certain that we can have numerous inflammations as a result of the virus, and it is probable that in tuberculosis also the tubercle-bacillus can produce inflammation, pure and simple, without any formation of tubercles.

The importance of the rôle which bacteria play in producing inflammation has been overestimated by some authors, who have attempted to ascribe all inflammations to their action. Hüter has been the most ardent advocate of this view. He defined inflammation as an endemic disease with no local limitation; the causes were bacteria, which existed everywhere outside of the body. He thought that he was able to find bacteria in every sort of inflammation, and that without these no inflammation could be produced, even by the actual cautery or by any sort of chemical substance. The Listerian method of bandaging, by means of which all organisms were supposed to be kept from wounds, and all inflammation warded off, was used as an argument in favor of Hüter's views. Zahn, a scholar of Hüter, claimed that when the frog's mesentery was exposed under conditions which rendered impossible the access of bacteria, no inflammation resulted. It would seem possible that, if the mesentery could be exposed and kept in a natural condition as regards moisture, pressure, etc., inflammation need not take place. The presence of bacteria on the surface is only one of the causative factors. We know that the system of bandaging and operating which, in honor of its discoverer, has been named Listerism, is no certain preventive of bacteria in wounds; and we also know that the most typical inflammation can take place when this process has been carried out in all its details. What Listerism does do, however, is to prevent an inflammation from becoming purulent. The experiments of Zahn on the frog's mesentery are not in accordance with the well-known fact that the frog is, of all animals perhaps, the least sensitive to the action of putrid fluids and bacteria of all kinds. In pathological anatomy we are constantly afforded examples of inflammation without the presence of lower organisms. Around the infarctions in the spleen and kidney there is always inflammation. These infarctions are generally due to an embolus of fibrin, which has collected on the roughened surface of a valve or on the aorta, and is carried by the circulation into a small artery. If the embolus is a simple plug of fibrin, an inflammation of light character is produced around the necrotic tissue; but if the embolus comes from an ulcerative endocarditis or an acute inflammation due to the action of infectious organisms, and the action of these is added to the necrosis, then the inflammation produced may be purulent or of the most severe character.

Necrosis of the tissue is one of the most important causes of inflammation. Cohnheim and Weigert have only recently shown what an important part this process plays in pathology in general, and in no domain is its importance more evident than in inflammation. Most of the traumas cause inflammation by causing a necrosis of the tissues of greater or less extent. If a foreign body enters the tissue it not only kills all parts through which it breaks its way, but all tissues in immediate contact with it after it remains imbedded. If a sharp cut is made in the tissues, all that is immediately cut by the knife dies, and in pinching and blunt violence, if the limit of the elasticity of the tissues is passed, necrosis is the result. Inflammation is never absent around dead tissue. The best example of such inflammation is found in the kidney infarction. The primary action of many of the bacteria is to produce necrosis in the tissue around them. This is seen in the capillary emboli of micrococci so often met with in the liver and kidneys. There is always a zone of necrosis around the minute embolus, and always inflammation. Necrosis may bring with it other dangers than that of merely setting up inflammation. Most of the bacteria are innocuous because they cannot overcome the resistance which the normal tissue offers to their growth. In necrotic tissue this physiological resistance is absent, and organisms which generally could exert no action, may attack the necrosed part, and as a result we may have even putrefactive changes in the part giving rise to the most severe inflammation and grave constitutional disturbances. Even in a simple necrosis, inflammation is probably the result of chemical substances which arise in the necrosed tissue.

It will be well to mention here the so-called neurotic inflammations. In experiments made on animals, with a view to determining the action of the vagus, it was found that when this nerve was cut a pneumonia almost always followed. Magendie found later that when the fifth nerve was cut a severe inflammation of the cornea on the same side took place in the course of a few days. Various inflammations of the skin have been found to follow injury of the nerve which went to the part. Other inflammations following injury either of the nervous centre or of nerve-trunks are well known. It was supposed that these inflammations were the direct result of injury to the trophic nerves which presided over the nutrition of the part. Whether or not there are such trophic nerves is a question in physiology which we will not discuss, but it is certain that the inflammation which follows nerve-injuries can be referred to other causes. Experimental pathology has taken away the ground for this neuro-paralytic theory of inflammation. It has been found that such inflammations are due to the continuous action of slight traumas. In the case of the eye, after section of the trigeminus, the cornea is perfectly insensible to small particles of dust falling on it, and to injury produced by contact with straw, etc. In many cases also the ulceration of the cornea seems to be caused by the tissue actually drying, not being moistened by the constant movement of the lids. The paralytic bed-sores are generally the result of continued pressure over bony prominences, aggravated by the action of the urine constantly dribbling from the paralyzed bladder. The pneumonia after section of the vagus is a true aspiration pneumonia, caused by the aspiration of food, saliva, etc., through the glottis, which is paralyzed by the operation. All this has been shown by experiment. Inflammation of the cornea never follows section of the trigeminus if the eye is protected from injury; this can be accomplished by sewing the rabbit's ear over the eye, or by some mechanical device. Bed-sores in paralytics are prevented by careful attention to cleanliness and the use of the water- or air-bed, by means of which pressure is equalized. Pneumonia after section of the vagus is prevented by the simple expedient of tying the animal on its back, thus keeping foreign matters from entering the glottis. Even the ulceration and severe inflammations which follow section of the nerves of an extremity may be obviated by enveloping the limbs in cotton. At present that form of inflammation which best seems to have a neurotic origin, is represented by the various herpetic inflammations in man, and these are beyond the domain of experimental pathology. It can readily be seen, however that injuries of nerves may predispose a part to inflammation by affecting its nutrition, and especially the nutrition of the vascular walls. The blood-vessels of a healthy part are not always of the same calibre; there is a constant contraction and dilatation taking place as a part calls for more or less nutriment. This is under the control of the vaso-motor nerves, and as these are paralyzed with the nerves of motion and sensation, it is evident that this must affect in a considerable degree the nutrition of the part. In paralyzed parts inflammation is apt to follow from a slight cause, and is often very severe.

In reference to time every inflammation may be divided into three periods, the first of which will embrace the purely vascular changes. In this stage two of the cardinal symptoms, the heat and the redness, appear. The second stage of inflammation will embrace the production of the exudation, and will cease when this has reached its height. In this stage the two last symptoms, the swelling and the pain which is so intimately associated with swelling, will appear. The third stage comprises the time from the height of the process to the restitution of a part to its normal condition. Every one of these stages may be interrupted by the death of the individual,

Inflammation.

and there is no pathological process which is so often followed by death. Death is not so often due to the vascular changes directly, as it is to the effect of these on the general system. These general effects of inflammation, their most marked manifestation being fever, will be considered later.

One of the terminations of inflammation is death ; another, which is very serious, is a necrosis of the inflamed part. This is usually the effect of the intensity of the inflammatory cause. The changes which are induced are of such a high degree that actual stasis with coagulation of the blood in the vessels takes place. In such parts the normal circulation cannot be restored ; there can also be no collateral circulation, for not a single one, but all the vessels of the part are destroyed. It is especially the hæmorrhagic inflammations which are disposed to terminate in necrosis, because here the vascular changes are so pronounced. The termination of inflammation in necrosis depends also on the state of nutrition of the inflamed part. Those in whom the circulation is very weak, and the tissues and vessels badly nourished, are especially disposed to it. Such conditions as are given in morbus Brightii and diabetes mellitus are apt to produce an inflammation of this severe character from a very slight cause.

The restoral of a part to its normal condition is the termination of inflammation which is most sought to be brought about. The less marked the inflammatory disturbances of the vessels have been, the easier can they return to their normal condition. The first thing that is necessary, in order that this shall take place, is the removal of the inflammatory cause ; if the inflammation is caused by the part being placed in an unnatural condition, the natural condition must be restored, and the irritants, such as foreign bodies, etc., must be removed or neutralized. In case the vascular changes have only reached that degree which permitted a freer transudation, this can readily be absorbed and the normal condition be restored. Even when the changes have been of such a degree that corpuscular elements are found in the exudation, restitution can in this case also easily result. In this restitution the circulatory changes must first be set aside, and the vessels must be restored to their integrity. It is the free circulation of blood which keeps the vessels, especially that part of them which is of most importance in the inflammatory process, the intima, in a normal condition, and a free circulation is necessary for the restoral of this. From what we have seen of the effects of changes in the vessels, it is evident that the more pronounced they are the more difficult it is for an active circulation to be re-established. In case the inflammatory cause lasts sufficiently long, or is severe enough to produce death of the endothelium and complete stagnation and coagulation of the blood, a complete restitution by a removal of the inflammatory cause is impossible. These vessels cannot be used again.

If the exudation is limited in amount, the white corpuscles in the part are sufficiently nourished to retain their life ; they are distributed through the tissues, and for the most part find their way back into the circulation by means of the lymph passages. The red corpuscles remain in the neighborhood of the vessels from which they have escaped, the pigment is dissolved out of them, and they become changed into colorless disks—"*shadows*"—and eventually disappear. When there are many of them the hæmoglobin is taken up by the tissue ; here it may remain for a long time as a brownish pigment, either enclosed in the cells or lying in the interstices of the tissue. Even the fibrin in the exudation can be completely re-absorbed ; it seems to be converted into a fatty emulsion which is easily taken up by the lymphatics.

All this can take place without any loss to the system, but when the exudation reaches greater proportions, when it measures quarts, the matter is different. In spite of the activity of the lymph circulation, and we have seen that in inflammation its activity is much increased, it cannot meet the demands which are made upon it. An immense exudation also places mechanical difficulties in the way of a return of the vessels to their normal condition, and is in itself a direct cause of inflammation. In addition to this the individual is usually much weakened, his circulation and nutrition very much reduced, partly in consequence of the local effects of the exudation, partly by the general effect which it exerts on his constitution. A lung which is compressed by the pleuritic exudation can naturally not function normally, and when the alveoli are filled with a fibrinous exudation there can be no exchange of gases. Restitution is always materially assisted when a natural outlet allows the escape of the exudation. This is always given in inflammations of mucous surfaces, and of canals which have a natural outlet, as the bronchi, etc. Before absorption to any extent can take place the solid part of the exudation must become fluid, and this is accomplished by fatty degeneration. By means of fatty degeneration a fibrinous exudation is changed into an opaque, yellowish, semifluid mass. This is well seen in that stage of pneumonia known as the gray hepatization, in which we find the whole of the lung of a grayish-yellow color. Where no natural outlet is given for the escape of the exudation, restitution is much hastened by making an artificial outlet. The abscess is incised, the pleura and peritoneum punctured, etc. Artificial aid is especially necessary when the exudation has a purulent character. The fluid part of pus is often absorbed, and the solid part, composed of pus corpuscles, remains of tissue, etc., remains behind and becomes changed into a dry yellowish mass which has about the consistency of moist cheese.

Lime-salts are very apt to be deposited in the caseous material, and in this way it is changed either into a firm stony mass, or into a gritty substance of the consistency of mortar. Such masses can undergo no further resorption, they remain in the system as foreign bodies and exert the same action. There is another reason for the prompt removal of a purulent exudation. Its resorption is often associated with grave dangers. We have seen that a purulent inflammation was, in nearly all cases, caused by the presence of bacteria, which produced what could be regarded as a special virus. Now, the absorption of the chemical soluble products of such an inflammation has a most injurious effect on the general system, producing fever and other disturbances. This is not the only, nor the chief, danger. The lower organisms which produced the purulent inflammation are found in the exudation, and they can be removed from here and deposited in some remote portion of the body, and here they produce the same effect that they did in the first instance. Such inflammations are termed metastatic, and, like the metastatic tumors, they arise from the deposit in one part of the body of an infectious agent which is taken from another part. This infectious agent may be carried from the primary inflammation by the lymph- or blood-vessels. Where these metastatic inflammations will be located, depends upon the locality of the primary inflammation. The liver abscess so common in tropical countries is generally metastatic, and is due to the deposit in the liver of infectious matter derived from a dysenteric inflammation of the colon, the carrier being the portal vessels. If the primary inflammation is seated in a part the blood from which is first carried through the lungs, the virus is most apt to be caught in the capillary circulation here, and the secondary abscess established in the lungs. From the small size of the bacteria, the causative agents in such inflammations, they can readily pass through the capillaries of the lung and be deposited in other organs, notably the kidneys and liver. Many abscesses which are supposed to arise without cause are really metastatic, the primary abscess being so small as to elude attention. As an example of a metastatic inflammation where the virus is conveyed along the lymph-vessels, we have the bubo in the groin following a sore on the penis.

These metastatic inflammations are not necessarily purulent. When the virus which produces the primary inflammatory focus is not a pus-poison, the metastatic inflammation has not a purulent character. There are certain infectious inflammations which only appear in certain regions of the body—the mumps, for example, only appears primarily in the parotid gland. The metastatic

inflammation from this is located in the testicle. These are true metastatic inflammations, just as is the abscess in the liver which follows dysentery, but with the difference that the inflammatory virus only finds the conditions suitable for its growth and development in certain tissues in the body. Inflammation of the knee-joint following gonorrhœa is another example of the same thing. In tuberculosis, when the virus finds an entry into the systemic circulation, it is distributed all over the body, and, as a result, there is almost an universal eruption of miliary tubercles. The inflammatory virus may also enter the systemic circulation, and if the virus is purulent we can have a general eruption of small abscesses. It is but seldom that the virus obtains in this manner a free entry into the systemic circulation. The best opportunity for this is given in cases of purulent inflammation of the cavity of the left heart. The ordinary inflammations here, which give rise to the so-called vegetations on the valves, have no infectious properties. Portions of the fibrin become broken off and carried by the blood-stream into remote organs, where they cause a circumscribed necrosis with inflammation around the necrosed tissue. When the inflammation of the endocardium is of an infectious nature, then, instead of a simple mass of fibrin, a virus, capable of exerting a distinct specific action, is carried into the small arteries and capillaries, and wherever it is

FIG. 1825.—Emboli of Micrococci in a Glomerulus of the Kidney. *a*, Capillaries filled with micrococci; *b*, small-cell infiltration; *c*, kidney structure in the neighborhood which becomes necrotic. From a case of pyæmia. × 400.

caught a purulent inflammation results. Multitudes of these small abscesses, in the skin and elsewhere, are seen in acute ulcerative endocarditis,

The pus-poison may be carried to other parts, and set up purulent inflammation by passing along natural canals and passages. From the bladder the virus may pass along the ureters to the pelvis of the kidney, and here, and in the urinary tubules, produce the most serious inflammations. The kidneys may be filled with small abscesses, every one of which has its point of origin in a group of micrococci contained in a tubule. Such abscesses can always be distinguished from those produced by embolism by the fact that in the one case a blood-vessel is the starting-point of the abscess, and in the other a urinary tubule. Other examples of this manner of infection are to be found in the epididymitis after gonorrhœa, and in the inflammation of the lungs after diphtheritic processes in the larynx or pharynx.

One of the most important accompaniments of inflammation is necrosis; this, we have seen, may be the cause of the inflammation, or it may result from it. It causes always a defect in the tissues which must be made good. In the cornea we have seen that this reproduction of tissue was in great part accomplished by a proliferation of the corneal corpuscles. This method of reproduction is limited in man to but a few tissues, and seems to be entirely wanting in the central nervous system and other more highly differentiated tissues. The efforts at regeneration of tissue may exceed the limit of that necessary to repair the damage done. In the callus formation around broken bone there is more bone formed than is necessary to supply the defect, and the fungous granulations on wounds and ulcers form another example of this. When the regeneration of tissue is not sufficient to supply the defect, a new-formation of vascular connective tissue takes its place. This new-formation of vascular connective tissue is of great importance in the inflammatory process. His first discovered that in the embryo, whenever there was a defect in the specific elements of a tissue, its place was always occupied by vascular connective tissue, and the same thing seems to hold good in inflammation. This is a terminus of inflammation which is directly the opposite of the other forms spoken of, in that its products become a distinct functioning part of the organism. This sort of inflammation has been distinguished from the other forms by being called *formative.* Although this new-formation of tissue from the exudation has been the object of much study, we are still not sufficiently acquainted with its details. Ziegler placed thin pieces of glass, so joined together that only a very small space was between them, under the skin and in the abdominal cavity of various animals. In every case, but especially when the operation was done so carefully that no suppuration followed, the space between the glasses was filled by a newly-formed tissue which could only have been produced from white blood-corpuscles. These experiments have been repeated with various modifications by Heidenhain, Tillmans, Senftleben, and others, and about the same results have been obtained. According to Ziegler, the space first becomes filled with white blood-corpuscles, some of which undergo fatty degeneration and break down; others increase in size until they become double or threefold the ordinary size. Such corpuscles appear to increase by feeding on the ones which have degenerated, and finally become changed into irregular large protoplasmic masses with numerous long processes. The formation of connective tissue takes place from these large epithelioid- and giant-cells by the protoplasm splitting up into fibrils. For the process to be perfect there must always be a new-formation of blood-vessels, and without this, although the cells may make some steps in progressive metamorphosis, they soon break down and degenerate.

These new vessels are in part a direct growth from the adjacent capillaries. At one place in a capillary, usually opposite a nucleus, a long, thin process is given off, which soon communicates with a similar process from the same or from another vessel. These become hollow, and a vascular loop is thus formed. This is the most common way in which the new vessels are formed, but it is not the only way. Both an intercellular and an intracellular vascular formation has been described. In the intercellular formation the cells become arranged in rows, then flatten to form true endothelial cells. These join closely together, and a tube is formed. The intracellular formation has best been studied. According to Ziegler, certain large cells send out long processes which unite with similar processes from other cells; these processes, after a time, become hollow, and the tube joins either directly with a capillary or with a long process from one, and the vascular continuity is established. Stricker asserts that there is a new-formation of red corpuscles in these cells, just as in the vascular area in the embryo. The writer has carefully studied the formation of blood-vessels in the inflamed cornea, but could not satisfy himself as to the correctness of this statement. The importance of the rôle which these newly-formed vessels play in bringing food to cells which are undergoing active changes is evident.

An inflammation may run through its course and the parts return to their normal condition in a few days, or even in a few hours, or it may continue for months or even years, and only terminate with the death of the individual. This difference in point of time makes the distinction between acute and chronic inflammations. An inflammation will persist as long as the cause of it remains,

and in almost all chronic inflammations we are able to find such a persistent cause. These abiding causes may vary much in character. The presence of inflammatory products acts as a cause. When the exudation is not entirely absorbed, and a portion remains which either undergoes caseation or has lime-salts deposited in it, this acts as a foreign body in setting up inflammation around it. The best example of this is given in the chalky caseous residue of an old pleuritic exudation, which, in consequence of constant inflammatory changes around it with new-formation of tissue, becomes surrounded by dense, firm connective tissue an inch or more in thickness. The newly-formed blood-vessels in an inflamed part are more easily affected by irritants than the normal vessels, and an influence, which would not be felt in the normal, is sufficient to set up active inflammatory changes in them. Thus, when a part has repeatedly been the seat of inflammation of greater or less intensity, it may continue in an inflamed state by being affected by very slight causes.

The condition of the individual has often much to do with the chronicity of inflammation. It is natural that blood-vessels which are poorly nourished should not have the same tendency to return to their normal condition. When the circulation is feeble absorption of the exuda-

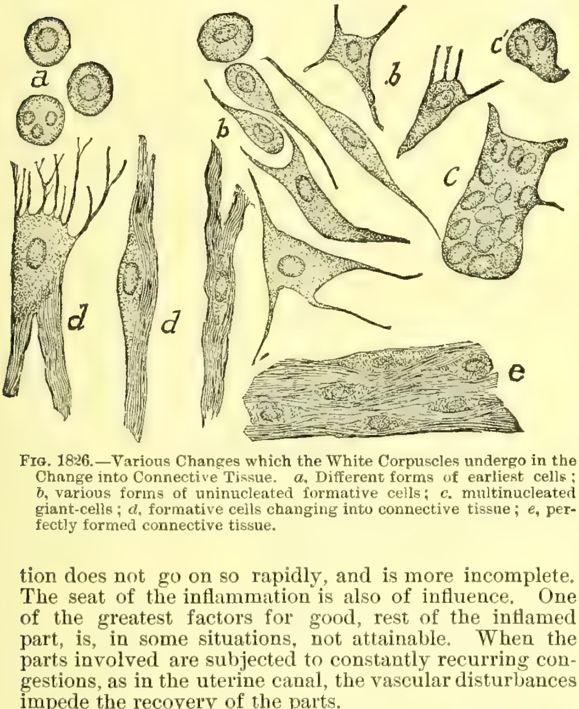

FIG. 1826.—Various Changes which the White Corpuscles undergo in the Change into Connective Tissue. *a*, Different forms of earliest cells; *b*, various forms of uninucleated formative cells; *c*, multinucleated giant-cells; *d*, formative cells changing into connective tissue; *e*, perfectly formed connective tissue.

tion does not go on so rapidly, and is more incomplete. The seat of the inflammation is also of influence. One of the greatest factors for good, rest of the inflamed part, is, in some situations, not attainable. When the parts involved are subjected to constantly recurring congestions, as in the uterine canal, the vascular disturbances impede the recovery of the parts.

The effect which inflammation has on the general condition of the individual depends upon a number of factors. It is evident that the seat of it must play an important part; the most circumscribed inflammation in an organ of such importance for life as the medulla oblongata will be more dangerous than the most severe inflammation of an entire extremity. One of the most marked effects on the body is shown in the rise of the general body temperature, the symptomatic fever. This does not depend upon the extent of the inflammation. The most severe acute inflammation of the kidneys may run its course entirely without fever, and even wounds as large as an amputation stump are not generally accompanied by fever, if the wound is treated on the open method. On the other hand, small suppurative inflammations, and even those not accompanied by suppuration, are accustomed to produce fever when they are situated in parts where a free drainage away of the products of inflammation is not possible. Many theories have been advanced to explain this symptomatic fever. That of Zimmermann, who regarded the inflammatory area as the seat of increased heat production, from which the heat of the entire body became increased, may now be regarded as false, since we have seen that there is no heat production in the inflamed part, and its temperature does not rise above that of the large internal organs. Still, the fever is something secondary to the inflammation, and some action must proceed from the inflamed area which affects the whole body. Whether the disturbing influence exerts its action by means of the nerves or through the circulating fluids, is a question which has been much discussed. The fact that the fever does not rise on the first day of the inflammation, but later, speaks against its nervous origin. As proof for this have been adduced the numerous cases in which a fever has been the effect of psychical disturbances, as fright; further, the attacks of fever in the course of certain neuroses; and, finally, the so-called urethral fever, that appearing after a severe catheterization, but with no wound of the urethra. Especially the urethral fever was taken as an example of fever from the stimulation of peripheral nerves. It may be regarded that the symptomatic fever depends upon the resorption of something from the inflamed area. It is an old experience of surgeons that fever arises and is highest when the most favorable conditions are given for resorption; and when the products of inflammation are removed, as when an abscess is opened, the fever diminishes. Various attempts have been made to ascertain just what is the substance which is re-absorbed. Billroth and Weber found at the same time, but independently of one another, that when the products of animal or vegetable disintegration are injected into the blood-current, fever is the result. Fever takes place, not only when putrid pus is injected, but when perfectly pure—the so-called laudable—pus is used. Further, it is found that it does not depend upon the corpuscular elements of the pus, for when these are filtered off, and the clear pus-serum is injected, the fever takes place. It is, however, the more severe, the more putrid and altered the substance is which is injected. It was objected that the pus-serum still contained elements which could not be filtered off—not the red or white corpuscles and their débris, but lower organisms, which were still in the injected fluid. These were regarded by some as the cause of the fever. This theory can be entirely set aside when it is found that fever takes place regularly when there can be no question of the absence of organisms. The simple fracture of bones is accompanied by it, and it also appears when the details of antisepsis are faithfully carried out.

Considerable advance was made when it was found that a rise of temperature took place after transfusion, particularly when the blood of an animal was injected into the veins of an animal of different species, with a destruction of red blood-corpuscles as the result. Further, the various ferments have the same effect, and even the injection of large quantities of pure water. Small quantities of water are efficacious when they contain suspended insoluble, inert substances, larger than the diameter of red corpuscles, as starch and carbon. When the injection is made into the venous system these insoluble particles are caught in the capillaries of the lungs, and disintegration of the stagnating blood takes place. The action of the peripheral nerves has been excluded by entirely severing the nerves of an extremity and then producing an inflammation.

As the result of all the experiments that have been made, it may be stated that the symptomatic fever of inflammation is the result of the absorption of certain products from the inflamed area. These products may be any material, both soluble and insoluble, which results from the disintegration of any of the constituents of the animal body. In fever there is a greatly increased oxidation, and this symptomatic fever may be regarded, up to a certain point, as a conservative process, having for its object the oxidation and complete destruction of the re-absorbed material.

W. T. Councilman.

INFLUENZA. Synonyms.—Epidemic Catarrh; Epidemic Catarrhal Fever; Fr., Grippe; Ger., Epidemisches Schnupfenfieber.

Definition.—Influenza is a specific, self-limited, epidemic fever, characterized by catarrhal inflammation of the mucous membrane of the air-passages, and, in many cases, also of the digestive tract, by nervous symptoms, and by extreme debility.

Etiology.—There is no positive knowledge of the occurrence of influenza prior to the beginning of the sixteenth century. Since then repeated epidemics have appeared at irregular intervals, and have rapidly spread over large portions of the civilized world. It is, however, maintained by many authors, perhaps correctly, that not a few of the general epidemics described in the earlier medical writings under various names (catarrhal fever, Italian fever) were epidemics of true influenza. Parkes traces the disease back to the ninth century. Since the great epidemic of 1847–48, in which were stricken more than one-fourth of the entire population of London, and fully one-half that of Paris, there have been no very wide-spread or severe visitations of this disease. In the early part of 1879, and the summer of 1880, it prevailed extensively in the United States and Canada.

It is very probable that the action of the morbific principle of influenza, whatever its nature may be, is not limited to man. Epizoötics, very similar in many respects to the epidemics in the human family, have frequently prevailed among the domestic animals, especially horses and dogs. Although these epizoötics occur independently, they often happen simultaneously with, or immediately precede, epidemics of influenza.

The phenomena of epidemic influenza are only comprehensible upon a theory of a specific infecting virus or germ as its exciting cause. Its rapid diffusion, sweeping over whole continents in a few weeks, affecting nearly the entire population in a certain district, irrespective of age, sex, or condition, in a few hours after its first appearance, indicates some powerful morbific agent in the atmosphere, which acts specifically upon the respiratory organs and the nervous system. The histories of the various epidemics prove clearly that the disease is not in any way connected with climate, soil, elevation, or any known local cause. It is highly probable that it is produced by a minute organism, but thus far it has eluded discovery.

Seifert and others have described a peculiar micrococcus, found in the expectoration of patients with influenza, to which they attribute the development of the disease, but further investigations are needed to establish the claim. It is still a mooted question whether the disease can be propagated by contagion, although some recently recorded observations point strongly to the conclusion that it is feebly contagious.

The period of incubation varies largely both in individual cases and in different epidemics. It may develop immediately after exposure, from which it has received one of its popular names—*Lightning Catarrh, Blitz-Katarrh*—but in other instances there is a distinct stage of incubation lasting from a few hours to several days.

One attack does not confer immunity from future ones; some few even experience more than one seizure during the same epidemic. Epidemics of influenza, as a rule, last from four to eight weeks, although many run a shorter course, and often end as suddenly as they began. The rate of progress varies greatly in different epidemics, and also in the same epidemic as it spreads over different districts.

Morbid Anatomy.—The anatomical lesions found after death give meagre knowledge as to the pathology of influenza. A fatal termination is almost invariably due to some complication, and the structural changes found *post-mortem* are characteristic of the secondary disease, and not of influenza. Death rarely occurs in uncomplicated cases. The lesions peculiar to influenza are almost exclusively localized upon the respiratory mucous membrane. The mucous lining of the larynx, trachea, and bronchial tubes is hyperæmic, swollen, and covered with frothy or viscid muco-pus. The catarrh may extend to the finer bronchi, but is ordinarily limited to the trachea and larger tubes. The bronchial glands are sometimes enlarged and softened. The gastric and intestinal mucous membrane is more or less congested in a considerable proportion of the cases.

The solitary and agminate glands of the intestine are not usually implicated.

Symptoms.—Influenza usually begins abruptly, but in a certain proportion of cases it is preceded by a feeling of indisposition or general malaise of two or three days duration.

A well-marked chill, or chilliness alternating with flushing and heat, is at once followed by symptoms of a severe naso-pharyngeal catarrh, with cough, sore-throat, frontal headache, pains in the limbs, general muscular weakness, depression of spirits, and thoracic distress.

The fever is remittent in type, variable in intensity, and rarely exceeds 104° F. in uncomplicated cases. The pulse is moderately increased in frequency, and changeable in quality and rhythm.

Coincidently with the rise in temperature the symptoms of an acute catarrh, which constitutes the chief clinical feature of the disease, manifest themselves.

There is a feeling of stuffiness or of cold in the head, the eyes are injected and watery, the nares are irrritated, and presently pour out an abundant secretion of mucus. There are frequent paroxysms of sneezing, and epistaxis is not uncommon.

The mucous membrane of the mouth is hyperæmic, the throat sore, and the voice hoarse. In the milder forms of the disease the catarrh does not descend below the larynx, but if the lower air-passages are implicated the symptoms become more pronounced, and the attack assumes a more serious aspect. Cough is rarely absent from the beginning of the illness, and in most instances is severe and distressing, recurring in paroxysms, which are worse at night. At first it is harsh and attended with a scanty muco-purulent expectoration. The expectoration becomes more abundant as the disease progresses, and in the later stages may be streaked with blood. Sharp pains in the sides and beneath the sternum, dyspnœa, and suffocative paroxysms, are generally experienced; these often exist without any recognizable pulmonary lesion.

The catarrhal symptoms ordinarily begin to decline about the third or fourth day; cough, however, may continue for an indefinite period, especially when dependent upon a complicating bronchitis.

Disturbances of the digestive organs are commonly present at some period in the progress of the attack. In the majority of cases there are anorexia, coated tongue, epigastric tenderness, and colicky pains. Nausea and vomiting may usher in the attack and continue throughout its course. In the beginning the bowels are confined, but, in the later stages, diarrhœa, often dysenteric in character, supervenes.

The nervous symptoms are always pronounced. Severe frontal headache and pain in the eyeballs are uniformly present. There is marked muscular soreness over the whole body, especially about the chest, neck, and legs, and sharp neuralgic pains dart along the principal nerve trunks. Cutaneous hyperæsthesia of the head and neck is met with.

The extreme prostration of muscular strength with depression of spirits is a very remarkable peculiarity of the disease. Patients, from the beginning of their illness, are weak, foreboding, despondent, and incapacitated for the simplest mental or physical work. This debility is wholly disproportionate to the severity of the catarrh or the amount of fever, and generally continues long after convalescence is fairly established.

Vertigo, especially on rising, and mild delirium are present in a considerable number of the cases. While restlessness and wakefulness characterize most epidemics, some, on the other hand, are equally characterized by somnolence; thus the remarkable epidemic of 1712 is known as the *sleeping sickness*, from the almost universal presence of this symptom.

In the graver forms of influenza, muscular tremor, subsultus, and fierce delirium are sometimes observed.

Ordinarily the disease attains its height on the third day, and then rapidly declines, but in the graver types of the disease, or those in which complications disturb the course, convalescence may be delayed until the tenth or twelfth day.

Convalescence is often announced by the appearance of some critical discharge, such as profuse sweating, a copious secretion of bronchial mucus, a free discharge of sedimentary urine, or an attack of diarrhœa.

Relapses are not uncommon.

The most important of the complications of influenza are those which grow out of the characteristic lesions of the respiratory tract, namely, laryngitis, capillary bronchitis, catarrhal pneumonia, and less frequently, croupous pneumonia.

These complications are all liable to creep on insidiously, and their presence is only revealed by "an aggravation of the ordinary symptoms, or by the blending of their proper symptoms with those due to the influenza."

Besides the diseases just enumerated, which are simply exaggerations of the ordinary lesions, the course of many intercurrent or pre-existing maladies is gravely affected by an attack of influenza. Among those especially unfavorably influenced may be mentioned phthisis, emphysema, diseases of the heart and kidneys, neuralgia, and other chronic nervous affections. The rekindling, during convalescence, of old and fading neuralgias, attested by many observers, is a very curious feature of the disease.

The statement commonly made, that influenza is an important etiological factor in the development of phthisis, is, to say the least, highly improbable, but that consumptive patients are very constantly worse after passing through an attack of influenza is a matter of general observation.

Pregnant women attacked by influenza are liable to abort.

Prognosis.—The prognosis is favorable, but it is modified somewhat by the character of the prevailing epidemic, and the physical condition of those undergoing the disease. The very old, the very young, and those suffering from advanced pulmonary, cardiac, or renal affections bear influenza badly. Infants, fortunately, are less likely than adults to contract the disease.

A very large proportion of the fatal cases in every epidemic can be directly traced to some complication which has become engrafted upon the original disease. The mortality of the more severe recent epidemics has not exceeded two per cent. ; however, the immense numbers attacked make the total mortality considerable, even at this small percentage.

Diagnosis.—Influenza is not likely to be mistaken for any disease other than acute, non-specific catarrh. Isolated cases of each do bear a striking resemblance, but it is only in those scattered cases of influenza which now and then appear as forerunners of an approaching epidemic that this resemblance could mislead.

The numbers affected, the high fever, the extreme prostration, the prominence of the nervous symptoms, the short, regular, and uniform course of influenza will readily establish the diagnosis.

Treatment.—Since influenza is a self-limited disease, the mild and uncomplicated cases may safely be left to the resources of nature. Rest in bed, gentle laxatives, refrigerant drinks, an occasional opiate, to restrain cough and pain, and the employment of such general hygienic measures as are indicated in the acute infectious diseases will suffice for cases of ordinary severity. On account of the singularly debilitating effect of influenza upon the mental and physical powers, all depressing remedies and measures are contra-indicated from the onset of the attack. Quinia and morphia, given early and in full doses, are said to sometimes abort an attack ; failing in this they will, in moderate doses, render efficient service in all stages of the disease.

The inhalation of steam, pure and medicated, is of signal benefit in ameliorating the laryngeal and bronchial irritation. In the graver types of the disease, special care must be taken to detect the inflammatory lung complications, which steal on so insidiously and add so largely to the fatality. These complications must be managed according to the principles of treatment laid down in other pages of this Handbook.

Convalescence is frequently delayed by general debility or the continuance of some of the complications or sequelæ, so that a moderately prolonged course of tonics, or even a temporary change of climate may be advisable.

But little can be done in the way of prophylaxis. However, it has been often observed that those who are much exposed in the open air during the prevalence of influenza, are the first to sicken with the disease ; hence it may be well for the aged and debilitated, who are likely to suffer severely, to remain within doors during the continuance of the epidemic influence. *W. J. Conklin.*

INGROWN TOE-NAIL. This affection is characterized by an inflammation of the soft parts underneath and alongside the edge of the toe-nail. It may be congenital, but more commonly it is met with in adults. In occasional instances it would seem to be hereditary. Its most frequent location is on the outer side of the great toe, although it not infrequently involves both sides of the toe, and even of both large toes. The disease seldom occurs in the smaller toes, and is of comparatively slight importance when it does.

Beginning insidiously with pain and soreness underneath the side of the nail, which are increased by pressure, the affection often terminates in suppuration and ulceration. The granulations become exuberant, the parts about the nail become hypertrophied, and the whole toe is swollen, tender, and painful, rendering the patient totally unable to wear a boot, or even to walk. The nail also becomes deformed. Its edges curve in, and act as a foreign body, constantly irritating the inflamed tissues. Pus collects underneath the nail, decomposes, and tends not only to aggravate the suffering, but to keep the toe in a filthy condition. The duration of the disease is often protracted, many people suffering from it for months or even years, before obtaining permanent relief.

Cause.—Tight or ill-fitting boots are frequently the cause of this affection. High and narrow heels, narrowness of toe, and insufficient length, are common and important defects in boots, shoes, and slippers. Every step taken upon a high heel tends to push the foot farther into the shoe, and thus to crowd and cramp the toes, and not infrequently the affection under consideration is the result. The accumulation of dried epithelial débris under the nail also acts as an irritant. Paring the corner of the nail too closely tends to produce this disease by allowing the soft parts, which grow more rapidly, to rise up and obliterate the groove that the nail should occupy. As this latter comes forward again it necessarily impinges upon the soft tissues, and may excite inflammation. A markedly convex nail bordered by thick masses of soft tissues, predisposes the toe to this affection.

Treatment.—This may be palliative or radical. The cause should be removed if practicable. The nail should be trimmed squarely across the end, and the edges should be allowed to project beyond the free margin of the flesh.

The soft parts are to be kept well pressed back from the nail at its root and sides, and the epithelial débris is to be frequently removed. The boots should be of good length, wide across the toes, and should have low, broad heels.

In the lighter cases relief may at times be obtained by scraping the nail thin with a knife, or better, with a piece of glass, and cutting a deep notch in the centre of the free border. A bit of lint, or of cotton, may be drawn under the edge of the nail to raise it from the sensitive matrix, and to give exit to any pus which may have accumulated underneath. The same object may be obtained by means of an elastic cord passed under the border of the nail, and the ends secured to the dorsum of the foot by adhesive plaster. Agnew makes use of a piece of cork, cut in a peculiar shape, to separate the nail and the flesh. Should there be much inflammation at any time, it should be treated with water dressings or flaxseed-meal poultices. A starch poultice is also an admirable dressing in many cases.

One of the best local applications to repress exuberant granulations is the powdered nitrate of lead. It is to be dusted upon the parts every day, until a crust is formed, underneath which healing will frequently take place. Should the crust become loosened by the suppuration, it may be removed and fresh powder be applied, until the granulations show a tendency to a healthy cicatrization.

The cause of the affection having been removed, many cases of only moderate severity may be satisfactorily managed in the manner above described. Not infrequently, however, either from neglect or from improper treatment, the tissues have become so extensively inflamed that more radical measures are required. Several methods for obtaining a permanent cure have been recommended. The most common one is to split the nail throughout its whole extent, and to remove about one-third of it on the affected side. This operation usually gives temporary relief, but it is often not permanent, for, as the nail grows, it again becomes embedded in the redundant and sensitive tissues. Another method, which has been advised and practised to some extent, consists in removing the nail, and destroying the matrix with caustic potash. The cases demanding an operation of this severity must be rare. I have never seen one.

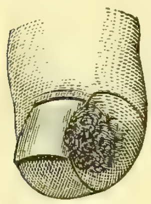
Fig. 1827.

The operation for a radical cure of this affection which, in my experience, has proved most satisfactory, is one which was brought before the profession many years ago by Dr. B. E. Cotting, of Roxbury, Mass. The nail is not interfered with, but all of the overlying tissues, together with the side of the toe, are sliced off freely. As the wound heals the contraction of the cicatrix tends to draw the soft parts away from the side of the nail, so that there is little danger that the latter will ever impinge upon the former.

The operation may be done as follows: The patient having been etherized, a narrow-bladed, sharp-pointed knife is thrust down through the toe, alongside of the nail, and made to cut its way backward as far as the matrix extends, and forward to the free edge of the nail, as shown in Figs. 1827 and 1828. The side of the nail should be exposed throughout. There is more danger of removing too little of the soft parts than too much. Unless a large portion is taken away the result may not be satisfactory. The exact location, as well as the comparative size and thickness of the parts removed, is shown in the accompanying cuts.

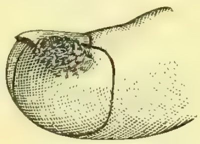
Fig. 1828.

For twenty-four hours the wound may be dressed with a dry compress and bandage, simply to control the hæmorrhage, no ligatures being required. Afterward the treatment may be in accordance with the fancy of the operator. I prefer absorbent gauze and iodoform. A weak solution of chlorinated soda makes the best wet dressing I have ever used. Recovery usually takes place in about two weeks, and in a short time thereafter the ordinary boot may be worn without fear of a return of the disease. Having performed this operation many times during the past eighteen years, I have never yet seen a case in which the result was not permanent and satisfactory. *George W. Gay.*

INHALATIONS. Inhalation is the method of applying remedies to the respiratory tract, whereby the medicament is brought into contact with the mucous membrane of the nose, mouth and pharynx, larynx and bronchi, and deposited possibly in the alveoli of the lungs themselves. It is a well-known fact that finely divided substances do penetrate into the air-cells, as in the case of colliers, grinders, and others, who are constantly breathing in fine dust while engaged in their occupations. On the other hand, it is extremely doubtful if any of the medicaments, used in any of the numerous inhalers at present in vogue, is deposited upon the walls of the ultimate lung alveoli. The conditions under which, and the extent to which, sprays or vapors enter the lungs, are by no means satisfactorily settled. Inhalers are used in a general way by the physician, without serious thought of what becomes of the medicament which they contain. We do not here allude to sprays directed immediately upon the pharynx and larynx, but to the nasal and oro-nasal inhalers used to such an extent in the treatment of the various forms of lung disease.

After numerous experiments with different inhalers, and with steam and air-spray producers, Dr. Hassell[1] concludes: first, that substances of a gaseous and unirritating character pass readily into the air-passages and lungs; second, that fumes from unirritating mineral and organic substances enter with comparative facility; third, that this is true, particularly, of the vapor of hot water, though the medicament suspended in such vapor is but little effective, unless the temperature be constantly maintained and the substance used be highly volatile; fourth, that medicated sprays, volatile and non-volatile, warm or cold, may reach the lungs, but in very diminished quantity; fifth, that the employment in oro-nasal and oral inhalers of carbolic acid, creasote, thymol, benzoin, etc., is of little utility.

Again, Dr. Hassell proves that an amount equal to *four-fifths* of these more important antiseptics is, when used in the ordinary oro-nasal inhalers, *recoverable after the completion of the inhalation.* This very important fact, relative to the volatilization of any given medicament, needs especial emphasis in view of the extremely unsatisfactory results following even the prolonged inhalation treatment.

The volatilization of any given medicament depends upon many things: its own volatility; the temperature, humidity, and motion of the air; the extent of surface exposed; the manner in which it is inhaled, etc. We are wont to forget how greatly temperature affects the evaporation of carbolic acid, for instance, which at zero is nothing, and at 90° F. is but slight. Hassell found that 0.500 of a gramme of crystallized phenol, dissolved in one drachm of rectified spirit, after exposure for two hours to 80° F., lost but 0.069 of a gramme; which confirms the statement that *four-fifths* of the substances most used remain in the inhaler.

Again, in a series of experiments on much-used medicaments, solid and liquid, exposed for one hour to 100° F., he found that forty grains of ol. pini sylvestris lost 13.3 per cent. of its weight; of ol. juniperi, 12.9; of thymol, 2.9; of iodine, 16.8; of coal-tar, 28.7; and of creasote, 3.5; and with many other much-used substances, even under the best conditions, and in the best inhalers, he found that the amount lost was very small. With these facts before us, and knowing that deep and strong inspirations greatly assist inhalation, and also, that in those very persons who are the subjects for the inhalation treatment the respiratory power is generally so greatly enfeebled, are we not justified in concluding that, as a rule, inhalations are really of much less value than is ordinarily supposed?

The Apparatus Employed in Inhalation.—The number of inhalers now in use is so great that it is neither possible nor necessary to allude to the great majority of them in this article. For full information those interested are referred to the works of Solis-Cohen and Oertel.

The simplest and most natural form of gas-inhalation is that of air itself, its condition being modified to suit certain requirements—for instance, the warming of the outer air to make it suitable for inhalation in cold weather by delicate persons; and for this purpose the apparatus of Dr. Joscelyn Seaton is the best and most convenient (*Lancet*, April 19, 1884).

No form of inhalation has excited more discussion than the use of rarefied and compressed air. Many kinds of apparatus have been employed for this purpose. I can refer to the most complete and useful forms only. In some the pressure is applied to the lungs only, in others to the whole body. One of the earliest forms was that of Waldenburg, constructed on the same principles as Hutchinson's spirometer. It consists of one cylinder, with its open end downward immersed in water, within a second or larger cylinder. By a system of cords, pul-

leys, and graduated weights the upper cylinder may be lowered or raised, and the contained air condensed or rarefied. Connected with the interior is a tube, with mouth-piece which fits tightly over the patient's mouth and nose. In determining the indications for pneumatic treatment in different chest diseases, Waldenburg was "guided by the causes of dyspnœa, whether the product of inspiratory or expiratory obstruction, or of both;" for instance, he concluded that in emphysema retarded expiration was the immediate cause of the dyspnœa, and in phthisis that inspiration was chiefly impeded; and he made the patient inspire condensed air or expire into rarefied air, as the condition demanded. Both these methods were found to give considerable benefit when properly employed. The great objection, unquestionably, to its use is, that of necessity the same air is breathed and rebreathed, and there is no means of medicating the air in the cylinder. The double apparatus of Cube and of Tobold, and the single apparatus of Schnitzler, are improvements on that of Waldenburg. The latter's double apparatus may be used for the inhalation of either compressed or rarefied air, or for the inhalation of compressed air followed by expiration into rarefied air. This last method Schnitzler seldom uses, as he considers it in many cases hurtful, owing to the great variation of pressure. The apparatus of Geigel and Meyer, on the same plan as those mentioned above, but with a double ventilator allowing of a constant and continuous effect, is considered by Dr. Hassell as by far the best.

These various forms of transportable apparatus have been used with more or less success. They are all, however, open to the objection, that it is impossible to medicate the atmosphere breathed; and it is greatly to be doubted whether the mere inspiration of compressed air and expiration into rarefied air increases the chest capacity or improves the diseased conditions (chiefly emphysema and asthma) in which this method of treatment is, or was, chiefly used. Another, though entirely different, form of apparatus for the inhalation of compressed air is what is known as the *pneumatic chamber*. In this apparatus the pressure is exerted upon the surface of the whole body as well as on the interior of the lungs. The pneumatic chamber is constructed on the principle of the diving-bell.

One of the first pneumatic chambers was devised and constructed in 1838, under the direction of M. Tabarié. It consisted of an iron chamber of an elliptical form, capable of accommodating from four to twelve persons, and to this was attached a small ante-room. Into the chamber the air was forced by a steam-pump until the required pressure was obtained, while the object of the ante-room was to allow of ingress and egress without any disturbance of the air-pressure in the chamber. There were also arrangements for the supply of fresh air and for the escape of the expired air, a mercurial manometer for measuring the pressure of the air, and a thermometer. Each sitting was supposed to last two hours. During the first half-hour the pressure was gradually increased to the required extent, at which it was maintained for the next hour, while during the last half-hour it was carefully lessened. This form of chamber has since undergone various modifications; first by Lange, who aimed at simplifying it and reducing the cost; he also made better arrangements for the ventilation, and for warming and cooling the air. Lange's chamber is cylindrical instead of elliptical, like Tabarié's, and is for four persons only; it has also a regulator for preventing the too sudden entrance of the air, and an arrangement for charging the air with volatile medicaments, as, for instance, pinewood-oil; for cooling the air, cold water is sprinkled upon the air-pump, the pipe, and even on the exterior of the chamber; while for warming it the room in which the apparatus is placed is heated by a stove. There is also an arrangement whereby the air can be rarefied.

It is unnecessary in this short article either to give engravings or to describe minutely the mechanical arrangements needed in order to fulfil the various requirements of a well-appointed pneumatic chamber. It must suffice merely to enumerate the more important details, viz., the means of producing compression and rarefaction of the air, the method of entering and leaving the chamber without disturbing the air-pressure, the arrangements for the admission of fresh air and for filtering the same, for the escape of the expired air, for warming and cooling the air, and for preventing it becoming overladen with moisture; the instruments provided for determining the degree of pressure, the temperature, and the humidity, as a manometer, thermometer, and psychrometer. For those who require to be made acquainted with all the necessary structural details, the reader is referred to the work of Dr. Oertel, who devotes nearly one hundred pages to the subject of pneumatic chambers.

There is little doubt that these pneumatic chambers are of great practical use, and extremely gratifying results have been obtained from them. (See Lectures by Dr. C. Theodore Williams, who has one in constant use at the Brompton Hospital, London.) Pneumatic chambers may be found at Lyons, Montpellier, Nice, Stockholm, St. Petersburg, Berlin, Vienna, Wiesbaden, Ems, etc. Such chambers, as may be seen, are very elaborate and expensive pieces of apparatus, and as such are entirely beyond the reach of any but the wealthy.

There is another form of inhalation-chamber, first proposed by Dr. Hassell (*British Med. Jour.*, August, 1883), the atmosphere of which is uniformly charged with any given substance in a gaseous or aëriform condition; though no attempt is made either to rarefy or compress the air. Dr. Hassell thinks that by spreading a large amount of the medicament on an extended surface (of some cotton fabric, which he considers the best), and by a proper augmentation of temperature, very great volatilization will take place. One of these chambers he has constructed at San Remo, and considers that in it he has a "powerful and valuable means of treating many diseases of respiration." The writer is, however, inclined to agree with Dr. Douglas Powell,[2] who thinks that Dr. Hassell's proposal to have antiseptic inhalation-chambers is impracticable, and of doubtful advantage, as the patients might not improbably suffer more from deficient supply of air than they would gain in lung medication.

Among other forms of apparatus devised for charging the air of rooms with medicament, may be mentioned Dr. Robson's eucalyptus machine, Messrs. Savory and Moore's vaporizer, and Dr. Neale's so-called *Chemical Lung*, the purpose of which latter is to take off the carbon dioxide and ammonia in the atmosphere of a room where a person has inhaled a long time.

The inhalation of medicated vapors is effected mainly by the well-known oral and oro-nasal inhalers. The fault of construction of all these inhalers is great, and the facts, as shown above, that four-fifths of the most important medicaments may be recovered after two hours' inhalation, and, furthermore, that the motor power is derived from the patient, whose respiratory power in most cases is seriously impaired, may well shake our faith in the efficiency of either oral or oro-nasal inhalers. Especially is this true of the latter, and it is extremely questionable whether one is justified in ordering patients to use them at all.

Finally, we would state that we have little confidence in the antiseptic action, in diseases of the lungs themselves, of the majority of oral and oro-nasal inhalers, as at present constructed, charged, and used, because, among other reasons, the quantities of phenol, creasote, and thymol employed are usually far too small, and their volatility too low. In affections of the throat, and of the upper part of the larynx, they may possibly be more efficient. For the more volatile substances, as alcohol, chloroform, ether, turpentine, eucalyptol, etc., these inhalers are, no doubt, much more effective, especially in affections of the throat.

Of the oro-nasal inhalers at present in use, those are the best which are provided with a valve to prevent the escape of the expired air through the sponge, with two nasal valves to allow of its escape from the nostrils, and with a flexible rim or border. A piece of india-rubber tubing is perhaps as good as anything to permit of adaptation to the contour of the face. The respirators of Dr.

Edward Blake and Dr. G. Hunter Mackenzie answer the above description in most respects.

The respirator of Dr. J. B. Yeo is one much recommended. It consists of a piece of perforated zinc, folded so as to fit over the nose and mouth, with an aperture in front for a small piece of sponge held in position by two folds of zinc. It has many faults, and the writer has seen no marked good proceed from its use.

Dr. W. Williams's oro-nasal inhaler is an improvement over Dr. Yeo's, as is also the globe-oro-nasal inhaler designed by Dr. Hassell, of which a full description may be found in his work. All these respirators are chiefly useful where there is an offensive odor from lung-vomicæ. The nasal inhalers, such as those of Dr. J. Ward Cousins, Dr. George Moore, and Dr. Feldbausch, of Strasburg, are also of little practical use, and, moreover, are open to this great objection, that when employed the wearer usually breathes through his mouth.

Spray-producers or Nebulizers.—A great many different forms of spray-producers have been constructed; many of these are obsolete and are no longer used. The object of them all is to finely divide, to atomize, as it is termed, the medicated fluids, and to project through very fine apertures the little streams or sprays of atoms with such force as to aid their entrance into the air-passages. The motor power which may be employed varies; sometimes the compression is produced by air, at other times by water or steam. When air is employed, the pressure may be exerted either by means of the air-pump, or, more easily and simply, by the hand acting on an elastic ball. The spray-producers worked by a force-pump for either air or water are expensive, and require for the most part the aid of an assistant, so that they are but little used. The forms of apparatus now generally employed are few, simple in their construction, and by no means costly. Dr. Sass's cold-spray apparatus is the most convenient now in use.

Steam-sprays.—In the steam-spray apparatus there are usually two receivers, one corresponding to that of the air-spray producer, namely, the receiver for the medicaments, and the other being the boiler for the generation of the steam, the two being brought into contact, as in the air-spray apparatus, by means of Bergson's tubes. Siegle's steam-spray apparatus, as modified either by Codman & Shurtleff, of Boston, or by J. Solis-Cohen, or by Oertel, is most effective and convenient.

No doubt, by the employment of sprays, either hot or cold, any quantity of a given substance may be sprayed into the mouth and thus applied to the fauces, and so far they are effective; also, by them medicaments may be made to reach the stomach in any quantity, and thus the system at large may be brought under the influence of the remedies employed.

A portion of the medicament used does certainly make its way into the air-passages; of this, satisfactory proof has already been advanced; but from all that has been stated the conclusion is fully warranted that the quantity which thus enters is, in proportion to the whole amount taken, comparatively small. Still the quantities which are absorbed by the mucous membrane of the fauces, and which enter the stomach, doubtless contribute in an important degree to the medicinal effects obtained. All sprays, however, whether cold or hot, possess this great advantage, that they are capable of diffusing non-volatile as well as volatile substances; and steam-sprays, from their greater penetrating power, are believed to more readily penetrate to the lungs.

Apparatus for the Inhalation of Vapors.—The vapor of hot water differs from steam chiefly in that it is given off at a lower temperature.

A great many contrivances have been resorted to for the inhalation of the vapor of hot water, either simple or medicated, from the open mouth or spout of a jug to much more elaborate and complete arrangements.

The essential requirements of a well-constructed vapor-inhaler are, a lamp to maintain the temperature of the water, a thermometer to register it, an admixture of air to cool the vapor, and a suitable mouth-piece, provided with valves to prevent the expired air from passing into the water or medicated liquid. Such an apparatus is Dr. Mackenzie's eclectic inhaler. Boiling water is placed in the receiver to start with, and the temperature is maintained usually at from 140° to 150° F. The patient may inhale for a period of from five to thirty minutes, according to the nature of the case, but the mouth should be removed from the mouth-piece from time to time. "About six inspirations should be taken in a minute." To avoid taking cold, the patient should remain indoors for half an hour after using the inhaler.

This, with the exception of Beseler's globe and Semple's atomizing inhalers, is the most useful apparatus we now have, and the writer can bear testimony to most excellent results from the use of comp. tinct. of benzoin in it, in acute and chronic bronchitis, and in cases of pulmonary softening and cavities. The chief objection to its employment is, that the person becomes greatly heated while inhaling, and is likely to take cold unless great care is used.

In Semple's inhaler (made by Parke Davis & Co., of Detroit) alcohol and glycerine, or fluid cosmoline, are the vehicles in which the medicaments are suspended, and the fluid is volatilized in the form of a smoke.

Again, the inhaler for dry or concentrated vapors, designed by Dr. Hassell, would seem to be a useful piece of apparatus, and it has the great advantage of absolute cleanliness.

Such, in brief, are the various forms of apparatus now used in the inhalation treatment of diseases of the throat and chest. It only remains for us to consider the latest and the most important and practical method, not only for the use of rarefied and compressed air, but also for the application of sprays and vapors to the respiratory tract. I allude to the *Pneumatic Cabinet*, and the method of *Pneumatic Differentiation*, as perfected and applied by Mr. Joseph Ketchum, a practical physicist of Brooklyn, N. Y. This apparatus promises to be of such great importance in the prevention and amelioration of pulmonary disease, and is now attracting so much attention in this country, that I shall describe it with some care:

The instrument in question is a cabinet of proper size and shape to hold a man in the sitting posture, rigid enough to withstand the superficial pressure when rarefaction is produced inside, and is easily transportable. It is made of steel sides, bottom and top, fitted to wrought-iron angle frame, with a heavy glass front and a door in the rear, air-tight when closed, but capable of being opened at an instant's notice. In front and below the glass is a projection which sustains the atomizing apparatus and medicine receptacle. In the centre of the glass an aperture is pierced, through which the breathing-faucet penetrates far enough into the cabinet to allow a soft rubber breathing-tube to be slipped on. The breathing-faucet is constructed of hard rubber, and is of such shape and design that, when in use, the condensate collecting in it on the patient's side of the stop-cock, flows out through a drip-hole in the latter, while the condensate formed in front flows back into the medicine receptacle and is re-used. At the side of the projection is another stop-cock entering the steel front of the cabinet, used for decreasing the rarity or pressure inside the cabinet without removal of the breathing-tube from the mouth of the patient. In front, and immediately over the glass, is a manometer gauge connecting with the interior of the cabinet, filled with mercury to the zero point, and graduated to one-tenth of an inch. On the top or roof is a bellows, whose interior capacity is approximately one-thirtieth of the cubic capacity of the cabinet. The interior of the bellows, by a valve in its floor, communicates with the interior of the cabinet. This valve is operated from the inside of the cabinet. The bellows communicates with the outside air by another valve in its upper side operated from the rear of the cabinet. The bellows is operated by a rock-shaft running across the top of the instrument, supported by shaft standards on each side, and to one end of which an operating lever is keyed. The saturation of the air is accomplished by the use of an atomizer and stand operated by compressed air or steam, and of such

height as to deliver spray directly into the mouth of the breathing-faucet.

The method of administration is so simple that, under the general instructions of the physician as to medication, length of time, and amplitude of force as indicated by the gauge, it can be, and has been, satisfactorily used by the invalid's ordinary attendant.

The patient is first instructed in the method of respiring entirely through the mouth, and is told that while the air will flow down into the lungs without any effort, a slight blowing force will be necessary to expel it, preparatory to the next inspiration.

He is next told that when the air of the cabinet is rarefied, he may experience a slight swelling of the tympana, and to relieve which he is instructed to swallow, thus opening the meatus of the Eustachian canal, and allowing enough of the enclosed air to flow into the throat to produce equilibrium with the surrounding atmosphere. He is next seated in the cabinet on a chair adjustable for height, and raised or lowered until his mouth is on a plane of slightly higher elevation than the opening in the glass front, and a clamp is placed on the external nares to prevent the escape of air by that channel. The door is now closed, the valve-rods having previously been placed to indicate that the valves are set to produce rarefaction; the operator passes to the front of the instrument, and, having closed the breathing and auxiliary faucet, with his eye on his gauge, moves the lever operating the bellows toward the rear with a slow, even motion, until the difference between the levels in the two arms of the manometer indicates a rarefaction of, say, from one and one-half to two inches.

The object of this procedure, before beginning the treatment proper, is to expand the residual air in the lungs, and if any has been imprisoned behind mucous or catarrhal plugs, or infarctions, to exert a pushing influence from behind and toward larger bronchi, and produce ultimate evacuation.

The rarefaction is now allowed to run down by the use of the auxiliary faucet until the manometer indicates the amount deemed proper by the attending physician, and the spray having been adjusted to the breathing-faucet and turned on, the patient is instructed to take the breathing-tube and place the mouth-piece with which the end is fitted in his mouth, in front of and against his teeth, enclosing the rim with his lips to prevent displacement by the interior pressure. The stop-cock is slowly turned on. Nature asserts herself, and the inflation of the cheeks and the rise of the thoracic envelope indicate that the restraint first offered by the stop-cock is now offered by the cell-walls, and the same influence that is distending the cheeks so markedly is distending the alveolar walls.

This first inspiration has distended every cell and avenue, and the process of diffusion with the air charged with vapor of the medicament proceeds with a rapidity commensurate with its enlarged avenue of approach, and the act of expiration commences. This is brought about by the patient's forced muscular expiratory effort, and the pressure of the cell-walls on the loaded air reduces its hydrometric condition to a point where condensation is effected exactly in proportion to the energy of the effort, minus the effect of the increased temperature. Subsequent respiration is no greater in amplitude than normal, except in so far as the feeling of inflation may induce a greater expiratory effort; but after a time the patient becomes fatigued, notwithstanding frequent rests (during which he respires the air in the cabinet), and the expiratory act becomes labored. The door is now opened and the valves, inside and out, are set for vibration of the inclosed atmosphere synchronously with the respiratory act from plus to minus, the weight of the outside air. In other words, the top valve is closed and the bottom opened wide. The door is again closed, and the breathing-faucet is opened, and with the lever the bellows is raised until it has reached an elevation equal to one-half its height, and the patient is instructed to again place the tube in his mouth and make his first act one of inspiration. At the same time the operator raises the bellows to its full height, and holds it during the interval preceding the expiration. Then allowing it to descend to the midway point, he forces it to completely collapse, thus compressing the air to the extent of one-half the contents of the bellows, and by this compression forcing the collapse of the thoracic walls and consequent compression and condensation. This method continues, if used as a pulmonary calisthenic, or as a "means of topical application of remedial agents," until in the judgment of the operator the dose or exercise is deemed sufficient.

Such being the construction of the cabinet, it will be seen that it can be put to the same uses as the various forms of apparatus we have mentioned. The method of treatment, however, by this cabinet is entirely different from any ever used before, viz., first, the diminution of atmospheric pressure on the thoracic walls and peripheral parts, and the forcible inhalation of a comparatively dense medicated atmosphere; second, the increase of pressure on the body generally, and forcible expiration into comparatively rarefied air; third, and most important, the alternate rarefaction and compression of the atmospheric pressure around the body, and the consequent involuntarily increased inspiration and expiration.

What is the result when we rarefy the air in the cabinet? We remove pressure from the body generally, the chest-walls expand, and the capacity of the lungs is increased, while the inspiration of the relatively dense air outside dilates the bronchi and vesicles, opens contracted tubes and atelectatic alveoli; and, to put it simply, we compel the patient to take an extraordinarily long and deep inspiration.

"We hold, again, that in this method not only is the enlargement of the chest and the capacity of the lungs increased, so that the tidal air is increased fifty per cent., but also that tubes are distended, air-sacs ordinarily inactive or but feebly expanded are brought into fullest action, increased oxygenation is produced, blood more fully vivified, and heart circulation stimulated; poorly developed, weak chests made stronger, pleuritic thickenings [3] and adhesions stretched, and bronchial contractions dilated" (Dr. Hudson).[4]

The results of treatment by this method of differentiation have certainly been extremely encouraging, and we have very good reason for believing that the medicated spray or vapor is carried down farther into the lungs by this method than by any other yet used. Those interested in the clinical results are referred to the papers given below.[5] The writer has little doubt that this method of applying rarefied and compressed air to the treatment of lung diseases will supplant all others. As the physiological effect of rarefied and compressed air applied in the apparatus is not only very interesting, but is absolutely necessary for an intelligent application of the method, the author gives below the results of some original experiments, by Professor H. N. Martin and himself,[6] upon the circulatory and respiratory changes observed in animals placed in the pneumatic cabinet, as follows:

1. When the animal is breathing air from outside the cabinet, rarefaction of air within the cabinet causes a marked fall of general arterial pressure, but has no influence on the pulse-rate. The fall of pressure lasts a short time only (ten to twenty seconds), and is followed often by a temporary rise above the normal.

2. This fall of systemic arterial pressure depends upon two factors: greater flow of blood to the skin when the air around the animal is rarefied, and greater accumulation of blood in the lungs when they are distended.

3. Of these two factors accumulation of blood in the lungs is the more effective, for if the animal breathes air from the cabinet and not from outside, rarefaction of air within the cabinet (in this case accompanied by no special expansion of the *thorax*) has but a trivial effect in lowering arterial pressure.

4. When the animal is breathing external air, rarefaction of the air within the cabinet usually has no effect upon the respiratory rate or the extent of individual respiratory acts, unless the fall of blood-pressure is considerable. If it is considerable, symptoms of anæmia of the

medulla oblongata are seen. In most cases there is more forcible dyspnœic breathing ; in some there are dyspnœic convulsions similar to those which occur when an animal is bled to death, and due to the same cause, viz., deficient blood-flow to the respiratory centre.

5. The rapid recovery of general arterial pressure, while the animal is still in a rarefied atmosphere but breathing external air, is probably due to excitation of the vaso-motor centre, which, as is well known, is excited whenever its blood-supply is defective.

6. The brain, inclosed in a rigid box, which is practically unaffected by variations in atmospheric pressure, has its circulation more disturbed in the pneumatic cabinet than any other organ except the lungs.

7. Compression of the air within the cabinet, while the lungs are in communication with the exterior air, causes a considerable but transient rise of blood-pressure. This is *probably* mainly due to the forcing of blood from the cutaneous vessels.

8. Compression of air within the cabinet, while the lungs are in communication with the exterior air, slows the pulse as the arterial pressure rises. This is probably due to excitation by increased intra-cranial blood-pressure of the cardio-inhibitory centre, but further experiments are necessary before this can be positively stated.

9. In certain cases, when the air within the cabinet is rarefied and the animal is breathing external air, the respiratory movements cease altogether for several seconds. As to the cause of this physiological "apnœa" we are not yet ready to form an opinion. It may be due to the extra accumulation of air in the alveoli of the lungs, or to distention of the lungs exciting those fibres of the pneumogastric which tend to check inspiration.

From these facts it is easy to see that this method should be used with care, but especially would the writer emphasize the *danger of submitting persons with any form of heart disease*, or old persons, to treatment by *rarefied and compressed air*.

The author arrived at this conclusion from his experiments, and it is an interesting fact that Professor Loomis[7] came to the same conclusion from clinical observation, and gives it as his most positive opinion that it is only with great risk that persons with any form of cardiac disease can be sent into high altitudes. I do not know that attention has been called to this point before.

THE USE OF INHALATIONS IN DISEASE.—Balsamic and antiseptic inhalations are employed for almost every form of acute and chronic catarrhal inflammatory disease of the nose, naso-pharynx, larynx, trachea, and bronchial tubes, and are certainly useful in many cases. Objections to cold atomized inhalations are the low temperature and excess of water ; and to steam atomized, or warm vapor, the heat and excessive moisture, which increase the susceptibility to, and risk of, fresh attacks of coryza, laryngitis, bronchitis, etc.

On this subject Beverley Robinson says : "Does not our experience warn us against the indiscriminate use of hot vaporized or cold atomized inhalations ? To what climates do we send our patients suffering from chronic inflammation of the mucous membrane of the respiratory tract ? Usually to moderately warm, equable, *dry climates ;* sometimes to cold, clear, elevated regions, where the daily average of temperature shows but moderate changes ; sometimes, also, to temperate regions, where there is considerable moisture in the air, but where, at least, there are no rapid changes of temperature, and no prevailing chilling winds. In the matter of artificial inhalations, therefore, to be truly rational, should the indications be changed, or should we not rather approximate, so far as we are able, nature's laws and nature's cure ?"

Warm, moist inhalations are often of great use in catarrhal troubles, especially in winter time, but great care should be exercised. On the whole, there would seem to be less danger and equally good results to be obtained by the use of Semple's inhaler. Robinson thinks very highly of the vapor inhalations produced in Beseler's inhaler. In acute nasal catarrh great relief may be obtained from the inhalation of benzoin, eucalyptus, creasote, etc. After considerable experience the writer is inclined to think the very best form in which to use these inhalants is that of Parke Davis & Co., Detroit. A petroleum product is used as a base or diluent, viz.:

℞. Ol. eucalypti .... ʒ j.
Fl. cosmoline .... ℥ j.

℞. Comp. tr. benzoin .... ℥ j.
Fl. cosmoline .... ℥ ij.

℞. Beechwood creasote .... ʒ j.
Fl. cosmoline .... ℥ ij.

The use of these inhalants will often stop the sneezing and flow of mucus from the nasal passages, so annoying in acute coryza. The writer is somewhat sceptical as to the practical good of inhalations in chronic nasal catarrhs, though many writers claim that they greatly assist the local treatment.

In dysphonia, so frequently connected with, or dependent upon, chronic nasal catarrh, vapor inhalations will often produce marked benefit to the voice and to the general condition of the pharynx. Vapor inhalations are undoubtedly useful in the treatment of simple chronic pharyngitis, and in this disease when accompanied by numerous enlarged follicles. They diminish the amount of secretion, while promoting the healthy functional activity of the glands of this region, and lessen and cause to disappear, at times, those painful feelings in the throat which are often the source of anxiety and considerable annoyance to debilitated patients in whom a neurotic element predominates.

In acute and chronic laryngitis they quiet irritation, lessen hoarseness, diminish cough, change the aspect of the inflamed mucous membrane, and, in certain cases at least, evidently hasten the disappearance of symptoms, and the establishment of a cure.

In cases of acute, subacute, and chronic bronchitis these inhalations are markedly beneficial, and deserve further and more extensive trials on the part of the medical profession. In acute bronchitis inhalations of compound tincture of benzoin, or of oil of tar, are productive of great ease to the patient by lessening the hard, irritating cough, and the tightness over the anterior thorax which is usually present in these cases to a more or less marked degree. In subacute and chronic bronchitis, inhalations of tincture of benzoin and fir-wood oil—one part of the latter to eight parts of the former—after one, or several weeks, diminish the cough, expectoration, and hoarseness.

Several cases of purulent bronchorrhœa of months' standing, in the writer's experience, have been entirely relieved by continued inhalations of compound tincture of benzoin alone, in Mackenzie's inhaler.

In asthma, too, of various origin, the use of the following inhalant has often been productive of great relief from the distressing symptoms :

℞. Ext. stramonium seed,
Fl. ext. hyoscyamus .... āā f ʒ j.
Fl. ext. belladonna .... ʒ ss.
Glycerine .... ℥ j.
Alcohol, q. s. to make .... ℥ iij.

In emphysema the most satisfactory method of treatment the writer has yet used is that of differentiation in the pneumatic cabinet—the alternate rarefaction and condensation of the air—so that the person is made to inhale a compressed atmosphere containing a medicated spray or vapor, and to exhale into one comparatively rarefied.

THE TREATMENT OF CONSUMPTION BY INHALATIONS.—The writer would state at once that he does not consider any form of inhalation of other than temporary good in true tubercular phthisis. In the catarrhal forms of this disease, however, especially in its early stages, much benefit may be derived from them.

Personally I have obtained the best results with benzoin in the formula given above. Beverley Robinson finds a mixture of creasote and alcohol, equal parts, most generally useful in the beginning of pulmonary phthisis. The inhalant is used in a Mackenzie or Semple inhaler, or better, is *applied* by means of the pneumatic cabinet above described. This method of treatment undoubtedly leads

to alleviation of the cough. Robinson says, "this is particularly true of catarrhal disease complicating tubercular infiltration of the lungs. Even in these cases, however, inhalation seems to give a sort of renewed vigor, and the patient feels decidedly cheered and encouraged.

"Again, in the use of all forms of inhalation, while the soothing and modifying effects are partly due to direct local application, still there are similar effects produced by the process of absorption and elimination going on in the mucous membrane lining the affected parts.

"In regard to the effects of vapor inhalations upon the sputa and the dyspnœa in phthisis, where these symptoms depend in a certain degree upon concomitant bronchial catarrh, the following facts have been noted: Not only are the sputa diminished, as a rule, by inhalation, but they show, not infrequently, manifest changes of color. They also become decidedly less thick and viscid, and from being green-looking and tenacious they are soon foamy, like soap-suds, and thinner, or show the aspect of mingled mucus and pus. The breathing is also frequently improved, and the patient can make more exertion without panting or becoming exhausted from lack of breath. At times the improvement of breathing, of the cough, and of the amount and character of the sputa is accompanied by auscultatory changes which seem to indicate improvement as regards the bronchial catarrh located at the apex or apices.

"Owing to the diminution of cough and the decrease in the abundance of the sputa, the patient's sleep is not so much disturbed—and thus I have found the use of the dry inhaler during the evening, and even at bedtime, evidently a greater promoter of rest than cough-mixtures containing anodynes."

The writer's experience enables him to confirm all these statements, especially the great relief from the use of the inhaler at bedtime. It has been my custom to employ it in this way for some time, and in many cases it does away with the need of codeia or morphia, the indiscriminate use of which, in phthisis, is so greatly to be condemned.

The writer's experience with oro-nasal inhalers in phthisis has been limited and very unsatisfactory. The great drawback to the use of the ordinary inhalers is the lack of inspiratory power in those very persons for whose benefit they are prescribed.

In the pneumatic cabinet, however, we have a means by which this may be overcome, for by the differentiation method we can make the person take just as deep and forcible an inspiration and as complete an expiration as we desire. Again, in this apparatus we have a means of preventing phthisical degeneration of the lung, as in those cases in which the only signs are the pulmonary crumpling, the mucous click, the dry râle of beginning phthisis; for by the forcible distention of the lung we may prevent that atelectasis of the lung which in itself causes and keeps up lung degeneration.

In such cases trouble has been, and may be, prevented, by a daily blowing up of the collapsed lobules (which follows rarefaction of the air in the cabinet), the lungs expanding to a greater extent than normal as a consequence of the increased thoracic expansion, and the collapsed and useless lobules are thereby "blown up" and brought again into play. *Frank Donaldson, Jr.*

[1] The Inhalation Treatment of Diseases of the Organs of Respiration. London, 1885.
[2] Diseases of the Lungs and Pleuræ. Third edition. London, 1886.
[3] See case reported by author in Maryland Medical Journal, February 13, 1886. [4] New York Medical Record, January 9, 1886.
[5] H. F. Williams, Medical Record, January 17, 1885, and N. Y. Medical Journal, October 3, 1885; V. Y. Bowditch, Boston Med. and Surg. Journal, July 16, 1885; E. Darwin Hudson, Jr., Medical Record, January 9, 1886; Mr. Joseph Ketchum, ibid.; Frank Donaldson, Jr., Maryland Medical Journal, February 13, 1886.
[6] Preliminary Account of Experiments in regard to the Circulatory and Respiratory Changes observed in Animals placed in the Pneumatic Cabinet, by H. N. Martin and Frank Donaldson, Jr., M.D., New York Medical Journal, May 15, 1886.
[7] Heart Disease and High Altitudes, New York Medical Journal, June 12, 1886.

INOWRAZLAW is a "Kreisstadt," in the district of Bromberg, and not far from the town of the same name, in the Prussian province of Posen. It is a newly established health-resort, having a casino, well-appointed hotels, etc. The following is the composition of the principal saline spring, per 1,000 parts of water:

Sodium chloride	306.810
Sodium bromide	0.168
Sodium sulphate	0.885
Potassium sulphate	1.705
Calcium sulphate	4.491
Calcium carbonate	0.285
Magnesium chloride	3.451
Ferrous carbonate	0.042
Total solids	317.837

The specific gravity at 63.5° F. is 1.207. There is also a stronger brine containing a much larger proportion of magnesium chloride and potassium sulphate. The water is diluted and taken internally, and is also used in the form of spray. *T. L. S.*

INSANITY. General Introduction.—*Historical.*—Insanity, in its historical aspect, forcibly illustrates the philosophic truth that theories have always governed the world, even in its most practical relations.

Religious and philosophic hypotheses determined for long ages the civil and social status of the insane, and the whole manner in which they were to be dealt with, as well as the means to be taken for their cure.

The Old Testament gives the earliest record of cases of insanity. Saul (*circa* 1063 B.C.), possessed by an evil spirit, was solaced by the music of David's harp, and became well again. Nebuchadnezzar, King of Babylon, "was driven from men, and did eat grass as oxen, and his body was wet with the dew of heaven, till his hairs were grown like eagles' feathers, and his nails like birds' claws" (Daniel iv. 33), and at the end of six years (569–563 B.C.) he recovered and was re-established upon his throne.

The poets mention Ajax, Orestes, and others as insane, and in ancient Egypt cases of mental derangement were sent to the temples to be cured by priests, and they were regarded as afflicted by the gods or possessed by demons. Similar views of divine inspiration, or of diabolical possession, prevailed generally until the time of Hippocrates (460 B.C.).

The Father of Medicine clearly propounded certain important truths in psychiatry that served as a basis for the science. He taught that the brain was the organ of the mind, and that it was subject to physical laws and diseases like other organs, and that insanity followed abnormal conditions of the brain. He described disorders of mind that essentially correspond with mania, melancholia, and dementia, and he divined the important bearings of heredity, and he dwelt on the value of a study of temperaments in the treatment of cases. These teachings became the accepted medical doctrine, and they were enlarged from time to time.

Aretæus (60 A.D.) more definitely portrayed the general symptoms as well as the course and prognosis of insanity. He regarded the various forms as simply stadia of the same disease. Cælius Aurelianus (100 A.D.) distinctly taught that insanity was brain-disease with predominant psychical symptoms; that there were mental and bodily causes, and that all severe measures of restraint should be rejected, and that medicinal and dietetic means of cure alone should be employed. He also fully emancipated himself from the humoral pathology of Hippocrates.

Galen (160 A.D.) recognized mania, melancholia, dementia, and imbecility, and he added the secondary and sympathetic origin of insanity from visceral sources to the generally accepted idea of brain-disease as the primary cause. He also distinguished between insanity and the delirium of fever.

These comparatively enlightened views of the nature of insanity were unfortunately destined not to endure. With the downfall of the Roman Empire, and with the decline of civilization, gross ignorance and superstition with regard to the insane again prevailed, and their lot became more wretched, if possible, than at any previous time. They were again supposed to be possessed of evil

spirits, and not only exorcism, but also the most ingenious and horrible means of torture were employed, and if, as martyrs of this fanatical theory, they survived the free use of steel and fire they were still liable to be left to wear out their life in chains. Thousands of them were executed as witches, and relatively few among them found protection and humane treatment in cloisters. Many of those were insane among the fifty thousands of persons whom a careful historical estimate states to have been formally executed as witches, or effectually persecuted to death from 1400 to 1700 A.D. This pitiful state of the insane continued throughout the Middle Ages, except in Oriental lands with superstitious theories as to their inspiration that served the purpose of averting harsh measures, and it was not until long after the Reformation and the revival of letters and of science that there was any very essential amelioration in their condition. Although special buildings were erected for the reception of the insane in Italy in the latter part of the fourteenth century, and in Spain in the beginning of the fifteenth century, and although subsequently in various countries efforts were made for their safe keeping in separate places, it may still be asserted that the care extended to them was simply custodial, even until the latter part of the eighteenth century. The consideration of those modern theories that again restored to the insane the rights of humane care and of curative treatment naturally comes under the following division of this article.

Nosological.—In order to systematically trace the origin of the early nosological systems of psychiatry, of which mention is about to be made, it would be necessary to consider a part of the history of general medicine and of the general evolution of knowledge during the seventeenth and eighteenth centuries. Suffice it to recall the fact that during the Middle Ages the concrete sciences could hardly be said to exist, and of the abstract sciences mathematics and psychology alone were especially cultivated—that it was not until the seventeenth century that Kepler and Galileo appeared as the heralds of the advance of modern science—that Descartes founded modern philosophy—that Bacon aroused the thinking world by his inductive method and scientific empiricism in the study of nature—that the great philosopher Leibnitz appeared as the harbinger of the dawn of a new era of knowledge in Germany, and that Harvey published his researches on the circulation of the blood. Just previous or subsequent to these master minds were other great thinkers like Boehme, Locke, Condillac, Kant, and Schelling with his remarkable and elaborate system of natural philosophy, the influence of which can be traced in German medical literature of the present day. The ingenious hypotheses of these men pervaded all channels of human thought, and formed a natural and necessary stage in the evolution of modern science. With these facts in view, it ceases to be a matter of wonder that for so long a time the early writers in psychiatry failed to emancipate themselves from metaphysical and philosophic theories. The sacerdotal phase of medical history that had extended from ancient Egypt and the Levitical physicians to the Æsculapian priests of Greece and Rome and throughout the Middle Ages, finally gave way to the philosophic phase of medical science of the seventeenth and eighteenth centuries. If the medical writers of this epoch escaped the rationalistic deductions of Descartes, Leibnitz, and Kant, they fell into the inductive methods of Bacon, Locke, and Condillac. The various medical sects, however, nominally cloaked under the terms solidism, humoralism, animism, and vitalism, were doctrinally based on some adaptive modification of the theories of these men.

Having thus briefly traced the ultimate source of the general medical doctrines of the authors about to be mentioned, it will be possible to speak of them summarily, and with the omission of details that would otherwise have been necessary.

In Germany there were two rival schools of psychiatry, the psychological and the somatic. Stahl (1660–1734) may be considered as the founder of the psychological school, of which he made animism the philosophic basis. He developed at great length the influence of the moral upon the physical man, and he taught that the spirit presided over the body and all its organic processes. He made a purely metaphysical division of insanities, and he regarded moral agencies as alone effectual in treatment. The most noted followers of this school were Heinroth, Ideler, Hofbauer, Blumrœder, and Reil. Heinroth, who was Professor of Psychiatry in Leipzig, was the best representative of the school. He taught that all evils, and insanity among them, spring from sin; that the spirit rules the body and can banish disease so long as there is no loss of moral freedom through sin. He denied the hereditary nature of insanity because, as he claimed, the spiritual and essential part of man cannot be transmitted. Cheerfulness and faith in God were the chief reliance for a cure. He made an able analysis of the faculties of the mind, and, in accordance with it, he furnished a metaphysical classification of insanities.

The somatic school, composed of men like Nasse, Jacobi, Vering, and Friedreich, held that physical disease was the cause of insanity, and they tried to construct a nosology based solely on somatic relations. Jacobi even went so far as to pronounce all insanity as merely a symptom of disease that was just as apt to be seated in other organs as in the brain. The mental symptoms were of minor importance—mere signs of some underlying disorder, to which the chief attention was to be directed—and the only classification of them was into: 1st, insanity without delusion; 2d, insanity with delusion; 3d, insanity with delirium or incoherence, and without delusion.

The labors of these men led at last to the thorough and systematic study of the somatic symptoms, and tended to establish a belief in the curability of the disease. The latter point was of great importance with reference to the general amelioration of the condition of the insane, who had ordinarily been dealt with as beyond hope of cure.

In France Sauvages (1762) published a work, "Nosologie Méthodique," that marked an epoch in nosology. He adopted the general plan of naturalists, and essayed a scientific classification of diseases into classes, orders, genera, and species. Insanity was included in the eighth class and third order, as vesaniæ. Both the psychical and physical symptoms were kept in view in this arrangement.

Pinel, whose renown is due in part to the humane and fearless way in which he removed mechanical restraint from his patients in the "Bicêtre," in 1792, classed insanity among the neuroses, and grouped it, on a purely symptomatological principle, under four heads—mania, melancholia, dementia, and idiotism. His general nosological idea was that a large number of symptoms should first be carefully studied and then grouped according to natural history methods, and his higher point of view was that of inductive philosophy, more especially as expounded by Condillac.

Esquirol followed in the main the classification of his great master, Pinel. He made important additions, however, in the recognition of partial insanities, with predominating gayety or sadness, and in clear distinctions between congenital and acquired states of intellectual weakness. His arrangement was as follows: 1st, lypomania; 2d, monomania; 3d, mania; 4th, dementia; 5th, imbecility and idiocy.

In England Cullen (1772) improved on previous nosological attempts under natural science methods. He arranged all diseases into classes, orders, genera, and species. Insanity formed order IV., vesaniæ, among the neuroses, and had four general divisions: 1st, amentia; 2d, melancholia; 3d, mania; 4th, oneirodynia (somnambulism and other derangements of sleep). The subdivisions were numerous and based on symptomatological or etiological distinctions that corresponded in many regards very truthfully with clinical facts.

In 1786 Arnold published a treatise on insanity, with a nosological arrangement based on Hartley's modification of Locke's tenet, that the source of all human knowledge is sensation and reflection; and naturally, any mental changes must be included either among sensorial ideas or the notions formed by reflection. Hence Arnold's two

main classes were, 1st, ideal insanity ; 2d, notional insanity. The first of these classes was subdivided into four, and the second into more than twenty, species, according to the psychical symptoms, which were considered to constitute the obvious and essential part of the disease ; and causes were rejected in the definition of the orders, as they were followed by such inconstant and variable mental results. Both practical knowledge and metaphysical acumen were displayed in the description of the different forms of insanity.

Other English authors that employed a psycho-symptomatological classification, were Crichton and Good (1798), both of whom followed the Linnæan method in their general nosology.

Did space permit, this brief review of psychiatrical nosology, up to the close of the eighteenth century, might be extended to include the writings that have appeared since that date ; but the literature of this subject has kept pace with the general development of medical science, and it is now so voluminous that it would exceed the limits of this article to do more than to name some of the chief modern authors and the leading principle of their classifications.

The psychological principle, consisting in the arrangement of mental disorders in accordance with some systematic division of the mental faculties, has been followed, among others, by the following authors :

Griesinger published, in 1845, a remarkable work that essentially formed a résumé of the entire scientific knowledge of his day on mental pathology. His division was primarily into thought, feeling, and will, and secondarily into states of mental exaltation, of mental depression, and of mental weakness. Ray and Maudsley have somewhat similar arrangements, though with differences in terminology.

Bucknill and Tuke in their standard work class under the intellect, feelings, and propensities, the forms of mania, melancholia, dementia, imbecility, and idiocy, and as further qualifications make use of the terms partial, general, and before and after complete development. Hammond classifies under intellect, emotion, and will, likewise ; but he differs from other authors in recognizing a form based on volition as existing independently of ideas and emotions.

Another important ground for classification is the causes of the disease.

Morel employed this etiological principle most freely in his treatise on insanity in 1860, and Skae, a few years later, elaborated it so as to include about thirty different types.

The pathological states that underlie the mental disorders would, if they were more fully known, be the most scientific basis of classification, and in view of this fact French authors, especially, have persevered in efforts to utilize these states exclusively in their nosological arrangements. Among them may be mentioned Parchappe, Voisin, and Luys. The two latter make vascular pathology a general ground of division. Still another principle is the anatomo-physiological, which was ably but prematurely used by Laycock in 1865. He recognized the law of constant relation between structure and function of organs, and he attempted to mark out the seat of the disordered mental functions by cerebral topography, and in so doing he presumed upon the truth of points in cerebral physiology that are still in doubt.

This anatomo-physiological principle has also been kept in view, with reference to its use in the classification of forms of mental disease, by Meynert, whose untiring zeal and industry in its development are well shown in his recent work, "Diseases of the Forebrain." Other nosological systems are founded not on one, but on several of the above-mentioned principles, and may be termed compound.

Thus Schüle arranges the varieties of insanity according to the causes and symptoms, and then establishes certain clinical groups. Ball divides states of mental alienation mainly according to symptomatology and etiology. Spitzka divides into pure insanities and complicating insanities. The latter is an etiological group, and the first group is subdivided into classes that are, respectively, symptomatological, pathological, and etiological.

Krafft-Ebing, in his comparatively recent standard work, gives one of the best modern classifications, which is as follows:

A. Psychical Diseases of the Developed Brain.—I. Psycho-neuroses. 1. Primary curable states : (*a*) melancholia—(α) melancholia simplex, (β) melancholia attonita ; (*b*) mania—(α) maniacal exaltation, (β) acute delirious mania ; (*c*) stupor ; (*d*) hallucinatory delirium. 2. Secondary incurable states: (*a*) secondary monomania ; (*b*) terminal dementia—(α) dementia agitata, (β) dementia apathetica.

II. Psychical Degenerative States. (*a*) Constitutional affective insanity ; (*b*) moral insanity ; (*c*) primary monomania ; (*d*) insanity with compulsory representations ; (*e*) insanity from constitutional neuroses ; (*f*) periodical insanity.

III. Brain Diseases with Predominant Psychical Disturbances. (*a*) Dementia paralytica ; (*b*) lues cerebralis ; (*c*) alcoholismus chronicus ; (*d*) dementia senilis ; (*e*) delirium acutum.

B. Arrests of Psychical Development.—(*a*) Idiocy ; (*b*) cretinism.

The long list of only partially acceptable arrangements of mental disorders witnesses to the inherent difficulty of the subject, for the complexity of the symptoms of diseased mind certainly cannot be less than that of normal mental phenomena. All scientific classification is but the methodical grouping, not of one order of facts, but of all the known data of a subject. A nosology of insanity, therefore, should contain some reference to, or abridgement of, the chief symptomatological, etiological, and pathological truths that have been ascertained as common to its several varieties. The psychical symptoms, without doubt, practically constitute the essential part of the disease, for during their absence insanity does not exist from a social or legal point of view, however evident its technical presence may be to the expert, and they would naturally occupy a foremost place in a nosological table, were it not that the causes and lesions that underlie them often present wider grounds for division, as well as more direct indications for treatment.

The first group, therefore, in the classification which is about to be given, is intended to show the prominent etiological and pathological relations of insanity, and the second group is made to include such remaining varieties as most naturally fall under a psycho-symptomatological principle of division. The endeavor has been to avoid the introduction of new varieties and of a new terminology, and at the same time to admit such forms as have been recognized by the most competent writers. In two or three instances only has a new designation been suggested for certain phases of mental alienation that seemed, in the writer's observation, to have a distinct clinical existence without any appropriate term. The natural history order of division is followed simply because it is convenient for marking degrees of subordinate relation, and not because it is supposed to add aught of technical value ; for such is the extreme intricacy of the phenomena of mental disease that it is questionable whether an exact scientific arrangement of them can ever be made as consistently as in the case of the things with which natural science has to deal. The separate forms of mental derangement will not be discussed here further than may be incidentally required in explanation of their assignment to certain of the orders, but the general psychical and somatic symptoms of which they are all composed will be fully considered under the head of Symptomatology in this general article, and the separate forms will be treated *in extenso* in the special articles which follow.

Classification of Insanity.

Group A.

(*Somato-etiological.*)

Class I.

From general organic arrest of development.	Order 1. Idiocy. Order 2. Cretinism. Order 3. Imbecility.

CLASS II. Emerging from constitutional neuropathic states, usually hereditary, though occasionally acquired.	Order 1. Instinctive insanity of childhood.	
	Order 2. Primary monomania.	
	Order 3. Moral insanity.	
	Order 4. Periodical insanity.	
CLASS III. With established neuroses.	Order 1. Epileptic insanity.	
	Order 2. Hysterical insanity.	
	Order 3. Hypochondriacal insanity.	
	Order 4. Choreic insanity.	
CLASS IV. In connection with the physiological crises.	Order 1. Puberty—Pubescent insanity.	
	Order 2. Maternity—Puerperal insanity.	
	Order 3. Menopause—Climacteric insanity.	
	Order 4. Senility—Senile insanity.	
CLASS V. With general systemic morbid states.	Order 1. (Toxic.)	Genus 1. Alcoholism.
		Genus 2. Morphinism.
		Genus 3. Plumbism.
		Genus 4. Hydrargyrism.
	Order 2. (Diathetic.)	Genus 1. Phthisical.
		Genus 2. Podagrous.
		Genus 3. Rheumatic.
		Genus 4. Pellagrous.
		Genus 5. Limopsoitosic.
		Genus 6. Malarious.
		Genus 7. Anæmic.
		Genus 8. Post-febrile.
		Genus 9. Myxœdematous.
CLASS VI. With definite pathological conditions of the encephalo-spinal vaso-motor or peripheral nervous system.	Order 1. With organic lesions of cerebral tissues.	Genus 1. General paresis.
		Genus 2. Syphilitic insanity.
		Genus 3. Organic dementia.
		Genus 4. Typhomania.
		Genus 5. Traumatic insanity.
	Order 2. With vaso-motor and peripheral lesions.	Genus 1. Sympathetic insanity.

GROUP B.

(*Psycho-symptomatological.*)

CLASS I. Feeling.	Order 1. States of depression.	Genera. (Primary.)	1. Cœnæsthetic depression.
			2. Melancholia simplex.
			3. Melancholia agitata.
			4. Nostalgia.
		Genera. (Secondary.)	5. Chronic melancholia.
			6. Secondary monomania, with depression.
	Order 2. States of exaltation.	Genera. (Primary.)	1. Cœnæsthetic exaltation.
			2. Mania simplex.
			3. Mania transitoria.
		Genera. (Secondary.)	4. Chronic mania.
			5. Secondary monomania, with exaltation.
CLASS II. Intellect.	Order 1. States of weakness.	Genus 1. (Primary.)	Primary mental enfeeblement.
		Genus 2. (Secondary.)	Terminal dementia.
	Order 2. States of stupor.	Genus 1. (Primary.)	Acute primary dementia.
		Genus 2. (Secondary.)	Sequential stupor.
CLASS III. Will.	Order 1. States marked by impaired volition.	Genus 1. (Primary.)	Abulic insanity.
	Order 2. States of suspended will.	Genus 1. (Primary.)	Somnambulistic insanity.

The classes in this nosology are independently enumerated in the two main groups, which are thus drawn from two distinct points of view—first as to the physical origin, and second as to the mental form, of the disease. In the first main group the source of the divisions is sought and found in general organic arrest of growth, in perversions and defects of development, in general neuropathic states that may assume the shape of the major neuroses or of mental disorder at the time of the physiological crises, in general cachexias, toxic and systemic morbid conditions, and in distinct pathological lesions of the higher nervous centres; while in the second main group the subdivisions are made in accordance with the psychical features and outward manifestations of the disease. The necessarily brief explanatory remarks that here follow about the different classes, orders, and genera, will be supplemented by more complete information in subsequent parts of this article, more especially under the head of Symptomatology.

The comparative racial, tribal, or individual study of the human family shows alike innumerable stages of physical and mental development or degeneracy. All human beings may be regarded as tending toward one or the other extremes of intelligence or fatuity, and as marking in their own generation one grade in the bodily and mental rise and decline of the family to which they belong, as well as illustrating the normal course of all mental life, from the feeble flickerings of infant intelligence to the plentitude of adult faculties, and to the impotence of second childhood. This general anthropological truth, together with the biological law that like produces like in parent and offspring, conjoined to the pathological fact of the transformation of neuroses, opens the way to a ready understanding of the first four classes in group A. These classes represent the constitutional and degenerative types of insanity—the hereditary forms par excellence, even though they may be acquired in some instances—and they are so arranged that the degree of hereditary degeneracy in the main diminishes seriatim from the first order of the first class to the fourth order of the fourth class. The marks of degeneracy in the first class are often self-evident, while in the second class it requires a more experienced eye to detect the signs of transmitted defect of organization. In the third class the law of the transformation of neuroses just alluded to appears, and in the fourth class the inherent instability of nervous centres reveals itself at the time of any constitutional strain, as found in the developmental and involutional crises.

The first order, of the first class, idiocy, embraces the various grades of mental deficiency, from general arrest of organic development, due to deleterious influences active at the time of conception, during embryonic life, at birth, or in the early years of childhood. The mental defects may be arranged in an ascending series, from complete absence of all psychical manifestations to the low grades of intelligence that mark the transition to imbecility. There may be simply reflex movements and vegetative life, without conscious perception or sense of personal identity; or the senses may be active and a vague idea of personality may arise, and simple residua of outward impressions may be duly organized in cortical centres and associated, so as to be subsequently revived by sensorial stimuli, and the connection between simple ideas and the vocal signs of ideas may be formed. If, instead of this simple form of organic memory, however, there be voluntary memory and attention, and if, instead of the simple presentative faculty of perception there be present the representative powers of imagination and recollection, with even slight logical ability, the case should be classed under the head of imbecility.

Imbecility includes every degree of mental, moral, and physical defect of development between the higher grade of idiocy and the average state of normal being. Feeble-mindedness is a term applied to the higher forms of imbecility, but it is not best to multiply words so long as there is no natural circumstance that demands it. As regards the degree of degeneracy in imbecility, and in idiocy as well, the most fundamental standard of comparison for the physical status is the power of reproduction of the species, and for the mental status the power of acquiring language.

Imbeciles of the minor degrees, engaged in manual routine occupations, may escape recognition as such, or they may simply—and this is more usually the case—become known as feeble-minded persons; or they may, by reason of special narrow aptitude or limited talent, become known as musical or mechanical geniuses.

Cretinism is both an arrest and a perversion of the growth of the whole organism, springing from peculiar meteorological and telluric influences. The fact that it is engendered by some specific noxious force of the elements, earth, air, and water, does not alter the philosophic rule by which its psychical manifestations are to be judged. Cretins, therefore, are to be psychologically classed according to the existing state of their mental powers, under idiocy or imbecility, of either of which they may represent the most complete or the slightest forms. As a matter of fact, there are more cretinous idiots than cretinous imbeciles, though in the cretinoid states considerable mental activity, and even decided talent, may occasionally exist.

Following next in Class II. are certain varieties of men-

Insanity.

tal derangement, accompanied by less gross defects of organization, but still the outcome of degenerative constitutional states that are ordinarily hereditary, though occasionally acquired, and that often betray themselves to the experienced eye by physical anomalies of structure as well as by functional peculiarities which will be hereafter described.

In Order 1 of this class the child rises above the functional level of idiocy and imbecility, and reveals its neurotic vice of constitution, if not in eclampsia or chorea, at least in a not less striking way, *i.e.*, in a perversion of its fundamental instincts. This perversion may appear in innumerable impulsive vicious acts, or in the most precocious and persistent demonstrations of aberrant sexual instinct, or may attain to the extreme degree of suicide or of homicidal violence. In accordance with the general rule, that the stronger the heredity the earlier the appearance of the insanity, it is placed prior in the degenerative series to the next form.

Primary monomania (Order 2) includes all those forms of fixed and limited delusions that are the morbid result and expression of a constitutional neuropathic condition, inherited in the vast majority of cases, though exceptionally acquired through acute diseases, or through mechanical, thermal, chemical, or any other kind of influences capable of originating permanent and deep-seated trophic disease of the general nervous system. It differs in origin, nature, and prognosis from those chronic partial insanities that are the sequel of the acute forms, and about the definition of which something will presently be said. The term monomania has become so general in medical and medico-legal literature that it is not to be discarded. It embraces clinical facts admitted by most modern authors, and it is better for writers to state definitely their own use of some word that better describes these facts, and consistently to adhere to it, rather than to exaggerate the danger of confusion from a mere verbal label. Surely, if some persons have a native and general organic vice of being, and if they are consequently by nature vain, narrow-minded, selfish, and suspicious, and get distorted ideas of things, and finally get a false and fixed idea that no force of argument or of objective demonstration can remove, and around this central delusion build up with a show of reason a whole system of fortifying delusions, but to the outer world seldom show other signs of mental derangement than this narrow circle of false conceptions, and go for years, or through life, without sinking into dementia, no confusion need spring from applying the term primary monomania to this affection of mind. On the other hand, if certain patients, after acute forms of insanity, make an incomplete recovery and give evidence of the permanent damage sustained chiefly by the retention of a few well-marked delusions, and sometimes so nearly resemble the cases above described as to be mistaken for them at first, in the absence of a reliable personal history, it is still well known that their false beliefs have no living or cumulative force, and that they will in time fade away and will not serve as the nucleus for other delusions, and that these patients will show a progressive loss of tone, of character, and of mental strength, and that they have entered upon a downward course that must end in dementia. For the time being, however, and, in rare cases, for more than one decade, they offer examples of fixed and limited delusions, which they will defend—truly not with the persistency of the primary monomaniac, but with such force of will and logic as they possess ; and as they are by no means to be confounded with chronic mania, of which mention will presently be made, they are best described by the term secondary monomania. These are the two main varieties of monomania with a distinct origin, course, and prognosis.

The cases of epileptic, pubescent, periodical, and other kinds of insanity, with morbid impulses to burn and steal, and that have been styled pyromania and kleptomania, are by no means cases of monomania, and this unfortunate use of the term has led to unnecessary confusion. It is possible that a monomaniac might commit theft or arson from the force of delusions or of impellent ideas, but this would be an incidence and not the essence of his disease. Single symptoms or single acts, however persistent, never constitute a variety of insanity, or a sufficient basis for the nomenclature of forms.

Moral insanity, Order 3, introduces another vexed question. The clinical facts are indisputable and unchangeable, while the conclusions that are drawn from these facts are variable and may be questioned. It is past all doubt that from congenital vice of organization there may be permanent moral deficiency, and it is equally certain that in those fully developed in moral nature disease may obliterate ethical feeling and leave the patient devoid of moral sense.

It may not be well to fully accord with some philanthropic psychologists, who are inclined to regard all criminals as insane and all extremes of immorality as partaking of the nature of mental derangement; but it is needful to give some name to that variety of insanity of which depravity and absence of moral understanding form the most decided manifestations, and which arises in connection with neuropathic states, inherited or acquired. The term moral insanity, already used by so many competent authors, is the one that is by preference retained in this nosology.

Periodical insanity, Order 4, is that variety which returns at stated intervals, either as mania or as melancholia, or which consists in the rhythmical alternation of these two states of exaltation and depression, separated or not by an apparent interval of health. In the latter instance it has been termed by French authors "folie circulaire," or "folie à double forme." In the great majority of typical cases a neurotic diathesis or the history of hereditary neuroses is to be found. Periodical insanity has also special features in common with the class of insanities with degenerative taint, with which it is therefore properly to be classed.

Class III. includes varieties of mental derangement in connection with established neuroses. The fundamental irritability and instability of the nervous centres expresses itself in epilepsy, hysteria, hypochondria, chorea, or in insanity. They are all allied neuroses, and they may be transformed into one another during hereditary or atavistic transmission. The insanity may precede, follow, or vicariously replace these neuroses, to which it may bear the more or less important relation of a terminal stage or of an epiphenomenon. The same line of motor, sensory, and trophic symptoms common to the neuroses may extend through the insanity, which may become in rare instances a complete rhythmical substitute for all these phenomena, so that there is established a periodical affection having stadia formed by the psychosis and one of the neuroses, with an interval of apparent health. In general the complexion of the insanity may be said to be derived from the neurosis that precedes it.

Order 1 of this class, epileptic insanity, is capable of division into a number of suborders of great importance from a medical and legal point of view, and they will be considered in the special article on this subject.

Order 2, hysterical insanity, also admits of certain subdivisions, one of which is epidemic insanity, which was typically illustrated, throughout the middle ages, by forms variously designated as tarantism, demonomania, and lycanthropia, and which has reappeared during the present century, both in Europe and in the United States, in a modified form attendant on extreme exaltation of religious feeling.

Order 3, hypochondriacal insanity, forms the terminal stage of severe forms of hypochondriasis as a constitutional neurosis, and it is to be distinguished from the hypochondriacal phase of general paresis, of monomania, and of other kinds of mental aberration, from which it differs frequently by a decided morbid anatomy ; for the paræsthesiæ that give rise to the characteristic ideas not rarely foreshadow the organic lesions that eventually occur and are to be found post mortem.

Order 4, choreic insanity, is best subdivided into that variety which appears in childhood, and that which occurs in adult life. For, as chorea is a disease in which the accessory cerebro-spinal structures and functions are

more especially involved, the degree of their education by the experience that age brings, will determine largely the clinical difference in the symptoms. As the spasmodic movements of the choreic child are simpler than those of the choreic adult, so, too, are the mental manifestations of incoördination much less complex in the former than in the latter. The relations of choreic to rheumatic insanity will be mentioned under the latter form.

Class IV. embraces the orders of insanity in connection with the physiological crises. All individuals that attain to old age pass through most of the evolutional and involutional stages of which the human organism is capable, but only a small percentage of them become insane from the exciting cause of the organic changes implied in the physiological crises, and in these it is necessary to presuppose some inherent defect of the nervous system.

The physiological crises here enumerated—puberty, maternity, menopause, and senility—are those that best serve a nosological purpose, but there are two others that have an etiological significance, and these are birth and dentition. It is not the duration but the depth and extent of the systemic changes effected that determine the relative importance of a physiological crisis, and birth, therefore, may in this respect be ranked in much the same category as the others. It is not alone that it suddenly alters the surrounding medium of existence, and gives rise to radical respiratory, circulatory, and nutritive changes, but that it is fraught with imminent dangers to the organ of mind itself, which, in its forced passage through the bony pelvic canal, may sustain the most severe structural lesions, eventuating in every grade of mental deficiency.

The average diameters of the fœtal head are greater in males than in females, and more of the former than of the latter sex suffer cranial injuries during delivery. It is possible, therefore, that the generally admitted excess of males over females attacked by insanity may be due in part to this earliest crisis of life. The student of mental pathology is impressed with the fact that thorough research is constantly increasing the proportion of cases in which the seeds of insanity are found to be sown very early in life. It may be, then, that the buccal, cutaneous, and gastro-intestinal effects occasioned by dentition, the second physiological crisis, have been overestimated; but the pathological cerebral results that may proceed therefrom have hardly received sufficient consideration. The turgescence in dentition is by no means confined to the gums, but there is a general afflux of blood to the head, and the eclampsiæ that are coincidences in some cases are in others immediate results, and they are often repeated with increasing severity, and they may end in death. In rare instances they have caused cerebral hæmorrhage, and it may well be surmised that they may determine lesions of a less palpable nature, not to mention the further fact that they may prepare the way for epilepsy, with all its unfavorable prognostic relations to insanity. That insanity does not often follow these early crises is due, not so much to their inadequacy as exciting causes, as to the general physiological fact that motor derangement in infancy is the correlative of intellectual disturbance in the adult. It is true that at this period there has been no actual development of mental powers, but the potentialities of mind are all there, contained in that delicate cerebral mechanism, and any damage sustained by it will result in future functional disorder.

When the critical periods of embryonic life, of birth, and of the first and second dentition are passed, there comes the physiological crisis of puberty, in connection with which arises pubescent insanity. The era of puberty, like the others to be mentioned, is not to be taken within too narrow limits, and it is by no means to be closely confined to the first appearance of the reproductive function, nor strictly even within the usually assigned range of from twelve to seventeen years.

Nature makes nothing in haste, and moves with majestic slowness in keeping with the wonder to be performed, and she always takes many years to make a full-rounded man or woman out of a boy or a girl. It is to be borne in mind that the psychical evolution does not proceed *pari passu* with the physical changes. The first sexual molimen arrives while the mental sphere is still pervaded with childish notions and feelings that are only replaced in subsequent years by those mature altruistic ideas and sentiments that are gradually evolved under the organic influences of sex.

It is the failure or the spasmodic course of this mental and moral evolution that forms one of the most essential conditions of pubescent insanity, which, like most forms of derangement from the perturbing influence of the reproductive organs, has usually a predominant tone of depression. The general relations between sexual and mental evolution are illustrated by the position of the foregoing classes on the general scale of human degeneracy. Thus it has been seen that there are degenerate human creatures with no higher functions than those of vegetative life, and in these there is seldom any sign of sexual excitation; that there are others, a degree more highly organized, having sexual feeling but no reproductive power, and others with slight intelligence and feeble procreative ability, and still others with sufficient inherent formative force for the development of the sexual but not of the mental functions, and finally the pubescent insanity order of beings, in whom the sexual and psychical evolution is accomplished, but with difficulty, and with irregularities in both orders of functions.

Maternity furnishes another physiological crisis in connection with the propagation of the race. There are women that perform the lesser function of ovulation and menstruation with but little more than ordinary signs of general irritability, who break down with complete mental derangement during the greater task of pregnancy and parturition.

In accordance with the general principle already mentioned, that inherited predisposition reveals itself the earlier the stronger it is, the heredity is presumably less in degree in this than in the previous order, though it would hardly seem to be less direct in some cases of mothers, daughters, and granddaughters, in direct line, who have suffered from puerperal insanity under precisely similar circumstances. The most practical subdivision of puerperal insanity is threefold—into that of pregnancy, of parturition, and of lactation. The insanity of pregnancy may occur at any time before delivery, but it is most frequent during the four months preceding confinement. It usually consists in exaggerations of the strange longings and appetites, of the morbid fears, capricious likes and dislikes, and affective perversions of this period, with a decided melancholic ground tone. Stupor is not frequent, but strong suicidal propensities are common. It may terminate with delivery or pass into the form next to be noticed.

The insanity of parturition appears within four weeks of confinement, and in a large percentage of cases within ten days of the parturient act. In most cases there is a sudden access of acute mania, which has something characteristic, not alone in the general physical appearance, but also in the restless incoherence—in the hallucinations of sight and hearing as well as of taste and smell—in mistakes in identity, and often in persistent obscenity of words and acts that point to the sexual origin of the trouble. It sometimes takes the form of melancholia, and still more rarely that of mania transitoria. It is to be distinguished from the delirious condition which, like any other traumatic delirium, may be developed by the mechanical violence and pain of labor, and from the delirium of puerperal fever. It is more frequent in primiparæ than in multiparæ, and it presents a different general physiognomy from the next subdivision of this order.

The insanity of lactation seldom appears before the second or third month after confinement, and it almost invariably proceeds from an ill-nourished, anæmic condition, which, in the first place, may have been caused or aggravated simply by the constant drain of lactation. It commonly assumes the shape of melancholia at first, though maniacal, and occasionally stuporous, symptoms occur later.

In addition to the phase of development and of full functional activity of sexual life already mentioned, there

is an involutional epoch, the menopause, that has its relations to mental disease, classed here as Order 3, under the term climacteric insanity. This epoch is not confined to the time of the cessation of menstruation, but to the years of most active involutional changes of the whole organism, which are ushered in usually by signs of decline in the reproductive organs during the fifth decade of life in women, and considerably later in men.

There are often pathological as well as physiological accompaniments at this period, such as profuse leucorrhœal discharges, menorrhagia, uterine displacements, local irritations, and reflex disturbances, which complicate the influence which the general trophic and retrograde changes exert as exciting causes of mental derangement. In those having hereditary predisposition to mental disturbance, the customary climacteric alterations in social feelings and in the whole affective nature are apt to pass beyond physiological limits, and the usual type of the insanity is some one of the states of mental depression. In some cases melancholia simplex passes into melancholia agitata, with frequent attempts at violence to self or others, made, however, without determination, in an automatic manner. In other cases the insanity may assume a reasoning character, and, though differing in real nature, it may have many features in common with primary monomania, with ideas of persecution and predominant sexual hallucinations that spring from the local organic changes in progress.

The question as to whether there is a climacteric in men is to be answered in the affirmative. The organic and psychical involution, however, is more gradual, and the types of mental alienation are not so well marked as in women, and they are in many cases difficult to distinguish from those of premature old age.

Senile insanity occurs with the final physiological era of life. Senility has the most widely varying temporal limits, and it may arrive as early as the fourth, or as late as the seventh, decennial period, and its real presence is determined only by the actual occurrence of involutional changes in the tissues of the various organs. This final era brings, both in vigor of mind as well as in strength of body, a natural decline that passes by easy gradations into second childhood. Garrulity, penuriousness, conservatism, and egotism, as the outgrowth of advancing years, are not abnormal; but if they are developed in old persons within a few months, along with irascibility, loss of natural affection, and immorality of conduct, they are symptoms of a pathological mental state, and they are due probably to vaso-motor disturbances, to inequalities of cerebral blood-supply from atheromatous arteries, to necrotic softenings, or to general convolutional atrophy.

Senile insanity may have the general form of melancholia, mania, or dementia. Typical senile dementia does not constitute probably more than twenty-five per cent. of the cases that occur during this period of bodily decline. There are even individuals, with inherited tendency to mental disease, in whom the insanity has many of the features of "folie raisonnante," and still others that have a general resemblance to paretic dementia. Some of the cases of mania and melancholia recover, in the sense that they regain the status of a person suffering a natural failure of mental powers.

The nosological basis of senile insanity is first clinical, in that persons with the bodily and mental traits of old age must necessarily furnish a different type of mental disorder from that of early life; and secondly, pathological, in that the tissue changes of this period, as exciting or predisposing causes, determine a certain order of abnormal psychical results. Heredity, according to a general law already indicated, is less in this than in any of the previous orders, and still there are those that bear within them a latent inherited weakness that only becomes evident at the close of life. It manifests itself in some families as premature old age and mental decay, and in others it assumes the type of some one of the kinds of mental derangement just mentioned.

Class V. includes varieties of insanity in connection with general systemic morbid states that may be the predisposing or exciting causes of the mental aberration. Order 1 is intended to embrace all toxic insanities, though only four of the most common genera are enumerated. The first of them—alcoholism—might have been classed under the neuroses, but it does not form one of them, except in certain degrees of development of the general systemic morbid state to which it gives rise, while, on the other hand, it is capable, in all of its stages, of becoming an exciting cause of insanity; and as it is strictly a toxic agent in all of its effects, direct or indirect, it is by preference retained in the present class. The important varieties of mental derangement in acute and chronic alcoholism will be made the subject of a special article, and therefore receive no notice here.

Morphinism, with its accompanying mental disturbances, is unfortunately becoming more common in this country, and opium may be called the alcohol of Eastern lands, in which certain kinds of insanity arising from its abuse have long been known. These pathological states may have the general type of mental depression or of mental exaltation, and they may be acute or chronic in their course. The special turn that the symptoms take is dependent largely on individual temperament, and on the presence or absence of hereditary tendency. One of the most remarkable acute forms may be termed phantasmagorial delirium, in which, through the extraordinary exaltation of the phantasy, the ideas in their rapid flight are projected as vivid sensorial realities. The condition at first may resemble simple opium intoxication, but the hallucinations persist, and finally overwhelm the reason.

Plumbism may be attended by a psychosis together with, or independently of, the motor and the sensory symptoms of this kind of poisoning. The psychical disturbances are acute or chronic in course, and of variable types. Acute states of stupor and hallucinatory delirium are common, and there is a pseudo-paralytic variety which, like the pseudo-paralysis of alcoholism, may be mistaken for general paresis. This pseudo-paralytic form is likewise to be distinguished from the hemiplegic dementia that occurs as the result of the arterial degeneration and cerebral hæmorrhages of chronic lead-poisoning.

In chronic mercurial toxic states, apart from the anæmia, arthralgia, tremor, and other physical symptoms, there are insomnia, hallucinations, and a general state of mental depression, with delusions and maniacal exacerbations. In occasional cases states of mental weakness are developed. In proportion as the toxic agent is both the remote and the immediate cause of the insanity, the symptoms have a degree of specific character. If strong hereditary predisposition is the remote cause, the toxic influence may simply excite an attack of insanity having different clinical features from those above mentioned.

In the diathetic order of insanities the general systemic morbid state may be both the remote and the direct cause. The co-existence of phthisis pulmonalis and insanity is like the common appearance of scrofula and idiocy. The diathesis and the mental disease may bear to each other the relation of prodrome or of sequel, or they may both be the common effects of a more general cause. The hypothesis that there is some intimate connection between phthisis pulmonalis and insanity would seem to be supported by the following clinical observations: 1, That the two diseases seem to be transformed into each other during hereditary transmission, so that phthisical parents beget children who become insane; 2, that in the same generation and family there are often some members phthisical and others insane; and, 3, that in the same individual the two diseases precede and follow each other, or co-exist. The proportion of phthisis pulmonalis among the insane is nearly double that found among a sane population of a class in which the surrounding hygienic influences are not more favorable. There is the further interesting clinical fact that the two diseases in some cases progress as if they were in a measure vicarious, so that the symptoms of one become latent when the manifestations of the other are most active. In some typical cases of phthisical insanity the brain disorder precedes the actual lung disease, though the anæmia, malnutrition, and other signs of the

diathesis are present. The most common type is melancholia, with delusions of suspicion and marked hallucinations. In the more advanced stages of the diathesis acute mania may occur instead of the ordinary phthisical delirium.

Podagrous insanity is the next diathetic type. The mental symptoms in gout are very common and well known, though they do not usually amount to insanity. The psychosis is apt to appear as acute mania on the sudden disappearance of the joint-affection. There have been authentic instances of the alternation of gout and mental derangement. In some cases, no doubt, the podagrous diathesis only favors the development of a latent vesania, but in other instances it would seem, by metastasis and meningeal inflammation, to be the immediate cause of acute maniacal states.

Rheumatic insanity is another form, in which the retention in the blood of deleterious products, or the general pathological state, may be regarded as the common cause of the motor, sensory, and psychical phenomena. There is usually maniacal excitement, with hallucinations and incoherence so long as there is any active inflammation of tissues, and in chronic cases melancholia or stupor may be observed. There may be choreic symptoms, but there are not apt to be suicidal impulses and acute mental depression as in true choreic insanity in the adult, and the sudden and brief outbreaks of choreic mania are also absent. The mania of rheumatic insanity is not an intensification of the delirium of feverish temperature, but is due to more profound brain disease, that may end suddenly in coma or death. There is sometimes a retrogression of all the physical symptoms during the height of the mental disturbances.

Pellagrous insanity forms a considerable percentage of cases admitted to Italian asylums. The pellagrous diathesis is developed under various unhygienic influences, of bad air and water, insufficient food, and more especially the continuous use of diseased maize that has a parasitic growth. The general symptoms are cutaneous eruptions, emaciation, chronic diarrhœa, and anæmia, and the mental disorder pursues a chronic course with hallucinations, depressing delusions, and suicidal tendencies, and often ends in complete dementia.

Limopsoitosic states may arise not only from forced or voluntary abstention from food, but also from loss of functional ability to assimilate nourishment that has been taken, so that starvation may occur in the midst of plenty as well as in mid-ocean shipwrecks or other like occasions. The essential cause is the absence from the blood of such nutrient materials as are requisite to sustain the normal functional activity of the brain-tissues. In former days, when severe religious fasts were more strictly kept, the mental disorders of extreme inanition were often to be observed on a wide scale. At the present day they are so rare that they are not always recognized when present, though they have a characteristic form. This insanity at first appears as a dream-like state, with hallucinations of the special senses and of tactile sensation, with illusive feelings of disturbed equilibrium, of wafting in the air, or of precipitation. The visions may be pleasing or frightful, and they are rapid and changeful. Consciousness is always disturbed, and there is always loss of voluntary memory and of power of attention, and if there be active response to outward impressions it is automatic. The further course of the mental disorder is determined by the state of the vital powers of the patient. If the exhaustion is extreme, the hallucinatory delirium will be replaced by a stuporous condition, but with remaining physical strength it will pass into a maniacal state.

The most practical interest attaching to limopsoitosis is the modifying influence which it exerts on the general symptoms of mental disorder when it becomes an intercurrent phenomenon in other psychoses.

The malarial diathesis has a causative relation to insanity. The mental disorder may have a chronic course, interrupted or not by returns of intermittent fever, during which the psychical disturbances may disappear only to recur on the complete subsidence of the malarial attacks. It is but natural to suppose that a paludal poison powerful enough to occasion such symptoms as coma and apoplectiform seizures might give rise to functional derangements of the mental faculties.

Acute forms of insanity, such as mania, occur in larval intermittent fever and have a distinct quotidian, tertian, or quartan type. The cerebral disorder takes the place of the usual symptoms of the fever, just as some of the lesser neuroses, such as trigeminal and sciatic neuralgias sometimes do. In still another rarer class of cases the insanity is not completely vicarious of the fever, but there is a regular alternation of the two affections.

The anæmic diathesis is the pathological basis of certain cases of insanity. The anæmia here indicated is not that which is symptomatic of tubercle, cancer, or other diseases. It may be called simple, to distinguish it from that known as pernicious, but it is simple anæmia of a chronic constitutional type, and often associated with inherited defects of trophic functions. It constitutes a diathesis with vaso-motor and sensory, as well as nutritive disturbances. There are cold extremities, rapid pulse, and palpitation of heart on slight exertion; cephalalgia, tinnitus aurium, muscæ volitantes, and great emotional excitability and a depressed frame of mind. The transition from this class of symptoms to positive insanity is easy. The mental depression becomes actual melancholia, with periods of great emotional excitement. In cases of extreme anæmia stuporous states or primary dementia may arise.

The post-febrile diathesis, consisting in impoverished blood, general malnutrition, and exhaustion of nervous centres, is sometimes the predisposing or immediate cause of mental alienation. The cerebral œdema, hæmorrhage, meningitis, and embolism of fevers also cause acute mental derangement. There are two classes of cases, those of the acute and those of the convalescent stage of fevers, and the former are more apt to be maniacal and the latter stuporous or melancholic. The various forms of the delirium of fevers have always been conventionally distinguished from insanity, but the distinction is theoretical rather than practical in certain cases in which the delirium passes by natural gradation into mental derangement, with a continuation of the same hallucinations and of the same delusive ideas. This is the origin of a minor part of the cases, the majority of which are strictly post-febrile and occur as independent sequels. A clinical rarity is a coincidence of the regular stadia of insanity and of fever, melancholia occurring with the incubatory, mania with the acute, and sequential stupor or melancholia with the convalescent stage of fever.

The chronic diathetic condition known as myxœdema is associated with psychical disturbances that amount in some cases to decided mental derangement. The formation of mucin by retrograde changes and the solid œdema from its transudation in connective tissues, the atrophy of the thyroid gland, and other pathological accompaniments of myxœdema do not, it is true, render evident the origin of the insanity. It may be that there is a cerebral transudation also that interferes with the blood-supply to cortical centres, and that the direct cause is circulatory or vaso-motor. Melancholia or mania may be the result, and in all cases there is an element of mental weakness and a strong tendency to dementia, which forms the termination of most cases of myxœdematous insanity.

The final division in this first main group of insanities is Class VI., having definite pathological conditions of the encephalo-spinal, vaso-motor, or peripheral nervous systems. The first variety is general paresis, paralytic dementia, or general paralysis of the insane, as it is sometimes called. It has a more extensive modern literature and a more definite morbid anatomy than any other form of mental derangement. It has ceased to be a generic term for various kinds of dementia with loss of motor power from embolic hæmorrhagic or luetic processes. It is a single disease that progressively involves in permanent disintegration the nervous structures of the brain.

The correlative functional derangement of motion, sensation, nutrition, and intellection follow in the order of the structural lesions. This order is usually that of relative functional importance from the cerebral to the spinal

centres, and it illustrates in its corresponding mental and motor symptoms the general law of dissolution of the nervous system, in accordance with which the higher accessory portions and the more complex functions suffer first.

General paresis presents mental phenomena of protean variety, but its general course is always the same, from states of exaltation or depression to states of mental weakness, and it uniformly ends in complete extinction of mind, if life is sufficiently prolonged.

Syphilitic insanity is a term which in itself at once expresses the etiology, pathology, and indications for treatment of certain cases that may thus, with some clinical reason, be separately classified. The luetic virus, through its effect on blood-making organs, develops a cachexia that strongly predisposes to insanity, and in the presence of excesses and strong emotions and other exciting causes hypochondriacal melancholia or mania may arise without cortical lesions that can be demonstrated. The typical cases of syphilitic insanity, however, do have gross organic lesions of nervous structures, and they may have the psychical features of severe melancholia or of explosive maniacal attacks, though, if prolonged, they all tend to pass into dementia, which is commonly associated with characteristic loss of motor and sensory functions. Syphilitic dementia also appears in a gradually progressive manner, without acute prodromal stages of exaltation or depression, and may have aphasic, ataxic, and paretic symptoms. It is not, however, to be confounded with general paresis, and the differential diagnosis will be hereafter discussed.

Organic dementia may have as its anatomical basis embolism, thrombosis, ramollissements, tumors, echinococcus, and other affections which produce mental disorder by interference with the circulation and nutrition of cortical centres, which usually undergo secondary atrophy. There are always motor and sensory symptoms that vary with the nature and seat of the brain disease. The mental symptoms are progressive enfeeblement of all the faculties, and notably of the memory, and occasionally there are mild forms of mental exaltation or depression. The final result is incomplete cure or complete loss of mind. A typical instance is apoplexy, with hemiplegia and its train of psychical symptoms, resulting in restoration to comparative physical health, but with permanent loss of mental strength.

Typhomania is the delirium acutum of some authors. The pathological process in typhomania is most acute, leading to rapid transudation of sanguineous elements into cerebro-spinal tissues, and the symptoms are more intense than in any other form of mental derangement; and, as a rule, with few exceptions, they rapidly end in general prostration, and it is from this terminal typhoid state that the affection has derived its name. Typhomania has material resemblance to, but is distinct from, the delirium of meningitis or of acute fevers, and it also differs from maniacal furor and from acute delirious exacerbations in other forms, and it must be classed as an independent variety of insanity.

Traumatic insanity is the more or less direct result of mechanical violence done to the brain or its membranes or osseous coverings. The pathological processes that follow trauma capitis give rise to motor, vaso-motor, and trophic disturbances, to profound changes in character, and to a decline of intellectual faculties that usually ends in dementia.

Sympathetic insanity has as its anatomical origin some lesion of the peripheral nervous system that is a reflex cause of irritation to the higher cerebral centres, which are in intimate sympathy, not only with all the bodily organs, but also with the most distant portions of the periphery. The same physiological law and a like pathological result may be here witnessed, in convulsive psychical disorder from morbid peripheral connections, as may occur in nervous centres, one degree lower in complexity, as seen in spinal tetanoid reaction to traumatic lesions of the extremities. In one instance there is provoked an irregular and aimless discharge of psychical force from cortical cells, and in the other of motor force from spinal cells. But whatever may be the pathogeny of sympathetic insanity, its clinical existence must be admitted; for reliable authors have placed on record cases of mania and melancholia arising directly from peripheral nervous lesions, and recovering suddenly after cessation of the local irritation.

All the above varieties of insanity in the first main group have now received a brief descriptive notice sufficient to define their nature and relative position in this classification.

The second main group will now be considered from a symptomatological and psychological point of view, and in order to do this systematically some formal division of mind is indispensable. In the present state of mental science the arrangement of the faculties under the titles of feeling, intellect, and will is, perhaps, more satisfactory than any other, and it is the one that will be here adopted. It is to be premised, however, that neither in the physiological nor in the pathological action of mind is there any such severance of mental faculties as is here schematically represented. The mind is a unit and acts as a single force in various directions, which have been conventionally regarded as separate modes or powers of mind. As an ultimate fact, emotion, ideation, and volition are indissolubly connected.

The classification of certain varieties of insanity under feeling, intellect, and will, therefore, simply means that the most evident pathological manifestations in the respective types are such as are described by the conventional terms emotional, intellectual, or volitional, and there is no intention to imply a completely independent existence of these separate orders of morbid phenomena. It is even a question often, that admits of only an arbitrary decision, as to the category to which a given variety of insanity belongs, and it can only be decided in a general way for the majority of cases. In most cases of melancholia and of mania the emotional disorder precedes in the incipient and survives in the convalescent stages the intellectual disturbances, and it is regarded as of most fundamental importance; and these forms are classed under feeling, though the other mental powers are also involved. Likewise, in dementia, classed under intellectual lesions, there are also emotional weakness and volitional weakness. Fortunately, if all the facts as to the psychical manifestations are presented in some consistent order, it is not of great import under what particular head they are described. Most insane acts are the combined result of delusive ideas, perverted feeling, and impaired will, and to know this fact is of more practical importance than to attempt to determine the precise degree in which each of the functions may chance to be involved in a special instance. Under Symptomatology additional grounds will be furnished for the nosological arrangement of this second group, of the varieties of which only a full definitional outline can here be given. Under Feeling, Class I., the primary divisions into states of depression and states of exaltation are of more radical importance than any others in psychiatry. They correspond psychically to such broad facts as pain and pleasure, to a sense of ill-being and of well-being, and they are based physically on distinctly different states of the functions of organic life. The brain, as the highest organ, has intimate relations of sympathy with every other organ and tissue of the body. The prevailing and fundamental moods of feeling spring from this deep source of the organic sympathies. From the combined visceral, circulatory, respiratory, and muscular organic sensations results the general sense of well-being and ill-being, and the general state of exaltation or of depression of feeling.

This fact is made the physiological basis of cœnæsthetic depression as the first variety of insanity among states of mental depression.

Cœnæsthesis is derived from two Greek words, and means, literally, common feeling, and it has been used by writers to denote a sense of existence, either painful or pleasurable. It is employed here to signify the prevailing conscious state of feeling, either of depression or of exaltation, which is the resultant of the subconscious organic sympathies of the whole organism. This general

state of feeling varies somewhat in different individuals and in the same person at different times, but it does not exceed physiological limits so long as it does not exclude the normal exercise of mental functions. When a patient has a permanent sense of physical discomfort and general malaise, and a continuous feeling of gloom that changes the normal course of his thoughts and actions, and checks the free play of his mental powers, he is suffering from cœnæsthetic depression. There may be forebodings of evil, but there is no actual delusion, and there may be indifference to family or friends, but no active affective perversion. The patient is, however, disqualified for his usual avocations, and he is affected with the most mild and most curable form of insanity. It might be considered as the prodromic stage, or as an abortive form of melancholia simplex. In most cases, however, it does not pass into melancholia or any other form of insanity. It is a pathological mental state that springs directly from organic sources as mentioned, and as it is desirable that a special designation should be supplied for it the term cœnæsthetic depression would seem most appropriate. It often occurs during the incubation of acute diseases, and whenever there is any deep disturbance of vital functions. It forms a natural transition between painful morbid states of mind, not usually deemed insanity, and fully developed cases of melancholia.

Melancholia simplex is a primary affection and it has very distinct mental and physical traits.

The psychical symptoms, considered not individually, as in a single case, but collectively, as occurring in a succession of cases, are: Deep changes in self-feeling, concentration and limited range of thought, difficult association of ideas and diminished thought-rate, impaired memory for recent events from lack of attention, persistent despondency of purely subjective and organic origin, a gloom that tinges all the ideas and leads to false interpretations of external impressions, social apathy or active anti-social feelings, loss of spontaneity and of will-power, suicidal impulses, præcordial panic, morbid fears, hallucinations and illusions of the special senses, and delusions in keeping with the depressed frame of mind, and originating often in illogical efforts to explain strange organic sensations or novel feelings of mental distress.

The physical symptoms, viewed collectively, also, are: Malnutrition and general loss of weight, incomplete respiration, defective circulation, with local ischæmias and general vascular hyperkinesis, præcordial distress, muscular inertia, diminished secretions and excretions, partial or complete suppression of sexual appetite and of catamenial function, derangement of sleep, cephalalgia, neuralgia, and, in most cases, an anæmic condition of the general system.

There is also an active form termed melancholia agitata, in which there is great motor restlessness, and very urgent expression of suffering is given in words and gestures, and there may be suicidal attempts. There is often an automatic repetition of words and acts, and other features that distinguish it from the true maniacal exacerbations that occur in melancholia.

Melancholia agitata is common in climacteric cases, and it is rather to be regarded in all cases as a modification and not as a distinct form of melancholia, and it has not been separately classed in this nosological scheme.

A type of mental depression that deserves a separate nosological position is melancholia attonita, or melancholia cum stupore. It is usually of primary origin, though it may alternate with or follow other forms. It is most apt to be the result of some severe emotional shock during a state of physical exhaustion. In such a case there is suddenly developed a paralysis of will, loss of recollection, apparent insensibility to outward impressions, complete cessation of all psycho-motor activity, as shown in a speechless and motionless condition, automatic muscular rigidity from flexor contraction, with passive resistance, slow and superficial respiration, and subnormal temperature. The precise state of mind is often intense concentration of attention upon a few hallucinations or delusions of a frightful character. Melancholia attonita may have a gradual convalescence or terminate in dementia, or pass into a fatal comatose condition from cerebral œdema.

Another primary state of mental depression having something special in origin and in symptoms is nostalgia.

Nostalgia is most apt to appear in young persons of simple habits and of limited mental resources and narrow experience in life, who have a feebly organized individuality. The inner mental life of such persons is made up of a few ideas and emotions that correspond to the immediate objects of their environment, and when they are removed to strange surroundings there is produced a void in their affective life and a self-estrangement that may pass suddenly or gradually into actual insanity.

The nostalgic patient is in a confused and helpless state of mind, is indifferent to outward impressions, is averse to any occupation and to the society about him, and passes from an apathetic condition into complete abstraction. He is absorbed in reveries of home, and his diseased phantasy pictures familiar scenes, and hallucinations of home sounds and voices may occur. In rare cases there is an explosion of violence or suicidal attempts or incendiarism. The somatic symptoms are insomnia, anorexia, emaciation, cerebral congestion, feverish temperature, and, in extreme cases, general physical exhaustion and death in a state like marasmus. If the patient be restored to native surroundings cure may follow rapidly. The Celtic is more prone than the Anglo-Saxon race to this mental malady. It has been said, too, that the inhabitants of mountainous districts are more obnoxious to it, and the Swiss and the Scotch peasants have been cited as affording instances of this fact.

Order 2 of Class I. contains genera of secondary origin. The study of secondary insanities is a thankless task, for the material is not attractive, and it has been greatly neglected. It has been too long the habit to include all chronic cases under the terms chronic mania and dementia. These cases of secondary origin differ from one another almost as widely as the primary types, and the fact of their incurability is not a scientific reason for suspension of endeavors toward their systematic arrangement. Their study is not only of theoretical interest, but it often affords an insight into the nature of earlier pathological states, and it is essential for general purposes of diagnosis, prognosis, and treatment; for the primary and secondary types have superficial resemblances that, in the absence of a personal history, may deceive for a time even an expert. These reasons may serve in part to justify the introduction here of certain varieties of secondary insanities. The distinctions are made as the result of many years' study of the chronic insane population of asylums for the insane, and it is believed that they can be readily verified by those having similar opportunities for clinical observation. Confusion in psychiatry arises not from an increase of exact nosological terms and of forms of derangement, but from lack of clear distinctions in terminology. It is best to avoid new terms, however, and resort is had to a clear limitation of those in use, and a general observance of this practice might lead in time to a more uniform nomenclature.

The first variety of secondary insanity is chronic melancholia. It is consecutive to melancholia simplex, from the chronic cases of which it has not been distinguished by many authors, and by others it has been relegated to that convenient domain of all unclassified forms, dementia. There are rare cases of melancholia simplex that continue without essential change for some years, but most cases of this form of insanity, if not cured, pass into chronic melancholia, and not into dementia. When the active bodily and mental symptoms which are so characteristic in melancholia simplex have passed away, it is highly inconsistent, if the insanity continue, to call it melancholia when it is chronic melancholia. The psychical points of difference are, that in chronic melancholia there is no longer the inhibition of thought and of association of ideas, no longer the same mental tension, and the thought-rate may be almost normal; perception and memory for recent events is improved, there is more freedom of choice in actions, and there is less emotional

suffering, though the fundamental tone of depression remains. There has been a kind of adjustment to the pathological order of things among the mental faculties, which, though impaired, have resumed in a measure their accustomed activity, and the remissions are much less marked than in the active form.

Diagnostic differences between active and chronic melancholia exist in the bodily symptoms. In the latter form active tropic disturbances are not common, nutrition is more normal, and circulation improved again. The anæsthesias and paræsthesias of the acute form are wanting, and there is less derangement of the general organic sympathies.

On the other hand, there is often established some gastric or pulmonary complaint. The physical powers of endurance are impaired, as well as the sexual appetite, and there is an increased need of food and sleep. Thus it is seen that both the physical and mental states in the two affections are very different. It may be claimed that the chronic melancholiac has lost the best part of his moral and intellectual nature, and that he is in a state of mental weakness. This is true in a certain sense, but he still possesses a degree of mental force and of reason not found in dementia, from which there is also the difference of a prevailing emotional mood in which the patient may remain for years, or to the close of a long life.

Thus chronic melancholia is distinguished nosologically from the simple and acute forms of melancholia, from dementia, and from the secondary form of partial insanity with mental depression, next to be mentioned.

Secondary monomania with depression is usually a sequel of mania, or of melancholia, though it may follow some gross organic brain disease, as cerebral hæmorrhage; or it may be the result of some constitutional affection, like syphilis or phthisis pulmonalis. In the great majority of cases it is the outcome of an imperfect cure of one of the acute forms mentioned. The patient reaches the mild depression that often precedes convalescence in mania, with a few remaining delusions, but does not go on to a perfect cure. The depressed frame of mind continues, or becomes more marked; the false ideas remain fixed, and they are of a disagreeable or suspicious nature, and they relate often to some hostile influence in the environment, or to some imaginary injury sustained, or they may be connected with hallucinations that persist. If melancholia were the primary form, the development is still more natural. The acute symptoms of melancholia subside and leave the patient without other signs of insanity than a few unchangeable delusions, a mild tone of depression, and a certain degree of mental impairment. The false beliefs may not influence the conduct of the patient so as to interfere with routine occupation, and, under favorable circumstances, life, or even self-support outside of an asylum for the insane, may be possible for many years. To the casual observer such a patient may not appear different from others, for reticence as to delusions is a lesson early learned in these cases; but to intimate friends there is evident a loss of the finer traits of character and changes in feeling and manner. The mental and moral damage sustained in secondary monomania is of various degrees in different patients, but in no case is it at first such as is found in chronic mania, or in dementia. In the course of years, however, all cases tend toward that "tomb of human reason," dementia, which they may reach sooner or later as there chances to be present hereditary taint, strength of constitution, and other circumstances favorable or unfavorable. Secondary monomania with depression differs from chronic melancholia by the more limited and unchangeable nature of the delusions, and by deeper changes in self-feeling and in personality.

Class I. includes, in Order 2, states of exaltation, and the first among the primary genera of this order is cœnæsthetic exaltation, which is the counterpart of cœnæsthetic depression already mentioned. There are blood-poisons, drugs, alcohol, a sudden rise of temperature, extreme inanition, and various other things that give rise to morbid systemic excitement and exaltation of feeling in certain persons. Cœnæsthetic exaltation is an analogous and prolonged morbid expansion of feeling proceeding from the deep source of the organic sympathies. There is a pleasurable sense of excess of vital and muscular force that is expended in ceaseless activity—great self-satisfaction that overflows in unusual social demonstrations—unbounded self-confidence that leads to venturesome acts, and an increased show of fictitious strength of all the mental and bodily powers. This departure from the patient's normal state of being does not reach the degree of maniacal excitement, and there are no hallucinations or delusions. The patient ordinarily remains in this condition for weeks or months, and gradually returns to perfect sanity. In exceptional cases some more marked form of mental derangement follows. The terms hypomania, or subacute mania, besides being inapplicable in other respects, do not describe the essence of this affection, which is the general systemic exaltation of feeling. Cœnæsthetic exaltation, therefore, is offered as an appropriate term for the mildest of pathological states of mental exaltation to be ranked under insanity. It will appear, from that which immediately follows, in what way it differs from ordinary mania.

Mania simplex, the next type in this nosological arrangement, is, with the exception of melancholia, the most frequent and important variety of insanity. The psychical phenomena of mania viewed collectively are: great rapidity of thought and readiness of association of ideas, increased facility of memory, the spontaneous origin of pleasing emotions, and a permanent tone of exalted feeling, hallucinations and illusions, and corresponding delusions; incoherence of ideas and of speech at the height of the disorder, perversions of instincts, with suicidal or homicidal tendencies, and loss of voluntary control of ideas and of actions.

The somatic phenomena are: insomnia, great muscular activity and promptness of muscular coördination, with absence of normal fatigue, increase of secretions and excretions, and of appetite for food, drink, and sexual intercourse, active respiration and circulation, and general loss of weight.

There are remissions and exacerbations of all the symptoms, and the excitement may reach the height of a wild delirium, during which the acts are sensori-motor or automatic, and consciousness and memory are impaired. The final result in acute mania is death, or a secondary state of mental weakness, or recovery after various phases of mental disorder hereafter to be mentioned. Mania as an independent disease is to be distinguished from the maniacal state, which may appear intercurrently in many forms of insanity.

Mania transitoria is an exceedingly rare type of mental disorder of primary origin. The mental condition is normal before and after the attack, which explodes with sudden violence, and lasts from an hour to a day, and is followed by deep sleep, from which the patient awakes oblivious of all that has occurred during the attack. There are hallucinations and illusions, incoherence, violent emotions, wild gesticulations and vociferations, alterations of consciousness, automatic and aimless movements, muscular spasms, signs of intense cerebral congestion, and withal a condition that is more than simple active delirium, and less than maniacal or epileptic furor. It is theoretically conceivable that this spasmodic discharge of incoördinate motor and intellectual force may be due to cortical irritation from qualitative or quantitative changes in the cerebral blood-supply, as in certain kinds of symptomatic deliria; and as cases of this affection have been placed on record by reliable observers, it is accorded a place in this nosological table.

Chronic mania is a state of mental exaltation of secondary origin. Some authors use this term in a wide and vague sense for many chronic states of general confusion and weakness of mind, while others limit its meaning to chronic partial insanities, such as are here classified as secondary monomanias. The vagueness in the use of this term corresponds to the existing confusion as to secondary forms of mental derangement, and shows the need of their systematic study and classification in accordance with actual clinical facts.

The term chronic mania is here employed, in a more literal and limited sense, to indicate a type of insanity well known to those accustomed to the care of the insane. The patient passes from acute mania, or from some other acute form of mental disorder, into a chronic state, in which the general frame of mind, the prevailing emotional tone, and the whole conduct are maniacal, although the more intense physical and mental symptoms of mania are absent. There are hallucinations and delusions, mistakes in time, place, and identity of persons, motor activity, insomnia, and general excitability. The appetite and general health are better than in the acute form. The patient is not infrequently noisy and destructive, and so remains year in and year out, and often shows no tendency to pass into dementia; and he may recover at any time within four or five years, and even after a whole boisterous decennium. Other terminations are death from general exhaustion of vital powers, or terminal dementia.

Secondary monomania with exaltation is given a place in this classification, in order to rescue one more separate variety from that promiscuous gathering of ill-defined forms termed dementia by some, and chronic mania by other authors. Secondary monomania with exaltation arises from mania, or from other primary types of insanity, or from gross brain disease, trauma capitis, insolation, and certain cachexias, as syphilis or phthisis pulmonalis, which are attended by more general symptoms of mental disorder, which finally disappear and leave this chronic partial insanity. The delusions are expansive and imply an extension of personal rights or powers, and they are permanently limited to one class or to a few classes of subjects, apart from which the patient may appear coherent and not irrational in conversation. There may be an air of hauteur or of exaggerated suavity of manner, but there is often no striking peculiarity of manner in the patient, whose insanity might escape detection among casual acquaintances ignorant of his history. The general affective tone is that of mild exaltation. Now, the actual loss of mind is much more real than apparent, both in the intellectual and in the moral powers, but the psychical condition is widely different from chronic mania or from dementia. It is chronic partial insanity with limited and fixed false conceptions, and with persistent expansion of self-feeling, and there is no term that so well describes it as the one here adopted.

The first variety of insanity among states of mental weakness is primary mental enfeeblement. It is a rare type that arises independently of any other form of insanity and gradually progresses to complete dementia. The impairment of memory, attention, will-power, and the loss of natural affections may become apparent in the course of a few months, and the stage of dementia may be reached within a year. Its pathogeny is obscure, as it is not associated with organic lesions of the brain. It is to be distinguished from acute primary dementia and from the progressive mental decay of certain cases of general paresis with slightly pronounced motor symptoms. Terminal dementia is a secondary form of insanity, which of all others is the most typical state of mental weakness. It is the termination of all uncured simple forms of insanity, and it consists in more or less complete obliteration of all the powers of mind. It may reach the extreme degree of mental voidness, and in the absence of all psychical manifestations the only signs of life are automatic and vegetative functions. It is absolutely hopeless in prognosis, and ends only in death. Terminal dementia includes every form of secondary dementia not otherwise designated in this classification.

States of stupor are very different from states of mental weakness, and they form Order 2 of Class II. The first variety is acute primary dementia. It is of primary origin and is often developed in states of physical exhaustion by some sudden powerful emotion. The abolition of mental functions is apparently complete. The patient is speechles, motionless, and helpless, and seems plunged in sudden stupor. There is no ideation, no volition, and but slight reflex movements. Sensation is greatly impaired, and only occasionally are feeble signs of perception present. Respiration, circulation, and metabolic processes are feeble, and spinal reflexes are usually absent. The end may be recovery, terminal dementia, or death. Acute primary dementia is a separate type of insanity, and it differs essentially from the stuporous state that follows other acute forms of mental derangement, and that is next to be noticed.

Sequential stupor is a frequent and important secondary state, that is most often the immediate sequel of acute mania, but also follows other acute varieties of insanity. The stupor may be as great as it is in acute primary dementia, although ordinarily it is very much less, and, etiologically considered, it is the expression of the extreme exhaustion of cortical centres that follows severe acute attacks of insanity. It may continue for weeks or months and end in terminal dementia, or it may form the transition to convalescence after acute attacks, and in the latter case it is marked by remissions. The degree of stupor corresponds in general to the severity of the insanity of which it is a sequel. The somatic symptoms are never so pronounced as in acute primary dementia. There are some other kinds of stupor, but they are not sufficiently uniform or important to be separately classified as distinct states of insanity. Thus, there is epileptic, alcoholic, and paretic stupor, and various anergic temporary states that are intercurrent symptoms rather than distinct forms of mental derangement.

The final division in this nosology is made under the head of Will, in Class III., which contains forms of insanity in which the chief manifestations are apparently due to impaired mental inhibition, or to complete suspension of volition. Will and moral feeling are the highest and most complex functions of mind, and as such they are the first to suffer in mental disease. In fact, it is an absolute rule that the inhibitive functions of will and the moral sensibilities are impaired in mental disorder.

Certain authors have fallen into error in describing forms of insanity with heightened will-power (hyperbulic). Morbidly increased emotional and motor activity have been mistaken for the very strength of will which, had it been present, would have checked the display of morbid symptoms. All mental disorder, therefore, is more or less characterized by loss of will (abulic), but the term abulic insanity is here limited to that variety in which the impaired inhibition is the most striking symptom, and in which the appearance of disorder of the other faculties is but slight.

In the abulic patient the appetite and propensities may not be abnormally strong, but they tend to pass at once into action from lack of mental inhibition, and they are not restrained like the desires of the normal mind. The improper suggestions, the absurd ideas, and the foolish impulses that are instantly banished by the slightest effort of normal will, find a permanent lodgement in the mind of the abulic sufferer, who struggles in vain to dismiss them, and finds relief only when they have been expressed in action. There is apparently a pathological increase of the cerebral reflex activity, so that impressions that would otherwise have been inhibited become embodied in action. The supreme nervous centres are here in a morbid state, like that of the spinal nervous centres, which, owing to heightened reflex excitability, respond immediately, by movements more or less coordinate, to every sensory stimulus. There is more disorder of the other mental faculties than is apparent, but the seeming lucidity of the patient, as contrasted with the absurdity of his acts, suggests to the observer the idea of wilful wickedness.

The manifestations in abulic insanity may include every form of perversity of conduct, and may extend to suicide or homicide. They differ from similar manifestations in primary monomania, and other degenerative types, in that in these latter there is an inherited and fundamental perversion of the instincts and of the emotional nature, while in abulic insanity the patient, previously of normal mental constitution, has acquired the disease that affects first the highest faculty—the inhibitive function of will. Abulic insanity is to be differen-

tiated from the simple psychoses with impulsive tendencies and with impellent ideas. Abulia, as an intercurrent symptom of various stages of insanity, will be described under Symptomatology.

In somnambulism there is partial or complete suspension of will, and also of normal consciousness. The somnambulistic states differ widely among themselves, and the claim here made is that exceptional symptoms in certain of these states cannot better be classed than under Insanity. Somnambulism is akin to catalepsy and epilepsy, and it almost invariably occurs in connection with a neurotic temperament. It has important medico-legal bearings, for during its continuance various breaches of the law have been committed, and more than one instance of somnambulistic homicide have been placed on record. When a patient with somnambulistic disorder of mind, and active delusions resulting therefrom, seizes his child, whom he dearly loves, by the feet and dashes its head against the floor with fatal effect, as occurred in the case of Fraser, of Glasgow, recorded in the *Journal of Mental Science*, October, 1878, he cannot be better regarded medically, or treated legally, than as one having suffered from temporary insanity.

If a patient with epilepsy suffers a like loss of will and of consciousness, and is led by delusions to a like act of violence, there is no hesitation in applying the term epileptic insanity to the case. It is from such considerations that the mental disorder of certain states of somnambulism is admitted in this classification of insanity.

Etiological.—All manifestations of mind are made by means of the nervous system, and the causes that affect the integrity of the cerebro-spinal centres are those that most directly interfere with the orderly display of mental functions. The question of the essential nature of mind, and of its existence independently of its physical organ, the brain, is not one of practical import. It is enough, from a medical point of view, to know that structural and functional disease of cortical and subcortical centres occasions every kind and degree of mental disorder. Insanity, therefore, is to be considered as one of the neuroses, and as having the same general etiology as other diseases of the nervous system.

It has been customary to classify the causes of insanity as predisposing and as exciting, and to subdivide them into physical and mental causes. Experience teaches that the same cause acts variously under different circumstances. Let the abuse of alcohol, as one of the most common causes, serve as an illustration. Thus alcoholic excess may immediately excite an attack of acute mania, or predispose to insanity that may be directly occasioned by traumatism or a powerful emotion; or, acting still more remotely, it may cause congenital mental disorder in the offspring of drunken parents; or, bringing loss of honor, of social position, or of fortune, it may, through psychical channels, lead to suicide or insanity.

Since the causes, then, are as complex as the relations of life, none but a general division of them is desirable. Perhaps as good a division as could be consistently carried out would be into those causes that are inherent in the individual, and those that pertain to the environment.

It is to be borne in mind that most insanity is the result of a long series of causes, composed not of one, but of all the physical and mental shocks to which man is exposed. All the untoward influences of life conspire to accomplish the final results. It is well to consider also that in one possessed of health and of a sound physical and mental heritage, no one cause, unless it be actual destruction of cortical centres, is capable of producing insanity. Any great strain of the system is manifested in the feeblest organ first, and if the brain gives evidence of failure it is because of some inherent weakness.

Hereditary Predisposition.—It is a general law of biology that like produces like. Not only are general and constitutional likenesses, but also specific and organic weaknesses, transmitted. In one family heart diseases, in another lung diseases, and in another brain diseases or mental disorders, appear in successive generations. There is an accumulated mass of evidence to show that the tendency to insanity is as clearly transmissible as that to epilepsy or any other neurosis, and it has often been observed that the exact type of the mental disease has repeated itself in the offspring. An insane perversion of the instinct of self-preservation, taking a particular form of suicide, has been known to occur in four successive generations. There is an intimate relation between insanity and the principal neuroses, and by the law of transformation they appear interchangeably in different generations. In the first generation there may be neuralgia, chorea, or hysteria; in the second epilepsy; in the third insanity; and in the fourth idiocy; or almost any other order of occurrence of these affections may be observed. Rapid degeneration of families would be more frequent were it not for the renewal of the stock by marriage, and the constant tendency of nature to restore the normal type. The hereditary transmission may take place latently through one or more generations, so that the child inherits insanity from his grandparent, and this is called atavism. The atavistic derivation of mental diseases is common. The tendency is called direct if the insanity appears in lineal ancestors, and collateral if uncles, brothers, or sisters are affected, and it diminishes with every removal of a generation from the tainted progenitor. The transmission is more apt to take place through the same sex, from mother to daughter, and from father to son. Authors have variously estimated, from statistics, the proportion of cases of insanity of hereditary origin at from twenty-five to seventy-five per cent. The discrepancy between them is partly due to the fact that some omitted, and others included, cases with collateral tendency. It is evident that such statistics are of but little value. It might be better to take a broader view of the whole subject, to regard a defective or unstable nervous system as the essential thing to be traced, to consider insanity and the allied neuroses as simply signs of the presence of this general pathological state of the nervous system, to attempt to establish the relations of this general state to other diseases, and finally to determine its frequency of hereditary transmission by statistics. It might be found that a parent absolutely free from every sign of this state of the nervous system never serves as a channel for the transmission of insanity, and that from this point of view there can be no such thing as atavism in relation to mental derangement.

Age.—There is no time of life exempt from insanity, which has been known to occur soon after birth and in extreme old age. In general terms it may be stated that youth and senility are the least liable, and that middle age is the most common period for the development of the disease. Statistics based on admissions to American asylums would indicate that the maximum rate is between twenty and thirty years, with a regular diminution for every decade up to eighty years, except that the decade ten to twenty years is intercalated between that ending with seventy years and that beginning with eighty years. In certain European asylums it has been found that the maximum rate occurs between thirty and forty years. These statistical conclusions take into account the relative proportion of the whole population to the numbers of those attacked at the various ages, but there would seem to be a fallacy in the failure to determine whether the asylum admissions corresponded to the first appearance of the insanity. Making an allowance for the fact that many of the cases had probably suffered from early symptoms of the disease previously to admission, the maximum rate would fall at a still earlier period.

The most reliable general conclusion is that insanity is most frequent during the years of greatest functional activity of body and mind, and as this period naturally occurs somewhat earlier in women than in men, it is probable that the maximum rate of frequency of occurrence of insanity in the former is from twenty-five to thirty-five years, and in the latter from thirty-five to forty-five years. It must be placed at a still earlier period for that large class of cases of hereditary origin—not later than the decennium fifteen to twenty-five years.

Sex.—The relative liability of the sexes to insanity is a question about which there is a vast amount of statistical

information and but few reliable conclusions. It is evident that it is not enough to know the relative proportion of males and females in the whole population to those affected by insanity, but there should also be determined the proportion of the sexes at the vulnerable period, twenty to forty years, to the comparative numbers attacked for the first time. Formerly more males than females were to be found in asylums for the insane, but at the present time the proportion would seem to be reversed in some countries. This may be due in part to the admitted fact that the mortality is less in the female than in the male insane population, so that the former tends to accumulate in asylums more rapidly. On the other hand, it can hardly be denied that males are more exposed to the exciting causes of insanity, and that the actual proportion of those attacked is somewhat greater than among women.

Civil Condition.—It would seem, from statistics, that there are more unmarried than married persons received into asylums for the insane, and that this statement also holds good when the relative proportion of the two classes in the general population to that of asylum admissions is considered. There is probably some truth, therefore, in the direct inference that celibacy is a predisposing cause of insanity. A source of error might exist, though, in the fact that the strongest persons and those most favorably situated would be most apt to marry, while the feeble in mind and body, and with greater proclivity to insanity, would be less inclined to assume the responsibilities of a family.

Occupation.—The influence of occupation as predisposing to insanity is of a complex nature and difficult to estimate accurately, but it is doubtless a powerful one in some cases. A glaring source of error is evident in some previous conclusions drawn from the relative total number of asylum admissions of the various occupations. Thus, if more shoemakers than sailors were admitted, it was concluded that the former were the more liable, whereas the contrary is the fact. The true result to be sought, of course, is the relative number in each occupation that become insane as compared with the the total number following that occupation in the whole community. Certain statistical conclusions, correctly derived in this respect, show a marked difference in occupations. In the learned professions, as thus judged by asylum admissions, lawyers are much more obnoxious to insanity than physicians, and the latter are more liable than ministers of the gospel. It appears, also, that army and navy life, both in commissioned positions and in the ranks, predisposes to mental derangement.

In other occupations there is a single evident deleterious cause, as in cooks and in all others long exposed to artificial heat; also in those exposed by their calling to poisoning by lead, mercury, or other toxic agents. Other occupations that are supposed to furnish more than an average contingent of insane are artists, governesses, actors, speculators, politicians, and a whole predatory and adventuresome class living on the border-line of criminality. As to the openly criminal class, taken as a whole, there can be no doubt but that it has the closest affinities with the insane, and that were more enlightened justice meted out to it, many of its members would be sent to asylums for the insane rather than to prisons. It may be well to note in this connection that imprisonment, more especially of the solitary kind, is a common cause of insanity, which may have something characteristic in the manner of its manifestations.

If the general observation that mental rather than manual occupation favors the development of insanity be true, it may be due not so much to the occupation as to the nature of those who enter it. It is not improbable, on the whole, that those who choose the learned professions have parents who have raised their families to an independent position by great exertions and intellectual strain, and that from them they have inherited an overactive brain, and a nervous temperament, and less physical stamina than is commonly found among those following manual employments. Or, as in the occupation of artists, it may be that those who naturally choose it have an unduly imaginative or emotional nature that in itself favors the growth of mental disorder.

Education.—The predisposition to insanity is born in some, and in others it is made by the force of a bad education. The nervous system of a child is very susceptible of permanent injury. To condemn a young creature of delicate organization to daily long hours of brain work at a time when all the vital energies should go toward bodily development, is a blunder that is but little worse than a crime. It is by such forced methods of early education that the neurotic constitution is frequently acquired. The child has also a vulnerable emotional nature, through which it may receive most serious damage. Great severity of discipline, unjust punishment, and prolonged harshness of treatment may become the direct cause of suicide or of insanity in children. The child is also exposed to the moral contagion of vicious habits on the part of parents. It imitates readily eccentric ways, violent temper, lying and deceitful actions, and every perversity of parental example, and it thus, through a bad home education, lays such weak and faulty foundations of character as may later, during the trials of life, result in its complete downfall into crime or insanity. The best education for a child is not that which fills its mind with the greatest amount of the details of knowledge, but that which best develops truthfulness, submission, sincerity, self-control, and self-reliance, and which gives the clearest ideas of its rights and duties in life, and fashions compact character that will be able to withstand all the shocks and storms of life. The influence of a wise education might be made strongly prophylactic as regards insanity; but the present faulty systems of education are one of the predisposing causes of mental derangement.

Civilization.—It would seem, so far as information goes, that insanity is much more common among civilized than among barbarous nations, and it can no longer be doubted that there are conditions in civilized life that have led to an actual increase in mental derangement. The excessive functional activity of any organ renders it more susceptible to disease, and the adaptations of the brain to the complex relations of life is a task of greater severity than may seem at first thought. A certain number of aspirants always break down, and some suffer permanent ill-health from excessive endeavors to attain a high grade of proficiency in the arts and sciences. The man must be exceptionally well endowed that can load himself down with learning and carry it with immunity through life. The attempt to raise a whole people to a higher plane of intelligence will surely be followed by injury to a certain number that cannot bear the process of mental development.

The overstrained and suffering brain of the highly civilized sufferer calls for artificial support, and tea, coffee, tobacco, opium, and alcohol combine, with loss of sleep, sexual excess, and constant anxieties, to convert the patient into the modern type of general paresis.

Besides emotional and intellectual strain, and the abuse of artificial stimulants, there is in the civilized, as compared with the barbarous state, hereditary predisposition, that cause of causes of insanity.

Among the savages the strong survive, but the feeble perish; but one of the universal attendants of civilization in all large cities is a class of beings, degraded physically and mentally, that recklessly propagate a large percentage of idiots, lunatics, and criminals. If sociological science ever attains to such a practical height as to abolish all these evils of civilization there will still be hope that insanity may decrease rather than increase with the higher evolution of mind.

The Seasons.—On exposure of the cerebral centres to great extremes of heat or cold mental function ceases and stupor or coma follows. The secondary result of this exposure may be some permanent disorder of brain functions. Various diseases of the nervous system are also developed by sudden changes in temperature. It is natural, therefore, to suppose that seasonal influences might bear some causative relation to psychical disorders. The broadest fields of observation of fluctu-

ations of temperature, as existing in extreme northern and southern climates, furnish no reliable conclusions, as they embrace at the same time so many different conditions of life, and varieties of race, and other dissimilar relations, as to render comparisons valueless. The greatest relative number of insane are found in the temperate zones, but this evidently has no relation to the effects of climate, but to the fact that the inhabitants of these regions are the most highly civilized; so that attention must be confined to the effects of climate on the same population during the changes of temperature of the various seasons. There is a somewhat satisfactory agreement of statistics that summer is the season that brings the greatest number of admissions to asylums, and this tallies also with the fact that suicide is most common in the spring and summer months. The objection that the insanity may not be of the same date as that of the asylum admission is not sufficient to invalidate the conclusion that summer is the time of year most prolific of mental disorder. Various circumstances may be suggested as favoring the predisposing and exciting influence of this season. In large cities the majority cannot escape from an impure and overheated atmosphere, and in the country the severest labors take place in the summer. In some persons there is a decided increase of the "nisus generativus" in the spring, so that sexual excess and exhaustion may follow, and there is often an unusual abuse of alcoholic beverages during the heat of summer. That season may exert some general influence as regards insanity might be inferred from the special effects of atmospheric changes upon large numbers of insane in whom exacerbations of symptoms often attend extremes of heat and the state of air preceding storms and other meteorological changes.

Physiological Crises.—In the evolution of individuals, as of nations, there are critical periods that decide future destiny. In man the very earliest phases of life are those most fraught with the issues of future physical welfare or misery. So early as the moment of conception the coming man receives an impetus toward genius or imbecility. The popular belief has become an admitted fact of science, that parents may beget idiots in moments of intoxication, solely through the alcoholic influence. It may be conjectured that lesser degrees of mental insufficiency may be generated at this earliest of critical moments. The dangers of embryonic life are also to be taken into account. The time will come when the same thorough study that has given such clear accounts of clubbed hands and feet, of amputated extremities, and of various deformities of hard and soft parts during intrauterine life, will be extended to embrace all those pathological changes of the nervous tissues, all those perversions or arrests of growth which occur "in utero," and which form the organic basis, not alone of many cases of idiocy and imbecility, but of certain hereditary types of insanity. The popular voice has always sounded an alarm in the ears of a somewhat incredulous medical profession as to the physical and mental injuries which the unborn child might sustain through maternal impressions or sudden emotions, and mothers have wisely tried to exercise prophylaxis in this particular. The observations that support this popular idea are now so numerous that to argue that they are mere coincidences is to reason against the mathematical law of chances. Attention has already been called to a culmination of critical circumstances at birth, and to the relations that the accidents of this brief crisis bear to insanity. The facts there stated are to be taken also as serving to explain likewise the excess of male over female idiots.

After the critical period of dentition there comes next in order puberty, which might well be named the hereditary physiological crisis, so constantly is latent predispotion developed in connection with it. The highest percentage of attacks of mental disorder, among those with decided hereditary taint, falls between fifteen and twenty-five years. The proportion of women is somewhat greater than that of men, and they seem to suffer more frequently with chlorotic and constitutional disturbances during this phase of development. The amenorrhœa and masturbation so often present are to be viewed in some cases as symptoms, and in others as accessory causes of the insanity.

Maternity is another physiological crisis of great etiological importance. Fifteen per cent. of all cases of insanity among women arise during the discharge of the maternal functions of pregnancy, parturition, and lactation. The accessory causes vary greatly in different cases. During pregnancy there may be reflex uterine irritations, qualitative changes in the blood, and through the diversion of placental blood-supply, inequalities of cerebral circulation, anæmic states of brain, and depressing emotions, as shame and distress of mind in the unmarried. During parturition there may be hæmorrhages, prolonged use of anæsthetics and instrumental delivery, death of the child, causing emotional shock; and following delivery septic and inflammatory conditions, lacteal and lochial suppressions, which, though ordinarily symptomatic, may also be causative; exhausting uterine discharges, mastitis, and depressing moral influences. During lactation there may be an impoverished state of the blood, impaired nutrition, loss of weight, and general exhaustion and anæmia. The percentage of attacks is much greater among primiparæ than among multiparæ, and much greater in illegitimate than in legitimate births. It is also to be noted that abortion and its attendant hæmorrhages may develop an attack of mental disorder.

Of more fundamental importance than these accessory causes is the inherited or acquired neuropathic condition which is present in most cases.

Popular belief has fixed upon the menopause as the critical period of life for women, and the fact of a like change in men from the retrogression of the reproductive powers has received no general recognition among the laity. There is, however, a gradual climacteric in men from fifty-five to sixty-five years that corresponds in its main features of physical and mental change to that which occurs in women from forty-five to fifty-five years. The complicating causes favoring mental derangement in women are neuralgias and reflex irritations from organic local changes, chronic metritis, uterine displacements and exhausting discharges, and psychical influences, such as the exaggeration of the popular apprehension of the period, consciousness of loss of womanly attractions, and of inability to bear a child on the part of those desiring offspring. In men there are often circulatory troubles from arterial sclerosis, general decline of nutritive activity, the beginning of cortical atrophy, fatty degenerations, and the first signs of that general structural decay that ends in complete senility. The final era of life, old age, brings with it a physiological and gradual diminution of all the bodily and mental faculties. The retrograde changes are sometimes sudden and pathological, and lead to mental derangement, in certain cases that amount to about six per cent. of total male admissions to asylums for the insane. The pathological basis of senile insanity is general cortical atrophy, arterial degenerations, miliary aneurisms, embolism, and softenings. Heredity is less active than in most other forms of mental alienation.

Neuroses.—The neuroses most nearly allied to insanity may be transformed into one another during hereditary transmission, may be severally conveyed to different children of the same parents, or may coexist, or follow one another in the same patient. The neurosis that has the most constant relation to insanity is epilepsy. Fifty per cent. of epileptics suffer in course of time from some form of impairment of mental functions. There is a gradual deterioration of mental and moral nature that is the common basis upon which are developed more active symptoms of psychical disorder. The active manifestations of mental disease may be, 1st, maniacal or melancholic states, similar to those from other causes; 2d, stuporous conditions; 3d, states of furor with blind and automatic violence; 4th, states of active cerebro-spinal automatism, with suspended consciousness, during which the patient speaks and acts as if in possession of his faculties, but with complete failure of memory for the events of the attack; 5th, states of confusion of consciousness and of ideas of time, place, and personal identity, with partial

recollection of the occurrences of the attack; 6th, epileptic dementia. The latter is a terminal state, but the other states may precede, replace, or follow the epileptic convulsions. There is also to be observed a hybrid-like affection in which there is an alternation of a vesania and epilepsy—the former taking the place of the interval of the convulsions. Epilepsia minor would seem to lead to mental failure even more frequently than epilepsia major. The female sex furnishes the greater number of cases of epileptic insanity. The earlier in life the epilepsy begins the greater is the danger of insanity, which is also more apt to result when the attacks are frequent and the disease is chronic. Infantile epilepsy, with hemiplegia and other organic lesions, is epecially apt to be associated with mental derangement. Whatever pathology the epilepsy may have had, whether discharges from the cerebral cortex, the central ganglia, or the medulla, whether angiospasm or angioparesis, and whatever the indirect cause may have been, whether insolation, traumatism, tumors, or other structural brain lesions, it is in all cases to be presumed that deep molecular changes in the cerebral cortex have taken place whenever insanity is permanently established.

The motor, sensory, and psychical disturbances of the hysterical neurosis afford natural material for the formation of a psychosis. The insanity that results is as protean in its symptoms as the hysteria itself. Many of the types differ but little from mania or melancholia, but more frequently there are fluctuating states of greatly impaired memory and consciousness, and again more prolonged conditions of delirium, with vivid hallucinations of all special senses, and occasionally ecstatic, cataleptic, or hystero-epileptic symptoms. In cases which have very strong hereditary taint the manifestations may resemble the degenerative types of insanity with the addition of hysterical characteristics. Hysterical insanity in the course of time loses its sudden exacerbations and remissions, and all its distinctive features, and the origin of the mental disorder is only to be traced in the history of the patient.

The hypochondriacal state, that is, a prodrome or intercurrent symptom of certain affections of the nervous system and of general diseases, is of short duration and does not occasion mental aberration. But the permanent hypochondriacal neurosis is not infrequently transmuted into decided types of insanity. In hypochondriasis the mental hyperæsthesia, the paræsthesiæ, and the circulatory disorders are evidences of morbid molecular changes that often end in positive organic lesions. The resulting mental disorder takes the form of hypochondriacal melancholia, or of states of great apathy and inertia, or of limited delusions and reasoning tendencies, as in primary monomania.

In chorea acute mania originates from the anæmic and exhausted state caused by great muscular efforts, loss of sleep, and insufficient alimentation. In other instances suicidal melancholia, or states of mental weakness, are developed out of the choreic neurosis. The relations between congenital defects of mind and chorea can often be studied in idiocy.

Certain diseases have etiological relations to insanity that are difficult to explain. Among them are affections having as prominent symptoms vaso-motor disturbances and changes in the thyroid gland, like exophthalmic goitre, myxœdema, and cretinism. Ball, of Paris, and following him others, have seen symptoms of insanity result from paralysis agitans, and fluctuate in correspondence with the severity of the motor disorder.

Cases have also been reported as springing from Ménière's disease, and Schüle and other German writers are inclined to regard neuralgia as an important factor in the causation of insanity.

Toxic Agents.—It is estimated that twenty-five per cent. of modern cases of insanity are due to the direct or indirect effects of the abuse of alcoholic stimulants. This assertion is made with reference to the immediate effects of alcohol on individuals that consume it, and if its remote baneful influences through generations are to be taken into account, it would be necessary to add considerably to the numerical strength of the statement.

It would be out of place here to review the degeneracy of individuals, or of classes of the community, or of entire races caused by alcoholic excess, or even to describe the organic diseases which it occasions, though in so doing indubitable evidence would be gained of its power not only to derange, but also to destroy, both bodily and mental functions. In the etiology of insanity it is active, first, in exciting attacks to which there is already an hereditary or an acquired tendency; secondly, in the developing *de novo* of characteristic types of mental derangement; and thirdly, in the transmission of weak and irritable nervous systems that predispose to mental disorder. The types of mental aberration caused directly are: first, gradual psychical degeneration that attains finally to complete extinction of the moral powers; second, ordinary attacks of mania and melancholia; third, delirium tremens; fourth, alcoholic dementia; and fifth, dipsomania. The latter form has a double origin, and includes two very different classes of cases. In one class of cases it results from a susceptibility to alcohol that is most intense and inherited from intemperate parents, so that on slight indulgence the patient every now and then loses all self-control and goes through a reckless alcoholic debauch.

In the other class of cases the dipsomaniac tendency is simply one of the morbid impulses that occur in periodical insanity, and it will be found on close observation that these cases present insane peculiarities during the interim between their drinking bouts.

In an analogous manner other powerful drugs, however they may differ in their physiological action from alcohol, or from one another, may, in long-continued and excessive doses, produce similar kinds of insanity. Examples of this are furnished in most countries by opium, and in India by cannabis indica. Cases of mental derangement have also been reported from the continued use of atropia, potassium bromidum, secale cornutum, chloroform, ether, and many other medicinal agents,; and the toxic psychoses arising from mercury and lead have already been mentioned. Food, water, and air may also become the media through which deleterious substances operate, as in pellagra, cretinism, and the mental disorder following paludal and carbonic-oxide poisoning.

Organic Cerebral Diseases.—Hæmorrhage into the substance of the brain from fatty degeneration and rupture of arteries, or from miliary aneurisms, is followed in most cases by some loss of mental vigor, which not infrequently ends in unsoundness of mind, usually of the kind termed organic dementia. A similar type of insanity occasionally results from abscesses, thrombosis, embolism, parasites (cysticerci, echinococci), and other focal diseases of the brain. In about thirty per cent. of cases of intracranial tumors more or less mental disturbance is to be found, and occasionally it reaches the degree of actual insanity. This is more apt to be the case in syphilitic, cancerous, and tubercular tumors, but it has also been observed in tumors not accompanied by a general cachexia as a complicating cause.

Meningitis and encephalitis, from whatever cause produced, are especially apt to occasion psychical disorder, and not infrequently they determine some definite form of insanity. Middle-ear disease, with caries of the petrous portion of the temporal bone, or necrosis of cranial bones from other causes, has been known to have been followed by meningitis or encephalitis, and mental disorder.

Trauma capitis has long been recognized as both a predisposing and an exciting cause of insanity, which is due, in the usual mode of operation, solely to the resulting traumatic meningitis and encephalitis, and to the diffused secondary tissue-changes. The varied types of insanity from traumatism are similar in general outlines to those arising from alcoholism. They are, first, traumatic mania, as an immediate sequel of the injury; second, general affective degeneration, in which the changes in character and moral nature are complete and permanent; third, general pseudo-paresis; fourth, dementia. It has also been observed that concussion of the brain or spine, without apparent sequences of abscesses or inflammatory accidents, has been followed by insanity.

Insolation is to be viewed in the same etiological light as trauma capitis, and the pathological mental states that issue from it are, in many respects, like those just described.

Multiple cerebro-spinal sclerosis always induces some degree of psychical trouble, and the insanity may take the form of melancholia or of progressive dementia.

The most typical diffuse affections of the brain, however, that have a direct etiological influence in mental disease, are anæmia and hyperæmia. The fact that there may be partial as well as general cerebral anæmias and hyperæmias has important bearings on the rationale of the clinical symptoms. Some authors have gone so far as to make cerebral anæmias and hyperæmias the principal means of explanation of the different varieties of mental alienation.

It is not necessary to repeat what has been already mentioned of the relations of spinal and peripheral nervous lesions to mental disorder, but it is to be added that surgical operations, involving especially the cranial sensory nerves, may excite attacks of mental disorder. In two cases that have come under the writer's observation the only immediate ascertainable cause was the extraction of several teeth, without any great loss of blood. The manner of action of peripheral lesions of nerves in the determination of mental disturbances, known as the reflex psychoses, is not yet fully understood. The nearest anlaogy, in tetanus from the action of a peripheral nerve-lesion on spinal centres, has already been cited. All of the above cases are to be distinguished from ordinary traumatic delirium.

General Diseases.—All diseases that alter the quality or quantity of the blood, or interfere with the usual manner of its distribution to the nervous centres; that impair general nutrition and establish general anæmia or cachexia, are capable of becoming both the predisposing and the exciting causes of insanity.

The specific fevers are very frequently attended by delirium, which is technically differentiated from insanity. It will sometimes be found, however, that this delirium passes by insensible degrees into some form of mental alienation, which may begin either in the incubatory stage or at the height of the fever.

The psychoses are most commonly post-febrile, and they are sequels more especially of typhus, typhoid, and intermittent fevers, and they follow less frequently variola, scarlatina, and rubeola. Other diseases having causative relations that are well known are gout and acute articular rheumatism, pneumonia, especially in those given to alcoholic intemperance, and phthisis pulmonalis, which furnishes some special features of mental disorder. Syphilis is multiform in its etiological bearings on mental disease, first, as a transmitted diathesis, and secondly, as a profound cachexia and predisposing cause, and thirdly, as a direct cause of certain kinds of insanity from structural brain-lesions. Gastro-intestinal disease, as is well known, is often attended by painful emotional conditions, and it has often been noticed that they are connected with certain pathological states of mental depression. It may not be that they are adequate causes in themselves, but they doubtless favor the development of insanity.

Heart disease is frequent among the insane, and it may be regarded both as a cause and as an effect in its relations to mental disorder. It is often accompanied by arterial degenerations, and in endocarditis cerebral embolism may result, and various other complications favoring brain disease and mental disorder might be mentioned; but it still would seem that its influence in the causation of insanity has been over-estimated. The view held by some German writers, that certain varieties of insanity can be definitely connected with special cardiac lesions, requires confirmation.

Diseases of the kidneys are not uncommon among the insane, but their pathogenetic relations to the mental disorder are obscure. Clouston and others are inclined to connect certain forms of insanity with the conditions attended by the abnormal proportion of certain constituents in the urine, and thus diabetes, uræmia, oxaluria, and phosphaturia, are placed in the light of causes. It remains for future research to establish the truth of this hypothesis.

The reproductive organs exert an important influence on the mind both in health and in disease, but they do not merit the prominent position in the etiology of insanity that some writers are wont to accord to them. The medical error of all ages has been to mistake symptoms for causes, and in no instance has this been more strikingly exemplified than in the misapprehension of the sexual manifestations of insanity. There is a widely prevalent belief, medical as well as popular, that a large proportion of all cases of mental derangement proceeds from natural or unnatural sexual indulgence. The symptom has here been mistaken for the cause of the disease. The scientific fact is, that perversion of the organic nature and appetites is a part of the very essence of insanity, and that the sexual instinct, as the most fundamental, is the one most constantly involved. In most cases of insanity increase, diminution, or perversion of the sexual appetite exists at some stage of the disease, and frequently as one of the premonitory symptoms. Thus the discovery of masturbation in the pubescent patient is at once regarded as evidence of previous vicious indulgence, and the origin of the insanity is set down as found. The patient, duly labelled as to the particular cause, with a symptom that is almost universal in this class of cases, is now consigned to the care of the asylum superintendent, who may recognize immediately the general neuropathic constitution of the patient, and may find on inquiry a host of more adequate causes that are not in themselves symptoms. In a similar manner, insanity of the general paretic is apt to be too often attributed to the sexual excess, which, if not, as in most cases, an early symptom, was at least attended by alcoholic abuse, that was a much more powerful etiological factor. It is doubtful whether the most excessive use of any natural function is, *per se*, an adequate cause of mental derangement in the absence of predisposition or of other co-operating influences. The special nervous centres that generate the force wasted by the function in excessive use may be exhausted, and some sympathetic disorder of the whole economy may follow; but rest will soon restore the physiological balance of the general system and the lost energy of the special function. Thus prolonged mental application may be carried to such an intense degree that all consecutive thought finally becomes an impossibility. The loss of attention and of will-power is as absolute practically as in insanity, but the state is not pathological, and will not so become if repeated an indefinite number of times in a healthy person. There are specially laborious occupations that result, at the close of every day, in physical exhaustion, but they do not develop disease in those of sound body and temperate habits. Still, it must be admitted that, although in sound constitutions excessive activity of mind and body, and indulgence of natural appetites, does not give rise to disease, the result may be widely different in abnormal conditions of the system. The man sound in mind and body cannot develop apoplexy or insanity by gluttony or venery; but the patient with atheromatous cerebral arteries, or with highly unstable cortical centres and hereditary predisposition may, in the one instance, die apoplectic from a too hearty dinner, and in the other he may become maniacal from a night's sexual excess, so that the question becomes narrowed to the inquiry as to the particular classes of cases in which venereal indulgence may become a cause of mental disease. In the first place, during the development of early life, in those of a neurotic constitution, sexual excess may arrest the complete evolution of mental and bodily powers, and produce mental alienation; again, in those who have reached maturity and who have a strong hereditary taint, it may develop the latent tendency to mental disorder; and in another susceptible class, especially in those advanced in years, it may induce general debility and thus be an indirect cause of insanity; and finally, like any other coincident cause, it may occasion an attack in those just bordering on mental derangement. If the numerical proportion of cases due to excessive sexual indulgence

be sought, no reliable statistics from which to derive it will be found, on account of the delicacy of the subject, and the difficulty of arriving at the facts in any given case. Possibly five per cent. of all cases of insanity may be attributed to some kind of sexual excess. But as in civilized countries only about one person in four hundred of the general population is of unsound mind, and as it is probably less than the facts would warrant to estimate that the majority of persons are occasionally exposed to the effects of sexual excess, it can readily be seen how great is the relative inefficiency of this cause.

It has been stated that the exercise of sexual functions is more essential to health in women than in men, and that the former bear venereal excess better than the latter; but it is fallacious to draw conclusions from physiological conditions that are so different. It is probable, on the contrary, that men have greater organic need of sexual activity, that they suffer more from deprivation, and that they are capable of the generation and expenditure in this way of a greater amount of nervous energy than women. In rare instances, in men of a psychopathic diathesis, forced continence may become the cause of an acute attack of insanity, but this is probably never the case in women. In what has been familiarly termed "old maids' insanity," also, the cause is not, as has been suggested, the suppression of sexual functions so much as the absence of objects of affection, and of all the mental and moral influences of married life and of the home circle, that correspond to the inmost needs of woman's nature.

Authors have expressed divergent views as to the relatively greater efficacy of unnatural over natural sexual excess in the causation of insanity. The physical train of symptoms produced by either form of indulgence is the same, though functional impotence limits earlier the natural than the unnatural indulgence, but the moral injury is greater in the degree in which the special practice is held in general contempt, and excites self-condemnation and moral degradation in the perpetrator. This has been illustrated by sexual aberrations at various periods of the world's history, and by the fact that, as revolting features of warlike and religious rites, they have not been followed by the same effects.

Masturbation, though practised by many animals, by savages in a state of nature, and by a large part of the human race at some time of life, is still so justly held in disgust, that moral contrariety and changes in character follow its continued practice.

Mental disorder is, in very exceptional instances, excited by another revulsive shock, due to the sudden interruption of a life-long habit of constraint of sexual feeling. The forces of the higher cortical centres, long accustomed to move in certain ways for the complete inhibition of sexual feelings and acts, cannot be suddenly arrested without painful commotion. The modest young woman, educated all her life to inhibit every sexual idea, may be thrown by the first claim of marriage rites into a perturbed state of revulsion of feeling that may end in what is termed post-connubial insanity. Doubtless, constitutional instability of psychical centres and other predisposing circumstances must be present in such an instance, which serves, however, to exemplify in an extreme degree a certain kind of painful psychical reaction and injurious moral strain, active in all addicted to unnatural indulgences and yet not totally degraded by them.

Local diseases of the reproductive organs in women, through reflex channels, may excite functional derangement of the organ of the mind. It is to be assumed that, in order that uterine or ovarian disease may accomplish this result, there must be some inherent weakness of the nervous centres. Local affections of the male generative organs have not the same etiological importance.

Psychical Causes.—The older authors assigned psychical causes for most cases of insanity, while modern writers are more inclined to regard them as of secondary importance, and some have claimed that they are never operative otherwise than through the physical changes which they induce, and that, therefore, they should be accorded no place in the etiology of the disease. The latter claim is founded on specious reasoning that applies with equal force to physical causes, which are likewise efficient only through the secondary physical changes which they initiate.

It is useless to pursue the question to its final limit, as it simply resolves itself into one of final causes, and of the relation between mind and matter. It is enough to know two things: first, that the influence of the mind on the body is direct and powerful, that an emotion may terminate life as suddenly as a stroke of lightning; and, second, that the reactive influence of the mind on itself is equally powerful, and that the recoil of an emotion on the mind that emits it may overthrow the balance of reason.

Psychical causes are of two kinds: exciting and predisposing. The former are usually more sudden, and the latter are more gradual, in their action. The exciting causes that quickly disturb the mental equilibrium are more apt to be of a painful nature, such as fright on exposure to danger, or horror at the sight of a terrible spectacle, or grief at the death of one loved, or at the loss of fortune or reputation, or a more massive emotion, like that of awe, that pervades communities in times of calamity by fire, flood, or earthquake. Anger, too, as long ago expressed in Latin, "Ira furor brevis est," may become maniacal furor, or pass into some acute maniacal state. It is within the limits of clinical observation that feelings of elation also may pass the bounds of reason and end in complete mental alienation. An explosion of excessive joy may unhinge the balance of mind as effectually as grief, and most persons are more schooled in sorrow than in joy, and they bear it more becomingly. None but exceptionally well-balanced minds can bear sudden accessions of wealth or honor with equanimity.

The types of mental disorder developed by these sudden psychical causes are mania, melancholia, and delirious and stuporous states.

The stupor is almost always the result of fright. The vaso-motor theory is probably the most acceptable as to the pathological mode of action of these emotions. The predisposing and gradual psychical causes, however, act through the permanent changes in nutrition, secretion, and circulation which they establish. They are all of a depressing nature, and many of them are modifications of the generic emotion, fear. Thus every form of worry and anxiety, so fruitful as predisposing causes of mental disease, implies some form of fear as to future events, and in former days superstitious dread acted as religious fear does at the present day. Prolonged states of trepidation as to evils of an indefinite form that leave room for the play of an over-excited imagination, are, of all others, the most decided in their injurious effects, and even strong mental fibres may finally yield to the tension of painful uncertainty. As an issue out of such states, the most direful events may be welcomed, and they may prove an actual relief to the patient. Also, repressed emotions that have been prolonged under circumstances that compelled the sufferer to a course of conduct inconsistent with his innermost feelings, and that have found no outlet in word or deed, are followed by most injurious results.

The sudden withdrawal of an object upon which tender emotions have long been centred is also a psychical cause similar to disappointed hope, in which there is the removal of an ideal good enjoyed in anticipation. All these predisposing psychical causes are cumulative in their action, and they usually produce mental derangement by a repetition of shocks, or they reinforce one another, and the insanity is the result of their combined action.

The emotion that may be most effective as a cause in one individual may be inoperative in another, and in all in whom extreme emotional vulnerability exists a pathological state of the cortical centres must be presupposed.

The influence of psychical causes may be witnessed on a large scale during great religious excitement or business crises, or in times of invasion of foreign armies, or during political revolutions. The evil results in such cases extend also to subsequent years, and even to the genera-

tion "in utero" at the time of the action of the causes. Moral contagion also affords an instance of the extensive operation of moral causes, as in the epidemics of insanity in the middle ages, and in subsequent analogous occurrences at various periods. The force of imitation, as in chorea and hysteria, may in certain persons become an exciting cause of mental disorder, the course of which it may also modify; and the examples of communicated insanity, or "folie à deux," are to be mentioned in this connection, as well as the fact that simulated mental disorder has been known to pass into the actual disease itself. Severe mental labor, performed as a matter of necessity and by great efforts of will, during times of emotional suffering, and loss of sleep are especially injurious, and may lead to an outbreak of mental disorder.

Frightful dreams often repeated are sometimes the origin of painful moods of mind, and also of insane delusions, and they are to be enumerated among accessory psychical causes. Loss of one or more of the special senses, and the permanent change of the mind to all the special external influences derived from them, may be accompanied by alterations of character ending in mental alienation.

The sudden change from a life of great activity to one of complete idleness, in those who have retired from professional or business life prematurely, has been observed to end in a form of melancholia. Finally, there are to be ranked among psychical causes all those manifold social forces that shape human mind and character—forces that carry forward unrelentingly the development of the race, favoring the survival of the strong and the elimination of the weak; forces that raise the nation to a higher grade of civilization, but increase the number of its insane.

Symptomatological.—All forms of insanity are composed of certain elementary symptoms. These symptoms are seldom all present in any one case, but such is the variety of the order of their appearance and of the manner of their combination that they constitute many distinct types of mental disease. In this general article the special types of insanity will not be separately discussed, but the elementary symptoms of which they are all composed will be considered under the two general heads of Mental Phenomena and Somatic Phenomena.

Mental Phenomena.—Insanity, in its essential manifestations, consists in the abnormal action of mental functions, either singly or in their co-ordinated relations to one another. A rational analysis of its mental phenomena is impossible without some clear division of mind into separate faculties. The general division into intellect, feeling, and will is here accepted. The subdivisions are systematically arranged with special reference to the needs of psychiatry, and the elementary symptoms of derangement of the separate faculties will be discussed in the order of this subdivision. Under intellect, to which attention will first be given, this order is as follows: presentative faculties (perception and consciousness), representative faculties (memory and imagination), rational processes (thought and reason).

Perception. Perception, as here understood, is the distinct consciousness of special sensations originating in some one of the senses of touch, sight, hearing, taste, smell, or kinæsthesis, otherwise known as the muscular sense or sixth sense. Its disorders are among the frequent symptoms of insanity.

The perception of the sensations of touch, as the primordial sense, including those of pain, pressure, and temperature, is very constantly disordered. The diminution or complete absence of the perception of painful sensations (analgesia) is confined more especially to acute stages of mental disease or to certain periods of epileptic, hysterical, or paretic insanity. The partial or complete abolition of perception of sensations of pressure and of temperature (anæsthesia) is found in fully developed states of mental depression or exaltation, and in stupor, and the partial forms (tactile and thermo-anæsthesia) are to be detected in "ascending cases" of general paresis. Heightened perception of painful sensations (hyperalgesia), and of the sensations of pressure and temperature (hyperæsthesia), and also perverted sensations (paræsthesia), are common symptoms of many forms of insanity. In states of arrested development (idiocy) there is often a radical defect of perception of all impressions derived through the source of touch; and a somewhat similar condition obtains in some cases of the instinctive insanity of childhood, and in certain cases of monomania.

Perception as regards the muscular sense is lost in general paresis, but in somnambulistic states it is often heightened, and it is always more or less deficient in congenital states of mental weakness. Space will not permit a detailed notice of the disorders of perception of each of the special senses in insanity, but deranged perceptions of sensations referable to one or all of them, known as illusions and hallucinations, will next be considered.

Hallucinations and illusions are among the most important mental phenomena of all forms of insanity.

An illusion is a false perception, or, in other words, it is the misinterpretation of a real sense-impression.

The special external stimuli which are always present in illusions, and which act upon the terminal organs of special sense in the usual way, do not excite normal perceptions, but false perceptions that do not correspond to the external reality. The picture on the wall is mistaken for a living being, and the noise of the wind for human voices. Hallucinations, on the contrary, are of subjective origin, and they arise in the absence of all the customary external stimuli of the special senses.

An hallucination is the representation of a sense-perception which is mistaken for a sensorial presentation. It is the psychical revival of a sense-impression without any corresponding external stimulus of the sense-organ. In hallucination the purely imaginary thing is mistaken for the real thing—the living being is seen in open space where there is no picture or other object, and voices are heard in the absence of noises.

The physiological and anatomical reasons for illusions and hallucinations are not difficult to understand in the main, though there is still much that requires further investigation.

The points to be noted are the peripheral-nerve expansion in terminal organs of special sense that receive the external stimuli, the conducting fibres that convey the external impression from these organs to the optic thalami and other cerebral ganglionic centres, and the sensory cortical centres in which the complete differentiation of the perception takes place. Morbid irritation at any of these points will be referred to the periphery, and may give rise to illusions or hallucinations. Even in the absence of the terminal organ, as in the blind, and in functional loss, as in the deaf, the result may be the same, just as subjective sensations referable to the fingers of an amputated hand are excited by irritation of the nerve-stump.

This centripetal origin of hallucinations is the counterpart of the centrifugal, in which intense hyperæmias of the cortical areas liberate ideas with such vivid force that they react downward upon the central sensory ganglia and are projected outwardly, and become actual sensorial perceptions.

Disease, therefore, of the peripheral organs, of the conducting fibres, or of the central ganglionic centres, is a cause of these pathological phenomena. Also inequalities in cerebral circulation, or changes in the quality of the blood, toxic substances, as opium, alcohol, and many other agents; general anæmia, and whatever increases the irritability of nervous centres; states of exhaustion from fevers, sexual excesses, hæmorrhages, or starvation, are all competent causes of illusions and hallucinations. They also arise from powerful emotions, or from the concentration of thought upon one subject for a long time. There have been instances in which an effort of attention would serve to recall them at will; but there is danger that they pass beyond voluntary control and become permanent, and the exercise of such an unusual ability should be discouraged, as it points to a morbid condition of the nervous system. Hallucinations and illusions occur in those not insane, and they only

indicate mental derangement when the judgment fails to correct the faulty perceptions, and when that which is imaginary is accepted as real. In sanity, sensorial error in one direction is corrected by the action of the other senses; but during insanity not only is this means of escape from delusion often wanting, but illusion of one sense is often fortified by false perceptions of other senses. Correlative illusions and hallucinations are thus generated in a reflex way from one special sense-organ to another, and usually between those most nearly allied, as between the intellectual senses of sight and hearing and the emotional senses of taste and smell. The completion of the most elaborate illusions and hallucinations is accomplished in like manner by the action of a single false perception that arouses into activity complementary sensorial residua.

Hallucinations are unilateral or bilateral, fixed in space or indefinitely located, constant or recurrent, and variable or invariable in character. Contrary to what might be surmised, those are the most obstinate and unfavorable that are characterized by fixedness or limitation in time, place, or nature. The patient that has diffused hallucinations that fluctuate from hour to hour will probably recover, but the lunatic that hears the same words from the same direction with constancy of recurrence is more apt to have some organic cause for his trouble which will probably become a fixed habit, even though the causative lesion may disappear. There are two exceptions to this rule, however. One is the case of correlative hallucinations of several senses, which, when once firmly established, are incurable, since they confirm and support one another in illusive action; and the other is the general mental enfeeblement of chronic insanity, in which the barriers between the real and unreal have been broken down, and the apparently multiple hallucinations are, more strictly speaking, sensorial delusions.

The proof that hallucinations originate subjectively rather than objectively is that they correspond not so much to external circumstances and influences as to past events in the life of the patient. Thus the general character of hallucinations changes with the life experience of the patient as to age, nationality, station, and occupation, degree of education, and general manner of life, and it often corresponds to the most strongly organized habits of thought, as in the case of painters who have visions of their works, and composers who hear the repetition of their musical phrases, and as in the case of Newton and the solar spectrum, and Luther and the devil. The nature of the hallucinations is also determined by the prevailing emotional tone, so that a marked change during the passage of states of depression into states of expansion takes place.

Delusions, too, determine in a measure the character of hallucinations and illusions, and this is more frequently the case than that the nature of the false belief is determined by the false perception. The direct physical cause of illusions is frequently obvious. Thus, illusions have a peripheral origin in visceral paræsthesiæ in hypochondriacal insanity. Illusions of taste and smell arise from a coated tongue in gastric disorder, and from a tainted breath in phthisis pulmonalis, and sexual illusions likewise are to be traced to ovarian or uterine disease.

Many interesting instances are on record of the removal of the local cause of irritation, and of the disappearance of the sensorial disorder. It has also happened, now and then, that the patient could control the illusion through certain points of pressure, or by closing the eyes or ears, or by change from the recumbent to the erect posture, and it will sometimes be found that patients resort to these expedients for relief. The cause of the persistency of illusions in certain cases is obscure, as in the illusions of smell in masturbatic and in puerperal insanity.

The force of expectant attention influences the origin of illusions in the insane. Just as any person in eager expectation of the coming of someone may mistake slight noises for footsteps, or make mistakes in identity otherwise than he would have done had he been less expectant, so the insane misinterpret sights and sounds in accordance with their ruling expectations. The emotional origin of illusions, too, is similar in the sane and the insane, though of a much more exaggerated nature in the latter.

Some persons absolutely cannot see things precisely as they occur when their feelings are strongly enlisted. Hence arise the honest but wide differences of statement under oath of eye-witnesses to actual occurrences. Many of the illusions of the insane betray a strong emotional bias, and are only extreme instances of this principle.

Patients refer hallucinations or illusions sometimes to their true internal source, but more frequently they locate them externally, and they distinguish between them and ordinary sense-impressions though they cannot doubt their reality. Hallucinations of the intellectual senses of sight and hearing are most common, and those of general sensation and of taste and smell are about alike in frequency. All hallucinations are more common at night than in the daytime; and it is probable that for this reason those of hearing are, upon the whole, more frequent than those of sight, the attention being confined to auditory, suggestive stimuli in the absence of external impressions of the other senses. This certainly is the case as regards psycho-sensorial hallucinations dependent on a pathological condition of both the cortical centre and of the peripheral mechanism of special sense. In general, hallucinations of sight are more common in acute, and hallucinations of hearing in chronic, insanity. All the senses are seldom involved at the same time, and a single sense is seldom affected throughout an attack to the exclusion of all the other senses. In very rare cases there are unilateral hallucinations of different senses, as of sight on one side and hearing on the other. It is probable that not less than sixty per cent. of all cases of mental derangement have illusions or hallucinations at some stage of the disease. In dementia illusions may still persist, but hallucinations disappear as the memory fails. The dependence of hallucinations on the memory is also illustrated in an interesting manner by the disappearance first in order of the hallucinations of words of foreign tongues known by the patient, and also of the elaborate hallucinations until none but the most simple remain in the advanced stages of the disease, and finally terminal dementia ends the history of these phenomena. Perception during insanity is altered in other ways than those above described. The time required for the perception of special peripheral stimuli may be greatly increased. This retarded perception is found in the acute stage of most states of mental depression, and in dementia. The opposite condition of quickened perception is often present in states of mental exaltation, and in some cases of hysterical insanity. Perception is also variously confused or impaired in the different kinds of mental derangement in proportion as memory and attention become affected.

Consciousness. Intellectual consciousness, which is present in all definite sensations and ideas, and in their mutual and combined relations, is that which is to be here considered; and organic consciousness, arising upon the psychical basis of the organic sensations, and constituting the fundamental element of states of feeling, will be noticed under the head of emotions. Space will not permit an examination of the pathological changes of consciousness in the sense of introspective attention, or in any of the limited meanings in which it is often used; but the facts witnessed in insanity of the gross changes of consciousness, viewed in the wide sense of a consensus of all the mental functions in harmonious activity, will be briefly stated. Clearness of consciousness is only attained by the perfect coördination of all the faculties, and in mental alienation obscurity and confusion of consciousness arise just in proportion as memory, attention, or any of the single mental functions fails to act in harmony with the others. Thus there will be found in insanity every degree of impairment of separate faculties, and every grade of loss of consciousness. In acute delirious mania the mind is crowded with ideas in rapid flight, and close attention is impossible, and consciousness is necessarily confused. In other cases there is a loss of memory, and a corresponding confusion of consciousness and in terminal dementia, with total amnesia, intellectual con-

sciousness no longer exists, though organic consciousness still persists as in the lowest forms of idiocy. In epileptic and paretic insanity there are partial or complete losses of consciousness that occur at various stages of these affections; and in all acute mental depression there is a painful limitation of consciousness, which amounts almost to complete suspension in melancholia attonita. In mania transitoria, maniacal and epileptic furor, acute primary dementia, and in certain stages of typhomania, there is complete loss of consciousness.

The sudden influx or withdrawal of large masses of ideas and feelings causes active disorders of consciousness in many other forms of mental derangement, and great interest attaches to disordered consciousness as seen in changes in personality; for the understanding of which, facts later to be mentioned, under cœnæsthesis, are needful.

The mental functions next to be noticed are those that are concerned in the reproduction of past sensations and ideas—the representative faculties of memory and imagination.

Memory. The memory seldom remains intact throughout an attack of mental alienation, and it most frequently suffers a variety of alterations during the different stadia of the disease, and every conceivable lesion of this faculty is to be encountered. Partial, periodic, progressive, and total loss of memory are familiar features of insanity, and here, as in other brain diseases, there is a general order of degeneration of mnemonic functions. The loss of memory is first for the simple, and then for the complex; first for the particular, and then for the general; first for that which is new, and then for that which is old. The loss of memory is, also, first for that which is intellectual and voluntary; second, for that which is emotional and involuntary; and, third, for that which is instinctive and automatic.

Occasionally in states of mental exaltation there is a slight increase of the power of memory. This hypermnesia is analogous to that seen in fevers and in other conditions of morbid excitation of cerebral centres. The rapid flight of thoughts facilitates the association of ideas, and the events of a life-time may be passed rapidly in review, forgotten languages may be recalled, and other wonderful feats of memory performed. The more customary condition in maniacal states is a profusion of fleeting ideas, with superficial attention and imperfect recollection. The lesion of memory in melancholia varies with the degree of depression. If there is great mental tension, inhibition of thought, difficult association of ideas, the memory may be greatly impaired; but in subacute cases there may be no apparent loss of this function. In primary dementia, mania transitoria, melancholic frenzy, epileptic, alcoholic, and maniacal furor, delirium acutum, and terminal dementia, there is total amnesia. In hysterical and epileptic insanity there are rare instances of periodical amnesia. In all vivid hallucinations and overpowering emotional delusions there is apt to be, for a brief period at least, loss of memory from lack of attention. Lapses of memory are also common symptoms in senile, paretic, and epileptic insanities, apart from the progressive amnesia that characterizes these affections. The general recollection which a patient has of an acute attack of insanity, after recovery, is of a summary nature as a rule, and in many it is of an unreal or dream-like character, and it is almost always disagreeable. It is well, however, to note the rare exception that all the minute details of an attack may be retained, and its prevailing emotional state may be recalled as more pleasurable than any ever known in normal existence.

Imagination. The imagination, like the other mental functions, gives evidence of the general pathological process in insanity. The higher forms of imagination, the creative powers of artists, poets, and inventors, is always impaired in insanity, which is never, as has been claimed, akin to genius except in the eccentric display of low forms of imagination. The highest creative imagination presupposes a memory richly stored with well-arranged material for recombination, quick perceptive and associative power, and powerful logical faculty, in addition to the spark of inspiration from the divine altar, and these are the tools with which the work of creative genius is always accomplished. This perfect coöperation of all the higher psychical functions is not present in mental derangement, and it will be found that one of the earliest symptoms of insanity is a failure of the higher forms of imagination. On the other hand, reminiscent imagination, the imaging power, the life-like representation of previous sense-impressions, and also lower forms of constructive imagination, more properly termed phantasy, are not only present, but they are greatly exalted in some kinds of mental alienation. It is morbidly exalted phantasy that creates the numberless pseudo-hallucinations in monomania; that shapes the monstrously absurd and extravagant ideas in general paresis, and that furnishes the hallucinatory phantasmagoria of epileptic and hysterical mania. The mental state of some chronic maniacs, like dream-life, or the play-time of children, is a continued display of unrestrained phantasy. The imaging power especially is often in a condition of great excitation, and it is interesting to note that the most lawless of faculties still acts according to some pathological law, in the uniform reproduction of the same fantastic array of snakes, insects, and animals in alcoholic and other kinds of delirium. Diseased imagination in the insane also reveals itself in odd conceits, in the discovery of capricious relations of things, in strained and whimsical double meanings of words, and in crazy rhyming and repartee that is akin to wit. It is in ecstatic states of mental derangement, however, that the phantasy attains the greatest height of pathological activity and yields those seraphic visions that absorb the spellbound patient. In states of mental depression there is ordinarily diminution of the power of imagination, and in stupor and in apathetic dementia there is complete loss of the faculty.

Rational Processes. The higher forms of thought, as generalization and abstraction, and reason as the crowning function of the mind, are dependent on perception, memory, and imagination, and their integrity is affected as the latter become disordered. In the most simple act of comparative reason the perception of similarity and difference and the revival in memory of past standards of comparison are implied, so that the irrational conclusions of the insane are often due to deranged perception.

The external stimulus of the organ of special sense may pass centripetally through diseased channels, and may be perverted on the way to the cortical centre of conscious perception, and falsified perception thus becomes one term of the comparison by which the erroneous conclusion is reached. In like manner the interdependence of all these rational processes and of the other powers of mind might be shown.

There is nothing specific or peculiar in the manner or methods of these higher forms of thought in the insane, as has been supposed, and, so far as they are accomplished at all, they take place as in health, with automatic regularity and in accordance with the organized laws of all thought, and the disparity of results is due to lesions of the primary faculties already described. The individual differences of mind are retained, and the reasoning madman will reach conclusions and defend his delusions with the same logical methods that he is accustomed to employ in health in support of his sane opinions.

In this connection properly belongs the consideration of the subject of insane delusions.

Delusions have long been ranked, both from a medical and a legal point of view, as the most important symptoms of insanity. It is better understood by physicians than by lawyers that they are not a crucial test of insanity, that they are but one of many other manifestations of the general pathological condition of the nervous system in mental aberration, and that they never in themselves constitute the disease of which they are only epiphenomena. An insane delusion is an irrational conviction, originating in, and continuing by reason of, functional or organic cerebral disease. It is a belief, contrary to fact and to common-sense, retained in the presence of such evidence as would have proved its falsity to the holder in his normal state of mind.

Delusions may be variously classified, but most attempts in this direction are as artificial as the phenomena are complex. The most important natural distinctions as to delusions are, first, their mode of origin, and second, their essential nature, and they will be here considered in accordance with this division.

The pathological origin of delusions, as regards the organ of mind, may be intrinsic or extrinsic, or, in other words, the conditions from which they spring may be intracerebral or extracerebral. The intracerebral origin may exist first in disturbances of cerebral circulation, in general or local ischæmias or hyperæmias of the cortical centres, or of the central sensory ganglia, or in active molecular changes and organic lesions of these regions. The delusions follow, secondarily, from hallucinations, as the primary result in disease of the optic thalami in the above instance. Again, the intracerebral origin may be from the presence of a toxic blood-supply, resulting from fevers or other affections, or from the ingestion of poisonous substances, like alcohol or opium, which in many cases give a specific tinge to the delusions generated.

The extracerebral origin of delusions is to be found in general irritations of the peripheral nervous system, in local disease of the visceral organs, in disease of the organs of special sense, and in general diathetic states.

Important among the intrinsic delusions are those termed primordial, which arise not through sense impressions or the ordinary channels of association of ideas, but as the immediate product of diseased mind-centres they are generated spontaneously and spring fully formed into consciousness, and they often create perturbation by the suddenness of their invasion. They are common in primary monomania, and in other forms in which there is hereditary instability of nervous centres. The delirious conceptions resulting from the retention in the blood of constituents that should have been eliminated are too well known to require notice here, and this is also the case in those arising from the abuse of alcohol or other toxic agents, which have often been known to redevelop precisely the same delusions in the same patient.

The extracerebral origin of delusions from peripheral irritations has long been recognized, and it is immaterial as to the result in this instance whether the false belief pass through the intermediate stage of an illusion or not. In numerous patients, with persistent delusions relative to some part of their body, autopsical examination has revealed the presence of chronic local disease as the origin of the false conceptions.

Gastro-intestinal disease and local irritations of the sexual organs are especially apt to give rise to these reflex delusions. The false conceptions that occur in connection with disease of the organs of special sense are frequently secondary to the illusions that spring from this cause. It has often been observed, also, that deprivation of one or more of the special senses favors the development of delusions—that a suspicious turn of mind results, with a fear of imposition, that may be increased by the false notions that spring from impaired perceptive power. In diathetic conditions, as in pellagrous and malarial states, and in phthisis pulmonalis, delusions appear as sequels of the cachexia, and they may have a rhythmical recurrence, and vicariously replace the physical symptoms in the malarial diathesis. Dreams are also a cause of delusions. Even in comparative health the disagreeable impressions of dreams may persist in waking hours, and they may require a strong effort of will for their dismissal, and in the mind already weakened by disease they may take possession of consciousness with the same force as sense impressions, and they may thus become accepted as realities.

It is probable that hallucinations and illusions are the most fruitful source of delusions in the insane, for it is more difficult for them than for persons in health to discredit the evidence of their senses. It is not infrequently a coincidence, too, that illusions of more than one sense conspire to confirm the false belief. The perversions of general sensations and of the muscular sense contribute largely to the false conceptions of the insane. The organic sensations, too, play an important part in the delusions of change of personal identity. The force of imitation, too, has a share in the origin of erroneous conceptions, as has frequently been seen in epidemic delusions and in the special type of "folie à deux." In the same patient one delusion often begets another, and there is often a central false belief about which the others are formed. It cannot be denied that the disposition to entertain certain kinds of delusions is inherited, and some remarkable examples of this have been observed, and it would seem that morbid modes of thought, like suicidal impulses, may be transmitted.

The more universal causes that favor the origin of delusions are general ignorance, superstition, and loose and illogical habits of thought. The person that has all these native defects of mind will much more readily become the subject of insane convictions from which there will be less liability of recovery.

Delusions may be divided, according to their nature, into organized and unorganized, and they may be subdivided into depressive and expansive, temporary and permanent, and passive without tendency to action, and active that are embodied in acts of violence or in other corresponding conduct. The latter distinction is of more practical than theoretical importance.

A delusion is organized when, taken as a centre of ideas and feelings, its internal and external relations have been logically arranged in the mind of the patient. A patient conceives the delusion that he is the object of a deep-laid and life-long conspiracy, and about this central idea are gathered, for its logical support, all the coincidences of his past or present life which even remotely favor the notion, and the external relations of the idea to persons and events are systematically arranged in the patient's mind, over which the delusion finally acquires a predominant influence. The delusion thus becomes an organized central point of departure and convergence for thoughts, feelings, and actions. All outward occurrences are finally interpreted solely in their bearings upon this ruling idea, and any serious opposition of this erroneous belief usually provokes violent emotional demonstrations in the patient. The most permanent and completely organized delusions are found in primary monomania, and in other hereditary types of insanity. Between these completely organized and the unorganized delusions are those having intermediate grades of complexity or simplicity of formation. The unorganized delusion is an isolated phenomenon having no special or established relations with other insane beliefs, and they are well exemplified by the rapidly changing erroneous beliefs in mania and general paresis.

As regards this principal division of delusions, however, it must be added that their essential nature is always dependent on the state of the mental faculties in general, and of the rational processes in particular. If the higher forms of thought and reason still exist and are not in functional abeyance, the false conception is always organized by an inherent law of the mind that invariably assigns causes and rational explanations for things subjective.

There is failure of organization of delusions, then, just in the degree that there is loss of the rational processes. The swiftly changing ideas of mania do not admit of attentive thought and of consecutive reasoning, so that the delusions are unorganized and mainly of sensorial origin. In acute melancholia there is painful concentration and slowness of ideas and inhibition of the higher mental functions, and the unorganized delusions are chiefly the vague embodiment of depressing emotions. In dementia and in all chronic forms of mental weakness the delusions are unorganized, in accordance with the general law above stated.

The nature of the delusion thus becomes, to some extent, an index to the general state of the rational faculties. Permanency is a feature of bad import in insane delusions, for the force of habit is as great here as in health. Every recurrence of the morbid idea serves to fix it in the mind, and it soon becomes an inveterate symptom that will continue even though the local disease in which it

originated may have passed away. The patient who believes that he has a lizard in his stomach may continue by force of habit to entertain the delusion long after the healing of the gastric ulcer, which may have been the physical origin of the idea. Probably this force of mental habit alone is sufficient to prevent complete recovery in certain cases in which a few false convictions become fixed, though there has been a return to comparative health in other respects. The general health may be good, and there is presumably no cerebral lesion to account for these inveterate delusions, and the only hope is that they may fade out in the course of time, as occasionally happens. The usual manner of disappearance of most delusions is gradual, and they tend to recur in a modified form for months after apparent recovery. The most temporary delusions occur in acute forms of insanity, and they are often due to rapidly changing illusions.

In chronic insanity the remnants of former insane beliefs and the empty verbal formulæ automatically repeated, are not in any strict sense to be ranked as delusions. The division, again, of the false beliefs of the insane into depressing and expansive, is clinically justified. The delusion is often the special outcome of the prevailing mood of mind, whether depressed or exalted. It is only in transition stages, or in rare instances, that it fails to reflect the dominant emotional tone. It is only because the false belief is mistaken in its entirety that there are apparently so many exceptions to this rule. Thus a melancholic patient may reveal the expansive delusion that the house in which he is confined has been purchased for him, and that the repairs in progress are for his benefit; and the rest of the conviction may not be mentioned, that the house is to serve as his funeral pile, and that he is to be buried in it as a punishment for his sins. As a general thing, then, the prevailing psychical tone determines the agreeable or painful character of the delusion.

A certain influence in the same direction is exerted by the natural temperament and disposition of the patient, and a delusion may be simply an extreme exaggeration of a native trait of mind, so that great self-conceit may pass into a belief in the possession of superhuman abilities. The delusions of primary monomania are sometimes of this nature. The outgrowth of intense suspicion, as an inherited characteristic of some minds, readily assumes the proportions of insane delusions.

False convictions of purely subjective origin differ somewhat from those having an objective basis of fact, so that external circumstances may have some influence in shaping the form of a delusion. In fact, among the insane of the same nation, during all ages of the world, there has always been a surprising sameness of false beliefs, due to similarity of environment; and the sexual, religious, and persecutive delusions are universal in all times and places.

A large percentage of all delusions are rooted in the generic emotion of fear, and they have their analogies in many morbid fears springing from functional nervous derangement, and termed agoraphobia, claustrophobia, anthropophobia, and other similar apprehensions, that are to be regarded psychologically as incipient delusions aborted in the emotional stage. Similar fears are common in insanity, and their genesis is to be found in physical conditions that may sometimes be temporarily relieved by remedies that stimulate the circulation and the nervous centres. Thus the painful prodromal stage of melancholia is often one of vague fear, in which every new event excites some corresponding apprehension, and temporary relief may be sometimes afforded by the stimulus of alcohol or opium.

This account of the origin and nature of delusions facilitates an insight into the reasons for their persistence. In health erroneous ideas also arise, but they are compared with past standards of experience, and judgment readily makes the necessary correction; but in insanity memory and discrimination are impaired, and the standards of comparison are either not furnished, or they cannot be used, and this is the most common reason why the delusion persists. In the hereditary madman the delusion may be an exaggeration of a natural trait of vanity or suspicion, and is, as it were, an inherent part of his nature; and what was tersely said in sacred writ of natural fools, two thousand years ago, is equally true today, "Though thou shouldst bray a fool in a mortar, yet will not his foolishness depart from him."

The reason for permanency is evident in those false beliefs sustained by an illusion due to chronic local disease of the peripheral organs, or in those generated by progressive organic cerebral lesions. In dementia the kernel of the delusion has gone, and the verbal shell remains as empty, sounding words, without meaning or feeling for the patient, and their repetition becomes purely automatic. In some instances patients do correct their delusions, and that, too, by means of external circumstances, or by judicious and timely assistance given them; and it is a common error to suppose that it is idle to attempt to render any aid in this respect in any case. The feasibility of any measure of relief depends entirely on the mode of origin and on the exact nature of the false conviction, which may be modified, if not removed, in certain cases. It has been stated that a primary central false belief may beget secondary false beliefs, and in this case the original delusion usually outlives the others, but when there is a change in the general emotional tone the delusions most in accord with it are those most apt to survive. This is seen in primary monomania, in which occasionally a change of the fundamental emotional tone from one of depression to one of modified expansion takes place, and thereupon compensatory delusions of grandeur may supplant or commingle with the primary delusions of persecution.

Preoccupation with that which concerns self is a common characteristic of most invalidism, and this selfish concentration is especially marked in insanity, so that one of the most universal traits of insane delusions is that they relate more or less directly to the patient. The loss of altruistic sentiments, which occurs as one of the earliest phenomena of mental alienation, deprives all ideas that relate to others of weight or influence in the mind of the patient, and leaves egoistic thoughts as the remaining material out of which false convictions are constructed. There is a rare form of delusion, probably of amnesic nature, by which current events are mistaken for repetitions of past experiences. The false conviction is that the present reality in each instance is but the renewal of a former occurrence.

Through defect of memory the patient fails to detect either the precise similarity or the exact points of difference between the two events, which are thus mistaken for things identical in form, and the sufferer passes into a painful state of increasing confusion of mind.

Finally, it may be said of all insane delusions that they are to be judged and dealt with not according to their outward verbal form, which is of little significance, but according to their nature and origin, which are alone of fundamental importance.

Apart from insane beliefs there are in mental alienation other formal deviations of the rational processes from a normal standard, and one of the most obvious of these is a change in thought-rate. A definite interval of time lapses between the reception of a peripheral stimulus and its conscious perception, and this fraction of a second varies for the different organs of special sense, and is greatly increased in many forms of insanity. Likewise there is a time-rate for rational processes, which may be shortened in mental exaltation, but it is ordinarily greatly prolonged in states of mental depression or of mental weakness. The words addressed the patient are duly apprehended, and the process of thought follows the usual channels, but with greatly retarded pace, and the correct answer is finally given after much delay. This retardation is often proportionately greater in the rational process than in the perceptive and reflex acts. These changes in time-rate are often of practical value in diagnosis and prognosis.

The review of the symptoms of insanity, as strictly comprised under aberrant intellect, is now complete, and attention will next be turned to such abnormal phenomena

as are embraced under feeling, as the second main division of mind. Feeling, with a view to the needs of the subject, is subdivided into organic sensations, cœnæsthesis, simple emotions, pleasurable or painful, and complex emotions, egoistic or altruistic, and its pathological disturbances will be considered in this order.

By organic sensations are here understood those subconscious impressions that are received by the brain from all portions of the human organism. The brain, as the presiding organ in the human economy, is in structural connection and in functional sympathy with every organ and tissue of the body. Muscular, neural, circulatory, respiratory, and visceral impressions go to form this common fund of organic sensations, that, from the earliest moment of existence, reach the cerebral centres in an unbroken sequence, and that are subconscious in health. It is only during disease, or abnormal change in the particular organic sensation, that the latter becomes clearly conscious and attracts special attention. The resultant of all the organic sensations, from all of the above-mentioned sources, is a general state of feeling or of organic consciousness, known as the cœnæsthesis, which is of great importance as constituting the basis of emotions. If, as is well known, the organic impression from a single functionally deranged organ, like the stomach or liver, may cause decided emotional depression, it can readily be understood that the sum total of muscular, neural, circulatory, respiratory, and visceral impressions may determine the fundamental emotional tone, the general conscious feeling of well-being or of ill-being, the pleasurable or painful cœnæsthesis.

Among the most early and constant occurrences in insanity are changes in these organic sensations that result in a depressed or exalted cœnæsthesis, a painful or expansive emotional mood, as most typically seen in melancholia and mania. The various factors that serve to compose the melancholic and maniacal state will be hereafter described. The altered cœnæsthesis is one of the most essential of these factors, as it furnishes the emotional basis of these states. If this ground tone of feeling be gloomy, the simple emotions that arise upon it will be painful; but if it be pleasurable, the emotions will correspond in character.

The alterations in the cœnæsthesis may be sudden or gradual. A gradual and physiological change is witnessed at the time of puberty, due to the influx of organic sensations from the reproductive organs. This alteration may become pathological, as already seen in pubescent insanity. In various forms of mental derangement the cœnæsthetic changes, though not so radical as those of pubescence, are often more sudden, and completely interrupt the harmony of relations between the brain and the whole system of organs. The disordered cœnæsthesis is important also as forming one element in the changes of personal identity so common among the insane.

The *ego* is the sum not only of the present and past states of intellectual consciousness, but also of states of systemic consciousness. It is dependent, therefore, not only upon conscious memory, but upon organic consciousness, which is alone active during nearly a third of existence, in sleep, and also in fœtal life. Now, when there is a sudden and decided alteration in either of these kinds of consciousness, a sense of divided personality arises.

If it were possible to substitute, in the old man with memory of the past intact, all the organic sensations of youth—a complete youthful cœnæsthesis—it would prove a rude shock to the sense of personal identity. Thus, in the insane the sudden changes in the cœnæsthesis that are so foreign to anything known in health, produce that general feeling of estrangement which favors delusions of change in individuality, of metamorphosis into animals, and similar irrational notions, which are initiated usually by perversions of some of the specific forms of sensation.

Having thus alluded to the organic source of emotions, and to their natural division into pleasurable and painful, it will be well to inquire into their higher relations, and into the nature of the changes which they constantly undergo in insanity.

The anatomical seat of the emotions is the cerebral cortex, and all definite emotions are inseparable from ideas, and with them they probably share the same cerebral centres. The constant afflux to these cerebral centres of systemic influences determines the prevailing emotional tone, but the special emotion is evoked by a sensation presented for the first time through one of the special senses, or by a feeling revived in accordance with the usual laws of association. The general character of the emotions in any individual will depend on the inherited and inherent qualities of cerebral centres, and on the structural variety and extent of the cortical association-traits established by the influence of habit, education, and environment. These general facts throw light on the pathological emotional disturbances so constant in insanity. In the first place, there are the radically distinct states of mental depression and exaltation, with corresponding painful and pleasurable emotions, determined largely by the cœnæsthesis. Then come hosts of emotions, arriving through no adequate external cause, but through perverted sensations of the special senses described under illusions. This is often the origin of the rapid emotional changes in mania. Again, innumerable morbid emotions are generated by local pathological irritations or variations in the quality or quantity of the blood supplied to emotional cortical centres.

The emotions thus aroused in mental derangement pass into muscular action, or they effect changes in secretion and in nutrition. The facility of motor discharge of emotions would seem to be much increased in states of mental exaltation, for the incessant muscular movements of maniacs are the coördinated expression of emotions rather than of the simple organic need of activity, or of the automatism of certain other types; while the glandular emotional effects appear to be greatly diminished in melancholic states, in which the most intense grief may fail to give rise to lachrymation. Again, while it is true that the depressing emotions and the malnutrition of melancholia are common symptoms of a general pathological state, it must also be admitted that there is no suspension here of the general law, that pent-up emotion that finds no outlet, either motor or glandular, will derange nutrition; and it was not without some reason that ancient writers represented the silent and motionless melancholiac as a prey whose flesh was consumed by his own corroding emotions.

Occasionally in acute mania, and in maniacal furor, and melancholic frenzy, there is to be witnessed a tumultuous outbreak of emotions occurring with the suddenness and violence of the epileptic motor discharge. The probable pathology of these tempestuous emotions is intense cortical hyperæmia, resulting in a spontaneous discharge of emotional force. In general paresis, too, the incoherent succession of exaggerated emotions would seem to be due to some similar pathological process in the cortex cerebri, rather than to the action of sensorial provocations, or to the usual laws of association of feelings. In states of mental weakness the emotional phenomena still continue, though in a greatly diminished degree, even in the absence of recollection; and not until the amnesic disorder has reached the stage of loss of association of ideas is there a complete extinction of the emotions as seen in terminal dementia.

The division of the more complex emotions into egoistic and altruistic is appropriate to the course of events in mental derangement. It is a rule, almost without exception, that the altruistic emotions are lost in insanity. This loss of the higher social feelings is not only one of the most diagnostic, but also one of the earliest manifestations of the disease. On the other hand, the egoistic emotions seem to be greatly intensified, but this is to be partly explained by the absence of the counterbalancing influence of the higher feelings. This early loss of altruistic sentiment, which is the only sure guide through all the intricacies of social life, and the consequent failure of the patient to adapt himself to the varying relations of his personal environment, often furnish the earliest indications of the development of mental alienation, which, as Esquirol long ago pointed out, begins with changes in the emotional nature.

To close this review of the pathology of feeling, as the second main division of mind, two of its most typical and antithetical conditions, viz., the melancholic and the maniacal states, will now receive a complete description, and, to avoid recurrence to the subject the physical accompaniments of these states will also be included.

The melancholic state, fully developed, presents the following phenomena: There is a paucity of ideas and a painful limitation of the range of thought, and of the association of feelings. There is partial loss of voluntary attention, and the persistence of a few fixed and gloomy conceptions in consciousness. Recollection is impaired, mental processes are slow and labored, and conclusions are reached with difficulty. There is tension of mind, increased mental inhibition, loss of spontaneity and of will-power. A phenomenon of the utmost importance is the fundamental emotional tone of depression, due to perverted systemic sensibilities and a morbid cœnæsthesis, which are the organic substrata of the gloomy emotions that constantly pervade the mind of the patient and constitute the essence of the psychical affection. The somatic phenomena are equally characteristic. The general physical features presented are those of complete anenergia. The flexors and adductors act, but there is relaxation of other muscles. The excess of action of the flexors over the extensors results in the bent posture of the body, and in the forward inclination of the head. The respiration is superficial, and often infrequent. The variations in the circulatory and vasomotor symptoms are such as have been confirmed by physiological experiments in induced states of physical pain. There is vascular hyperkinesis and increase of blood-pressure, and the arterial tension and narrowing, with the corresponding cerebral anæmia, would seem to favor Meynert's view, that the general malaise is partly due to dyspnœic suffering of nervous elements insufficiently supplied with oxygenated blood. The angiospasm often extends to the cutaneous capillaries, and results in a pallid aspect or in lividity of the extremities. There is diminution of secretions and excretions. The perversion of general and special sensations favors the origin of the delusions that arise as the culminating manifestation of this general melancholic state.

The maniacal state also presents a typical combination of psychical and somatic symptoms.

The mental phenomena are an increased flow of ideas, great rapidity of thought-rate and of all the psychical processes, unusual facility of memory, of imagination, and of the association of ideas. The resultant of the organic impressions is most agreeable, and the pleasurable cœnæsthesis is expressed in a most expansive emotional tone. There is a sense of unbounded satisfaction and a great exaggeration of self-feeling. Emotions of a painful nature may be momentarily provoked, but in the main the feelings correspond to the general joyful frame of mind. There is a complete absence of mental inhibition, and this removal of all the customary checks of thought and feeling imparts an additional agreeable impression, of freedom. Illusions and delusions arise, but they are seldom permanent, and they are apt to be displaced by the surging crowd of new ideas.

The somatic symptoms are a great organic need of bodily activity, increased muscular innervation and coördination, and heightened muscular sense—almost ceaseless coördinated movements that are psycho-motor in most cases, though sensori-motor or automatic in others, and that are not followed by any natural sense of fatigue. Insomnia is a constant symptom. Polydipsia and polyphagia are not uncommon, and there is usually an increase of the sexual appetite. The secretions and excretions are frequently increased, and respiration, circulation, and nutrition are active; and still there is ordinarily a gradual loss in weight.

The melancholic and maniacal states above described are not to be confounded with the melancholia or mania as distinct types of insanity pursuing a definite course, though they form an integral part of these types; but they also constitute the prodromes, sequels, or intercurrent phenomena of many other forms of mental derangement. Thus, general paresis may have either of these states as intercurrent phenomena that only temporarily interrupt but do not stay the onward course of the disease, and it would be a mistake, on the occurrence of the melancholic state, to call the general paretic a case of melancholia.

The pathological manifestations that are embraced under *will*, as the final division of mind, will be here described, along with the disorders of the appetites, which are regarded as having a deep relation to the will; for appetites, when conscious, constitute desires that are the basis of will, and their perversions in insanity are symptoms of great practical importance.

The appetites that are daily recurrent throughout life are hunger, thirst, and sleep, and the only organic need that is not thus recurrent is the sexual appetite, which returns with variable strength and frequency at all stages of existence, with the exceptions of childhood and senility. In mental derangement the appetite for food is usually much diminished. Food is sometimes refused through gustatory illusions or delusions of poisoning, or real perversions of the sense of taste, but more frequently from an instinctive loathing of food that often amounts to sitophobia. In other cases a small amount of food causes satiety, and a full meal excites nausea. There is occasionally an increase of appetite, as in certain stages of mania, general paresis, and dementia. This boulimia in mania may be the natural result of excess of activity and waste of tissues, but in general paresis and dementia it is often due to gastric anæsthesia and to the entire absence of repletive sensations. In hysterical insanity both extremes may be encountered in a recurrence of anorexia and polyphagia.

The perversions of appetite in mental disease have their analogies in the pica of pregnant women and of chlorotic girls, in clay-eating among southern negroes, and also in chthonophagia in the West Indies, and in Hudson Bay territory, and in various similar practices in many parts of the world. The greatest extreme of depraved appetite among the insane is seen in the devouring of their own excrements. This coprophagy in idiocy may possibly signify a simple reversion to low forms of appetite, as often seen in animals, but in active mental derangement it is an unfavorable indication of the depth of the pathological cerebral processes. Anthropophagy in epileptic and in puerperal insanity would seem to be more nearly allied to perversions of the sexual instinct.

Thirst, like hunger, undergoes abnormal variations in mental disease, and it is decreased, rather than increased, as a rule.

Polydipsia sometimes occurs in mania and general paresis, and in many forms of insanity there is a craving for hot and spiced drinks, and especially for alcoholic beverages.

Sleep is greatly deranged in the acute forms of insanity. In mania insomnia is a constant symptom. The maniac frequently goes days without sleep, and for months together he may not repose in sleep more than two or three hours out of the twenty-four, and still he shows no signs of somnolence or of fatigue. In most forms of mental depression sleep is greatly diminished, and interrupted by frightful dreams. In the convalescent stages of insanity, as in dementia, sleep may be greatly prolonged.

The sexual appetite is usually increased in states of mental exaltation, and decreased in states of mental depression. In mania it may reach the height of satyriasis or nymphomania, and in melancholia or dementia psychical impotence is not uncommon.

Abnormal sexual manifestations are frequent in pubescent, puerperal, climacteric, and hysterical insanity, and in senile dementia there is sometimes a final flame of sexual passion before the total extinction of the desire. Mental disease may cause the most abominable perversions of the sexual instinct, leading to unnatural indulgences, sexual feeling between those of a sex, anthropophagy, and a combination of homicidal and sexual impulses. The diseased manifestations of this instinct in women are more apt to occur periodically with the catamenial molimen, which brings often an exacerbation of all the mental symptoms.

The artificial appetites in mental alienation gain renewed force, and there is often an insatiable longing for drugs and alcoholic stimulants, which should be administered with a knowledge of the readiness with which artificial appetites are acquired by the insane.

The will, regarded as the highest power of the mind, as the controlling and directing faculty, is always impaired in insanity. The forcible manner and uncontrollable conduct of maniacal patients have been called hyperbulic, as revealing unusual will-power; but this is a mistake, for the highest function of will is to restrain. The maniacal patient has completely lost the supreme will-power, which is the control of the thoughts by the fixation of attention and he has also lost the second most important function of will, which is the control of actions.

On the other hand, abulia or hypobulia, as indicating total or partial loss of will, are constant clinical symptoms.

The instinctive and automatic character of insane actions is to be attributed largely to the withdrawal of intelligent volitional control. There are numerous ideas in the insane that emerge into absurd actions, that in health would have been at once inhibited by an effort of will. These ideas by repetition soon become persistent in the insane, and they are then impellent ideas, that, from lack of volitional restraint, are uniformly expressed in acts that are often confounded with those springing from emotional irresistible impulses. The vivid idea of any action is always accompanied by nascent motor impulses for its performance, and these are inhibited in health, but not in states of impaired volition. The impellent idea, which is simply the nascent motor impulse which has escaped inhibition, may issue through any of the customary motor channels in speech, gestures, fixed attitudes, and in every imaginable simple action. The patient is impelled to utter a certain word, to touch a certain object, to assume a certain posture, independently of any definite aim or motive. The reflex excitability of motor-centres to ideational stimuli is increased, the restraint of will is greatly diminished, the revived motor impulse reissues in action. Such is the *rationale* of impellent ideas, which pass into acts to be distinguished from those purely automatic, and from others due to emotional or instinctive impulses.

The emotional morbid impulse is irresistible chiefly through failure of will-power, but it may also be due to the actual diseased intensity of the emotion itself, and the acts to which it leads are such as denote a more definite motive than those just described.

There are still other morbid impulses dependent on the perversions of the lowest appetites and instincts, and on latent brutal and destructive tendencies inherent in all human nature, and possibly having served some wise purpose of self-preservation during the evolution of the race. That these destructive tendencies are inherent, and that they are not created *de novo* by the disease, might be abundantly proved by reference to many dark pages of the world's history. Insanity, as a disease, works out a diversity of pathological products, but in their formation no raw material is used other than that which nature herself has furnished. All these morbid impulses which spring from this animal substratum of human nature are, for want of a more general term, designated instinctive. These instinctive morbid impulses compose the majority of those termed irresistible among the insane, and during impairment of will they lead to the most brutal acts of violence consciously perpetrated, and differing from similar deeds automatically performed while consciousness is in abeyance.

These instinctive morbid impulses are wont to recur periodically, and with increased force, until they culminate in acts that deliver the patient often from extreme mental agony, to escape which he will often inflict severe injuries upon himself.

The lesions of the will are especially marked in insanity caused by alcoholic excess, and by the abuse of opium and certain other toxic substances.

Finally, as will is dependent on memory and reflection, it is evident, in all chronic forms of insanity, why it gradually disappears as the association of ideas becomes impaired, until finally the patient is left without voluntary power, in a purely automatic state of existence.

Somatic Phenomena.—The somatic phenomena of insanity are usually present as early as the mental manifestations, and they are not only useful in diagnosis, but they also furnish most important indications for treatment.

The symptoms that relate to the muscular system naturally engage attention first, since psychical changes—normal or abnormal—are expressed through motor channels. The alterations in the special mechanisms of speech and locomotion vary much in different forms of insanity. The voice undergoes an early change of tone through altered innervation of the vocal chords, and the musical quality is replaced by a characteristic harshness; the pitch is often lowered, and instead of pleasing inflections, there is finally established a disagreeable monotone. The peculiarities of insane speech are too numerous to receive notice here. The physical defects of utterance in general paresis, delirium acutum, organic dementia, and certain acute states, are due to imperfect innervation, or to partial paralysis of labial, lingual, palatal, or laryngeal muscles. In congenital mental weakness the amount of imperfection in pronunciation is an important guide to the degree of mental deficiency. In mental derangement from organic brain disease ataxic aphasia may be present, and aphonia paralytica is occasionally found in hysterical insanity. Such functional defects of speech as occur in health may be retained in mental disorder, or they may occasionally disappear—as in the instance of balbuties of psychical origin, that may be replaced by perfect fluency in mania.

The gait in mental disease may simply indicate the general maniacal, melancholic, or demented condition, or it may betray various kinds of incoördination and loss of motor power, as in paretic, alcoholic, syphilitic, and hysterical insanity. The paretic gait is distinct from the ataxic gait, which is never seen in a typical form, except in the early stage of "ascending cases" of paresis.

Some departure from the usual mode of walking is a common symptom in many forms of mental aberration, and is due to a variety of causes, such as changes in the general muscular tone and in the muscular sense—anæsthesia of extremities or other sensory troubles, stomachal or aural vertigo, disorder of cerebral circulation—and to hallucinations or delusions. Walking backward or in a circle, from some delusion, may not be an unfavorable symptom, though it is most common in chronic cases; but certain involuntary retrograde or circus movements point to incurable organic cerebral disease.

Handwriting, playing upon musical instruments, and other acts of complicated muscular coördination often furnish early signs of developing mental disease, and the loss of the musical qualities of the singing voice is a very constant symptom. The diagnostic value of handwriting as a symptom of defects of muscular innervation and coördination is real, and it may also show amnesic trouble and mental oddities; but otherwise it is not of much practical significance. If a sufficient number of specimens of the chirography of the same patients, taken in health and in various stages of the different types of insanity, could possibly be obtained, it is presumable that some uniform variations might be discovered; but the material of this kind, thus far published, is so insufficient for definite conclusions that the interpretation of insane handwriting, except in the particulars above mentioned, is as vague and unscientific as are attempts to read the character of sane persons from their chirography. In contradistinction to these acts, initiated by volition, are numerous muscular movements, not of a voluntary nature, that also form a part of the somatic symptoms of mental disorder. The incessant movements in acute delirious mania, in typhomania, in epileptic and maniacal furor, are purely automatic, as may be also sighing, laughing, and crying in these states. In chronic mania and dementia, also, the swaying to and fro, the rubbing of the hands against some part of the clothing, and many

similar movements are unconscious and automatic. The automatism in epileptic insanity is characterized by such a series of complex coördinated movements as to excite the suspicion of intention and wilfulness on the part of the patient; but the acts performed are not only motiveless and involuntary, but they are also unconscious and without recollection. Every conceivable lesion of motor function occurs in insanity.

Paralysis of single muscles, or of groups of muscles, or of whole portions of the body, is to be observed in syphilitic, alcoholic, and paretic insanity. There are also the hemiplegia of organic dementia, the paraplegia of hysterical insanity, and the complete loss of muscular power in the terminal stage of typhomania and of other acute states of exhaustion. The dysphagia that leads often to a sudden fatal result in general paresis is due to paralysis of the muscles of deglutition, as well as to anæsthesia of the parts. Tremor is a common symptom in the toxic insanities, in general paresis, in senile dementia, in the debility following the acute stages of various types, and also as a sign of great emotional perturbation. Fibrillary contractions are to be seen, more especially in general paresis, and clonic spasm of single muscles is not infrequent. Masticatory spasm is common in the terminal stage of general paresis and in organic and alcoholic dementia, and this grinding of the teeth, that also occurs in other forms, is a most unfavorable symptom, which points to active brain disease.

Various kinds of tonic or clonic spasms are occasionally encountered in alcoholic, paretic, hysterical, epileptic, puerperal, and traumatic insanity. Choreiform movements are found in idiocy and imbecility with congenital hemiplegia, and in organic dementia.

Catalepsia spuria or catalepsia vera may be intercurrent in pubescent, hysterical, epileptic, and malarial insanity, and also in melancholia attonita and other forms. The facility with which the muscles may be moulded into almost any strained position (flexibilitas cerea), which is retained for an indefinite length of time, is very marked. In one case under the writer's care catalepsy alternated with the maniacal state, at intervals of some weeks, for nearly a year. Ecstasy and trance are also to be observed as rare phenomena among the insane. Permanent muscular contractures, chiefly of the flexors, are liable to occur in primary dementia, melancholia attonita, terminal dementia, and in the cases in which a single posture is habitually retained, and also as the result of organic brain-lesions in organic dementia. The muscular atrophy which often takes place may be due to disuse or to the nature of the brain-lesions, as in syphilitic insanity and in delirium acutum.

Circulatory and vaso-motor disorders are among the most common somatic symptoms of mental derangement.

As the vascular tone, or average degree of contraction of the blood-vessels, is maintained by vaso-motor mechanism, the centre of which is in the medulla oblongata, having connections with cortical vaso-motor centres, it is evident how the powerful emotions in mental alienation may effect reflex vascular disturbances, and how cerebral lesions involving these centres may produce vascular disorders.

A wide division of angiological affections in insanity may be made into abnormal contraction of the blood-vessels (angiospasm), which is found in states of mental depression, and dilatation of the vessels (angioparesis), which exists in states of mental exaltation. Thus, in profound melancholia, through angiospasm of the superficial vessels, the skin is often blanched or livid, and cerebral anæmia results likewise, and the arterial contraction is often felt in the wiry pulse; while in mania the vascular dilatation gives rise to an opposite condition of the superficial circulation and to cerebral hyperæmia. It has been stated by some observers that there are characteristic changes in the sphygmographic tracings among the insane; that the normal tricrotic pulse becomes dicrotic or monocrotic. The dicrotic pulse is said to be most common in dementia and in the chronic types of insanity, and the monocrotic pulse is found in general paresis and denotes complete suspension of vaso-motor innervation of the vessels. Whatever truth there is in these observations must not be applied too narrowly to special forms of mental derangements, which are often attended by very dissimilar physical conditions; and, as the entire arterial tonus may be changed directly or in a reflex way by lesions of the peripheral, spinal, or cerebral nervous system, it is not best to draw precise conclusions about the pulse in the various special types. Physiological experiment has established beyond all doubt the fact of arterial contraction and increased blood-pressure in painful states; and the above-mentioned conclusion, that angiospastic and angioparetic conditions coincide in the main with states of mental depression and of mental exaltation, respectively, is, perhaps, the chief statement that can be safely made in the present state of knowledge. During great muscular exertions in maniacal states the pulse often remains normal, or it is but slightly increased in frequency, and during the rise of bodily temperature the pulse among the insane does not increase with the corresponding regularity as in health.

An important symptom connected with impaired capillary circulation, great irregularity of the heart's action, and other circulatory disturbances, and accompanied by a painful weight and intense distress in the præcordial region, is præcordial panic. The patient suddenly attacked with præcordial panic breaks out into a cold sweat; he is seized with a feeling of bodily dissolution, or with a sense of some awful impending calamity, and his suffering may become so unbearable as to drive him to suicide, or to other acts of destructive violence.

A somewhat common symptom in epileptic and paretic insanity, mania, melancholia, and in chronic mania, is the "insane ear," or hæmatoma auris, in which blood is effused beneath the perichondrium, and as it is gradually absorbed, the ear shrivels and becomes an unsightly feature.

Hæmatoma auris is dependent on trophic changes in the tissues of the ear, or on degeneration of the vessels that supply the part favored by local hyperæmia, as seen in other portions of the head and face, or on mechanical violence. Any of these causes is sufficient to produce hæmatoma auris, which is by no means confined to the insane, though the conditions that favor the affection are doubtless more common among them than among the sane.

This affection of the ear, when due to trophic and vascular disease, is unfavorable as regards the prognosis of the mental disorder, and it not infrequently coincides with vascular degenerations in the brain, as is notably the case in general paresis.

Among circulatory and vaso-motor disturbances common in the insane are also to be mentioned cerebral anæmias and hyperæmias, cephalalgia, vertigo, local ischæmias and hyperæmias of the cutaneous surface, livid and mottled skin, cold extremities, and generally impaired capillary circulation, pulsation of the abdominal aorta and of other large vessels, and also of the carotid and temporal arteries.

Anomalies of nutrition, of secretion, and of excretion are among the important symptoms of insanity.

In congenital states of arrested mental development—idiocy, cretinism, and imbecility—the nutritive defects of both the hard parts and of the soft tissues are very great. Common occurrences are rachitic affections, defective dentition, facial and cranial deformities, microcephalus and macrocephalus, imperfect or premature ossification of the cranial sutures, and various atrophic affections of the bones and muscles.

In general paresis and other forms there is mollities ossium and consequent liability to fractures. The nutritive changes may cause the bones to become soft and yielding, so that deformities result, or to become very fragile, so as to break on the application of slight force.

In syphilitic, paretic, and organic dementia there are various lesions of the bones and joints, and false anchylosis results in many forms from prolonged flexion of limbs.

Cutaneous trophic affections are also frequent among the insane. Eczematous, herpetic, petechial, and other

eruptions are found. Decubitus may be a serious complication in general paresis, typhomania, and organic dementia.

The skin is often dry and furfuraceous in melancholia, and coarse and oily in some other forms, and in pubescent cases seborrhœa is sometimes marked. Pigmentation of the skin is not infrequent in puerperal and paretic insanity, and also in many chronic cases, and melanoderma is sometimes extensive.

These pigmentations may disappear, and this is usually the case on recovery from the mental disorder. In typhomania and paretic dementia there is sometimes a remarkable desquamation, and the hair also may fall out. The hair is apt to turn gray sooner in insanity, and this may take place in spots gradually, or suddenly, and the natural color may return on recovery. In chronic cases of insanity the hair frequently has altered electrical and nutritive condition, and appears coarse and bristling, and hirsuties has been observed in some instances. The cutaneous secretions are diminished in melancholia and increased in mania.

There are, in rare cases, undoubted changes in the quality as well as quantity of the perspiration. As anidrosis is found in melancholia, and hyperidrosis in mania, so chromidrosis has been observed in paretic and hysterical insanity. The perspiration sometimes has a very offensive odor, that no cleanliness or bathing will remedy, and this is especially the case in epileptic and puerperal mania.

The secretion of saliva is sometimes increased in mania, melancholia attonita, and in acute primary dementia, and in exceptional instances the ptyalism is very great.

Ptyalism seldom occurs in chronic cases, and the drivelling in terminal dementia is simply due to failure to swallow; and the same symptom in general paresis is owing to dysphagia paralytica. In mania there is an increase of the sympathetic saliva, which is remarkably viscid, and during the rapid utterance of the patient may become frothy, and it is this circumstance that has given rise to the popular idea that a madman "foams at the mouth."

The gastro-intestinal and visceral secretions, in general, are diminished in states of mental depression, and this accounts in part for the constipation and indigestion which are such constant symptoms.

The urine in melancholia is diminished, and contains less sodium chlorides and less urea than in health. In acute mania and in the early stages of general paresis, during which a large amount of food is often taken and the tissue-changes are especially active, there is usually an increase in the amount of urea and of the inorganic salts; but these constituents are diminished in the final stages of paretic and terminal dementia.

The plausible hypothesis that the emotional and mental activity in acute states of mental derangement would be attended by rapid disintegration of nerve-tissue, and a corresponding excess of phosphates in the urine, has not been borne out by recent researches, which show a positive decrease of phosphoric acid in the urine in acute mania, as well as in chronic mental disorder. It will probably be necessary, in order to establish definite relations between abnormal changes in the urine and special states of psychical disease, to understand more fully the trophic and vaso-motor conditions which underlie both of them.

Thus, in immediate post-epileptic maniacal states, in acute toxic mania, in the apoplectiform seizures of general paresis, and in all similar cases in which there are especially active vaso-motor and trophic disturbances, the most decided changes in the urine, such as increased phosphoric acid, albumen, and casts, are to be found in the absence of organic renal disease.

The blood undergoes alterations in insanity. Gross changes in its composition are present in the anæmic, scorbutic, and purpuric conditions, and also in the toxic insanities. The products of retrograde metamorphosis, that should be eliminated, are doubtless retained in some instances, and have their share in the pathology of the mental disease; but the attempt to connect special psychical symptoms with definite changes in blood-composition is as yet premature. It is to be hoped that physiological chemistry may at some future day furnish data for conclusions not yet warranted by facts within our knowledge.

Menstruation is suppressed ordinarily in all the acute stages of insanity, and is reëstablished in convalescence as soon as the physical forces are restored. The return of this function, if not accompanied by signs of returning reason, is not a favorable symptom usually. The menstrual suppression is not the cause of the exacerbations to be seen in all forms of the catamenial periods, for in cases in which amenorrhœa is not present the same periodical manifestations occur, showing that the pathology is not so much the retention of that which should be eliminated as the morbid irritation of cortical centres through reflex channels.

The lochial discharges in puerperal mania, like the flow of milk, are usually suppressed, and in this instance it is possible that the retention of septic material in the blood may have some causative relation to the mental phenomena.

The bodily weight, as an indication of the general state of the nutritive processes, is of great practical value in insanity. There is a rapid loss of weight during the most acute stages of mental disorder, and a decided gain in convalescence.

In melancholia extreme emaciation sometimes occurs; and in mania it is not as great, though it is usually appreciable even on inspection. Gain and loss of weight also coincide with remissions and exacerbations, and in periodical insanity there may be the usual difference between depressed and exalted states in this respect.

In confirmed cases of mental alienation the weight may return to the normal standard, or there may be some permanent increase; but ultimately there is apt to be emaciation, or even marasmus, if acute disease does not remove the patient.

This loss of weight in the initial and terminal stages, and gain in the intermediate stage, is the rule in general paresis. The relative increase of weight during convalescence is greater in women than in men, and it is most marked in puerperal and pubescent insanity.

Temperature is a bodily symptom never to be overlooked in the insane. All the early classical definitions of insanity mentioned that it was an affection without fever. Although its general character is apyretic, there are many decided fluctuations both above and below the normal standard.

During the enormous muscular efforts of mania a large amount of heat is generated; but it is lost by conduction and radiation and evaporation through the skin, which is usually moist and often exposed, and owing to vaso-motor dilatation more blood passes through the capillaries, so that the rise of temperature is seldom more than one degree even in the most intense excitement.

In melancholia the temperature is subnormal, to the extent sometimes of one or two degrees, and this is due to a diminution of the nutritive and biochemical changes, and more especially to a decrease of oxidative processes in the muscles as the chief thermogenic tissues. There may be an actual increase of temperature in melancholia during exacerbations with violent muscular exertions.

The decided variations of temperature in general paresis are probably caused by pathological processes involving the cortical thermic centres. In the early stages of general paresis there is usually a slight rise of temperature, especially toward night, and in the final stage the temperature may fall several degrees below the standard. In delirium acutum, delirium tremens, status epilepticus, and after apoplectiform seizures in general paresis, there may be a rise of temperature of several degrees. All the acute forms of insanity may lead to states of exhaustion or of actual collapse, in which there may be very low temperatures. Inequalities of temperature are sometimes to be discovered between the two sides of the body, and also in limited cutaneous areas corresponding to local ischæmias or hyperæmias, and the scalp especially exhibits great local variations of heat in certain cases.

Among the elementary somatic symptoms none are more interesting than the sensory disturbances. Anæsthesia, which is one of the common symptoms of many forms of mental disorder, may be due to impairment of consciousness and of attention, as in melancholia attonita, in states of stupor, and in terminal dementia, or it may be due to changes in the nervous cells and conducting fibres of the sensory mechanism itself, as in paretic, syphilitic, and alcoholic insanity. Hemianæsthesia may be found in hysterical insanity, and in organic dementia there is usually some form of anæsthesia. Analgesia apparently exists in some cases, and it may explain the nonchalant way in which some patients cut, burn, and mutilate themselves. It is probable that the insensibility to heat and cold so often seen in mania and other forms is of psychical origin, but the thermo-anæsthesia of the paretic patient is due to organic lesions.

Anæsthesia of the larynx and bronchiæ probably accounts for the infrequency of coughing among some classes of the insane suffering from lung diseases, and for suffocation among general paretics who crowd masses of food into their pharynx. Insane patients are to be found in all stages of phthisis pulmonalis without any cough.

Anæsthesia of the gastric vagus explains polyphagia in some patients who fill their stomachs without any feeling of repletion.

Paræsthesiæ and paralgesiæ often give rise to delusions among the insane, who attribute the sensations of creeping, numbness, formication, and other anomalous feelings to electricity or irritating gases.

Hyperæsthesia is found in hysterical and hypochondriacal insanity, and in the acute stages of some other forms, and the extreme restlessness of some patients arises from muscular hyperæsthesia. Increased irritability of visceral sensory nerves may occasion that great systemic need of food and other abnormal conditions of organic life alluded to under cœnæsthesis. The sensory disturbances of the organs of special sense are doubly important on account of their intimate relation to delusions and hallucinations. Hyperosmia is found in the early stages of general paresis in hypochondriacal and hysterical insanity, and in other types. The patients are conscious of odors that are imperceptible to others, and they may detect in this way attempts to give medicine in food. The perversion of olfactory sensations leads them to delusions that their flesh is decomposing, that there are dead bodies about, that they are persecuted by foul odors, and to other similar ideas. The loss of smell in general paresis and in senile dementia is occasionally due to atrophy of the olfactory nerves, and in organic dementia it arises from central lesions.

Gustatory hyperæsthesia may exist in hypochondriacal or hysterical insanity, but paræsthesia of this sense may be found in many forms. Patients often complain of bitter and sour tastes that are not purely imaginary, but that are due to some actual change in the physiological condition of the organ. Gustatory anæsthesia is not uncommon among the insane. The impairment of taste is sometimes due to dryness or to heavy coating of the tongue, and at other times it arises from lesions in some one of the various nerves that contain the gustatory conducting fibres, and it is probably of central origin in hysterical cases with hemianæsthesia, and this is certainly the case in general paresis.

Optic hyperæsthesia is a very rare symptom found in hysterical mania, and in some conditions of mental exaltation; but the luminous appearances, flashes, and sparks of which the insane make frequent complaint, are perhaps signs of optic hyperæsthesia.

Amblyopia and amaurosis are frequent symptoms in insanity, and they are not often associated with lesions that can be demonstrated by the ophthalmoscope except in alcoholic, syphilitic, and paretic dementia. The usual narrowing of the field of vision with scotoma has been observed, and changes in the perception of colors is probably present. Hemianopsia and diplopia are to be enumerated among the visual disorders in paretic and syphilitic insanity. There are other visual phenomena among the insane that are difficult of explanation, such as diminution or increase in the size of objects, their inversion or blending with other things, and still other disturbances due perhaps to a combination of sensory and psychical defects. Acoustic hyperæsthesia, so far as it signifies heightened sense of hearing, may be found in hysterical insanity; but, as painful sensibility to all sounds, it is common in many forms of mental disease. In the early stages of melancholia and of hysterical and hypochondriacal insanity patients often suffer greatly from slight noises, and to avoid this source of distress they sometimes close their ears with cotton or with their fingers.

Hyperæsthesia acustica is often associated with tinnitus aurium. These hissing, humming, and whistling sounds are a source of great annoyance to the insane, in whom they form the material for various delusions.

Neuralgia may be an accidental symptom among the insane, but it often bears some relation to the general pathological condition of the nervous system found in certain types of mental disorder. It ordinarily occurs early in the disease, though in syphilitic, paretic, toxic, and diathetic insanity it may manifest itself in more advanced stages. There is occasionally a species of alternation by which the neuralgia appears during the remissions and disappears during the exacerbations of the psychical symptoms, and Brodie and others have reported cases in which the neuralgia was deemed the original, and the insanity the derived, affection. It would seem more logical, however, in these cases, to regard the insanity as the major neurosis, and the neuralgia simply as a prodrome, unless the latter is very severe and of long duration. It is not impossible that a recurrent neuralgia might, in a reflex manner, redevelop a mental disorder with which it had previously been long associated; but this would imply great instability of nerve-elements and a completely developed diathesis insana. It is also a clinical fact that a recurrent insanity often brings with it a renewal of former neuralgias and of previous sensory disturbances, but the whole symptom-complex, psychical as well as physical, is here simply to be viewed as the immediate result of a more general pathological condition.

Pathological.—The pathology of insanity is based on the following broad theories, supported by scientific facts and by physiological experiments too numerous to be mentioned: First, that the brain is the organ of the mind; second, that it is a physical organ, and that its psychical functions are hence dependent upon physical conditions; third, that alterations of these conditions, or of the physical organ itself, will be attended by corresponding changes in psychical manifestations.

Alterations of the brain and of its psychical functions may be effected by mechanical, thermal, or chemical agents; by excess or deficiency of blood-supply; by changes in the composition of the blood; by inflammation, and by reflex irritation. If the material lesions thus produced are not circumscribed, but diffused over a considerable portion of the cerebral cortical centres, which are the chief seat of mind, some kind of mental derangement almost uniformly results. As cerebral physiology has not yet succeeded in the assigning of special cortical areas as the seat of definite psychical functions, it is not only beyond the present range of science to specify the exact mental faculties that will be involved by particular lesions, but it is still more impossible to predict the precise nature of the incoördination of the various faculties which will follow a given brain-lesion. The cerebral pathologist cannot define lesions that will necessarily produce mania, or melancholia, or any other type of insanity due to the spasmodic, unbalanced, or incoördinate action of faculties; but he can affirm that certain extensive lesions will occasion dementia or the progressive abolition of all mental functions, as in general paresis. The skilful observer may with some accuracy in chronic cases predict from the degree of mental impairment the amount of brain disease; but he will not venture in recent cases to foretell from the character of the mental symptoms alone the nature of the pathological tissue-changes. Exactly similar lesions may cause mania in one person, melancholia in another, and acute delirium in a third instance. The individual mode of reaction to

the cerebral injury sustained will vary in each case with the age, sex, general constitution, temperament, and hereditary tendencies of the patient. A free statement, therefore, as to the general facts of the morbid anatomy of insanity may be made, but a most guarded interpretation of them is needful. In the first place, it may be stated that there are numerous and decided cerebral lesions in insanity; that these lesions are sometimes causes, occasionally merely concomitants, and frequently results, of the mental disorder. They are much more constant in the chronic than in the acute cases. Their presence in three or four types is almost a uniform certainty, in the majority of forms it is the rule, and in a small minority of cases it is the exception. The number of cases in which no lesions are to be found has constantly decreased as the means of research have become more accurate and scientific.

The gross and the microscopic lesions which science has thus established, and which will presently be described, are not all peculiar to insanity. Only a few of them are confined to mental derangement, and the others are to be found in various affections of the nervous system or in other diseases of the general system; but this fact does not disprove their causative relation to insanity. All the gross organic brain-lesions are efficient exciting causes of insanity in some cases, and are inadequate in others. In some persons a slight traumatic brain-lesion causes insanity, but in what is known as the "American crowbar case"—one of the grossest brain-injuries ever survived—caused no distinct type of mental derangement.

The difficulty of the problem which it remains for science to solve lies therefore not so much in the discovery of lesions as in the interpretation of their relations to the mental disorder.

The pathological theories customarily held in regard to the stages and forms of insanity without appreciable brain-lesions have been changes in the quality and quantity of the cerebral blood-supply, reflex irritation and sympathy, and nutritive molecular alterations in the cortical cells. Doubtless any of these pathological conditions are capable of acting as exciting causes of mental derangement.

The morbid anatomy of insanity is too large a subject to be fully treated within present limits, but the chief gross and microscopic changes will be mentioned.

The Cranium.—Changes in the size and shape of the cranium are more common among the insane than the sane. In the first place, the average cranial capacity among the insane is a little below the normal. This is especially the case in the degenerative types of insanity and in congenital states of arrested development.

After the microcephalus and macrocephalus of idiocy and imbecility, and all their allied deformities, there comes a series of lesser malformations and asymmetries in minor grades of imbecility and in primary monomania, which have been fully described by German and French authors. The cranium may be flattened at its vertical, occipital, or frontal portions, or it may present great inequalities of surface and differences between the sides, or it may have a lateral twist or a rickety conformation.

In general the brachycephalic would seem to predominate over the dolychocephalic type in the exaggeration of the cranial diameters, and occipital deficiency is especially common.

All these cranial peculiarities point to some general defect or perversion of growth, in which the nervous centres have also probably shared in some degree, though it has been claimed by some authors that in brain atrophy in adult life there are corresponding contractions of the osseous parts, and that this may be the nature of the cranial changes in chronic insanity. The material changes in the osseous tissues are frequently very great, especially in chronic cases. Thickening of the calvarium is one of the most common post-mortem findings, and the inner table is apt to partake most actively in this morbid process. The diploë is often greatly encroached upon, and this takes place to such an extent in some cases that hardly any cellular structure is to be seen. The eburnation is not so rare an appearance among the insane as has sometimes been stated, and the writer has found it a large number of times in the course of several hundreds of autopsies. Still the skull-cap is much more often thick, soft, and vascular than thick, pale, and dense. The congestion is often very marked, and the pinkish tint becomes reddish in spots.

The inequalities of the outer and inner tables do not agree, and the latter is deeply indented in correspondence to vessels and Pacchionian bodies.

The skull-cap is occasionally very thin, and when held up to the light it is seen to be diaphanous about the parietal regions, or even over a large portion of the vertex. Exostoses and various small bony deposits on the inner table are sometimes found.

The Dura Mater.—The dura mater, as the result of chronic inflammatory processes, will often be found firmly adherent to the calvarium over the whole vertex, so that separation from the bone is impossible. Other evidence of this chronic pachymeningitis, besides the connective-tissue adherences, are minute osseous formations (osteophytes), and in the falx bony plates of some size are occasionally found with small pellets of bone. In general paresis and some other forms there is pachymeningitis interna hæmorrhagica, with the formation of vascular membranes over the vertex, more especially containing blood-cells, pigment, and brain-sand, and varying greatly in the different stages of the inflammation in density, extent, and general appearances. The dura mater is in rare instances found to be completely adherent to the other membranes and to the brain, as the result of extensive inflammations. All these inflammatory affections of the dura mater are most common in paretic, alcoholic, toxic, and syphilitic insanities.

The Arachnoid.—Thickening and opacity of the arachnoid are very frequent appearances in all cases of insanity, but especially in those that are chronic. There are also occasionally adhesions to the other membranes, and some portions of the arachnoid will be found much more thick and firm than others.

The Pacchionian bodies are usually increased in size, and they penetrate the dura mater and wear for themselves receptacles in the osseous tissues.

Fine granulations of the arachnoid and various exudates of blood-constituents are also found in exceptional cases, and most of the abnormal appearances are probably the result of repeated congestions that are more intense and prolonged among the insane than among the sane, and the pathological changes in the arachnoid among the former differ in degree rather than in kind from those found among the latter.

The Pia Mater.—The most constant pathological appearance in the pia mater is varying degrees of congestion or inflammation. In some cases exudations and adhesions to the cortex cerebri over the vertical and parietal regions are present, so that attempts at separation result in the removal of brain-substance attached to the pia mater. The vessels are sometimes greatly congested and tortuous, and small extravasations of blood in the membrane are to be seen. A different condition of the pia mater is the result of anæmia of the membranes following repeated congestions. The vessels of the pia mater are distinctly seen to be varicose and tortuous, and there is more or less limpid effusion. If there is much brain atrophy there is usually a corresponding amount of fluid, and the pia mater itself may be œdematous, and the dark veins within it pursuing a serpentine course offer a peculiar appearance that is characteristic of terminal dementia and other very chronic forms of insanity in which there is general anæmia or marasmus. The most extensive adhesions of the pia mater to the cerebral cortex are found in paretic, syphilitic, and alcoholic insanity, though they are by no means confined to these forms. Serous infiltration of the pia mater in cases of atrophy is usually associated with dilatation of the ventricles, and the appearance of the choroid plexuses corresponds in the main with that of the pia mater.

Cerebral Vessels.—The changes in the cerebral vessels depend somewhat on the general physical condition and on the advanced age of the patient, and they are more fre-

quent in chronic than in acute cases. These morbid vascular appearances are especially apt to be found in general paresis and in alcoholic, syphilitic, and epileptic insanity.

Dilatation of vessels is one of the most constant results of repeated congestion and distention. The vessels are found not only dilated but tortuous, and even convoluted, and this pathological condition is found in acute as well as chronic cases, though it is most marked in chronic brain atrophy and in general paresis, and the vessels are not necessarily hypertrophied.

Changes in the coats of vessels are also very frequent occurrences among the insane. Hypertrophy of the circular fibres of the muscular coat of the arteries has been repeatedly observed, and it has been attributed to prolonged excess of functional activity. The delicate connective-tissue membrane that surrounds the arteries may be found thickened and opaque. The fibrous coat in very rare instances is also hypertrophied. The perivascular canals are often greatly dilated and impart sometimes a sieve-like appearance to sections of the brain-substance. Morbid deposits of granular pigment and of hæmatoidin crystals are found upon the adventitia, more especially at the bifurcation of arteries, upon the capillaries, or upon the delicate connective-tissue membrane.

Another morbid appearance which has been described as frequent among the insane is proliferation of the nuclei of the walls of the vessels. These nuclei may be very numerous, and they are smaller and rounder than the normal nuclei. Other recorded appearances are plugging of the minute arteries with aggregations of white blood-corpuscles, and a similar morbid condition has been found in the veins as the result of extreme stasis.

The arteries also undergo various inflammatory, sclerotic, and atheromatous changes that occasionally lead to their complete obliteration. The proliferation of the nuclei, thickening of the inner coat, inflammation, and subsequent sclerosis of arteries would seem to be different features of the same general pathological process which may be found in its various stages in the same patient. Miliary aneurisms and various forms of dilatation of minute vessels have also been described. As regards all these morbid changes of the blood-vessels, it can only be said that they are unusually frequent among the insane, but that they are by no means highly characteristic lesions, and that they are not even circumstantial proofs of mental unsoundness.

The Brain-substance.—Atrophy of the brain-substance is one of the most constant pathological findings in chronic cases of insanity. The whole volume of the brain is diminished, and the space caused by the shrinking is filled by fluid in the ventricles, by subarachnoideal effusions, and by œdema of the pia mater, and occasionally by thickening of the other membranous or osseous tissues. The atrophy is not confined to the convolutions, and the white as well as the gray matter is involved. The atrophy is increased by general states of malnutrition and marasmus, but it is still greater than among those of sound mind who die of wasting diseases, so that it may be regarded as one of the essential pathological results of chronic insanity.

The convolutions are flattened and thinner than normal, so that the sulci are deep and gaping, especially in the vertical and parietal regions. There are changes in color and consistence of all the tissues, which are dense and firm, and they may cut like coagulated albumen or even like hepatic tissue. The white substance has a dingy or grayish color, and occasionally it is perforated with small apertures that are plainly visible in prepared sections, and this cribriform appearance may also be found in the gray matter. The brain-substance in atrophy is usually anæmic, but if death takes places in the status epilepticus, or under some other circumstances, it will be found congested. The amount of congestion is indicated not alone by the appearance of puncta vasculosa on section, but by the readiness of their reappearance when washed away. There are exceptional cases of atrophy in which the brain-substance is found not indurated but infiltrated, and less firm than normal. The atrophy of the cortex cerebri takes place very unevenly, being most marked in the vertical and parietal regions, and there is a diminution in the average depth of the cortex that is often very evident on section, and the outer layers of cells suffer ordinarily more than the inner layers during this atrophic process.

The weight of the brain is not as much diminished in cases of atrophy as might be supposed, for while there is a loss of volume there is also, in some cases, an increase in the specific gravity of the brain-substance.

In general there is a gradual loss of brain-weight in chronic cases of insanity, independently of diathetic and marasmatic conditions.

The brain suffers fewer changes in weight from general conditions of malnutrition than do other parts of the system, and in acute forms of insanity that lead to states of great inanition, there is still hardly any appreciable loss of brain-weight corresponding to the general emaciation. It is an important pathological fact, however, that the brain-wasting which does occur involves the cerebral areas most actively concerned in intellection.

Hypertrophy of the brain is a very rare occurrence, so that some pathologists have denied its existence; but it does occur among imbeciles and epileptics, and as a cause of insanity. True hypertrophy consists in an increase not of the ganglion cells or fibres, but of the neuroglia.

There is an apparent hypertrophy which is not infrequently met with in autopsies of the insane, and it is due to general congestion and to various exudates. The brain convolutions are, in this instance, found flattened against the cranium by the pressure that also obliterates the normal appearance of the sulci, and after the skull-cap has been removed it can only be readjusted with a certain amount of force, owing, seemingly, to an expansion of the cranial contents. In these instances the membranes and the brain-tissues offer all the appearance of extreme hyperæmia of an acute character. The white matter has a reddish tinge and the puncta vasculosa are numerous, and there is less fluid than normal in the ventricles. In true hypertrophy there is the same flattening of the convolutions and obliteration of the sulci, but the membranes and brain-tissues are exsanguinous.

The Ganglion-cells.—The nutrition of the ganglion-cells of the cortex cerebri is greatly disturbed in acute insanity, but actual degeneration of the cells does not take place until after a certain duration of the pathological processes. This degeneration of ganglion-cells, found in almost all chronic cases of insanity, is most common in the outer layers of cells of the superior portions of the frontal and parietal convolutions, and it is apt to take place in circumscribed spots, though occasionally a whole layer undergoes atrophy.

The most important pathological change is atrophy of the ganglion-cells.

In the early stage of this atrophic process the cells may appear swollen, but the body of the cell soon shrinks and the nucleus stands out prominently, surrounded by fine molecular remains of the cell, and by a certain clear space, and the nucleus itself finally loses its outlines and partakes of the same general decay. Other cells in intermediate stages of this process of degeneration are to be seen, having lost a few or all of their processes as well as their general contour.

Another form of decay of the cells is pigmentary degeneration, for which a normal analogue exists in the pigmentation of cortical cells with advancing years. The granular pigment gradually replaces, more especially in the large pyramidal cells, the processes, the cell-wall, and finally the nucleus itself. The exact nature of this granular material is not known, though it is accompanied sometimes by deposits of hæmatoidin granules, and it has been shown that it is not of a fatty nature.

Calcification and hypertrophy have also been reported as among the pathological changes of brain-cells to be found in chronic cases of insanity.

The Neuroglia.—The quantity of neuroglia and the number of nuclei may be greatly increased or diminished in dementia and in other chronic forms of insanity.

The sclerotic processes that occur in the cerebro-spinal nervous system of the insane may begin in the vessels or in the connective tissue or neuroglia, and in the latter case there is a proliferation of the nuclei of the neuroglia and a fibrillation of the surrounding matrix.

Miliary sclerosis has been described as a form of degeneration of the connective tissue without proliferation of the nuclei of the neuroglia, which become greatly enlarged and dense, and displace the neighboring fibres and vessels; and subsequent contraction of the hyperplastic tissue may take place to such an extent in hardened sections that vacuolation is observed.

Amyloid corpuscles and colloid bodies are not infrequently found in prepared sections, but they may possibly be due to post-mortem changes and to methods of preparation, and they afford no reliable pathological conclusions.

For the pathology of the various types of insanity the reader may refer to the special articles which follow.

DIAGNOSTIC.—The diagnosis of insanity in some cases is full of difficulties and responsibilities, while in other instances it is as perfunctory as any duty the physician has to perform, so far as any exercise of scientific judgment is involved. In about one-third of all cases the insanity is so evident, or is allowed to advance to such a matured stage before medical advice is sought, that the question that remains for the physician to solve is one of treatment rather than of diagnosis. In another third of the cases the laity is incompetent to form a definite opinion of the patient's mental condition, and the general practitioner, though recognizing unsoundness of mind, requires careful study of the case to determine the exact form of the insanity.

In the final and exceptional third of cases, to which the medical practitioner is liable to be called, the insanity is in an incipient stage, or is of such an ill-defined form, or of such gradual development, that great doubt and perplexity may attend not only the lesser diagnosis of the fact of unsoundness of mind, but also the greater diagnosis of the special type of insanity with which he has to deal, and in this instance the services of an expert in mental diseases are usually sought, though unfortunately in many cases not until much valuable time has been lost.

The diagnosis of insanity in its purely medical relations comprises the fact of mental alienation, the form of the mental disorder, and also the stage and the physical basis of the disease, and all other features essential to treatment. The diagnosis in its medico-legal relations embraces the determination of the fact and of the form of insanity, and also of the exact state of the mental faculties at a given time—of the condition of the consciousness, memory, and understanding during the performance of civil or criminal acts that may involve the reputation, property, or life of the patient.

The diagnosis as regards competency to make contracts, testamentary capacity, and criminal responsibility, ordinarily taxes to the utmost the discrimination of the expert in mental diseases, and if the practitioner, inexperienced in psychiatry, is as wise as he is honest, he will not lightly assume the responsibility of the pronouncing of an opinion in these cases.

The diagnosis of insanity is independent of the question of the deprivation of the civil rights or of the personal liberty of the patient in a commitment to an asylum for the insane, although it may imply the advisability of such a measure if it prove to be that of a dangerous type, or of one that may profit more by asylum- than by home-treatment. This is a question that arises in connection with diagnosis often, but it will be discussed under the head or Treatment.

The diagnosis of every case of insanity is to be based, first, on a personal history, and secondly, on a personal examination of the patient. It may be possible to form an opinion in certain cases from either of these sources of information, but the physician who wilfully neglects either of these essential elements of diagnosis exposes himself to the charge of professional negligence or ignorance. The manifestations of insanity are so numerous and fluctuating that present symptoms do not indicate the past duration and course of the affection as in many physical diseases, and a thorough history of the case is essential to a complete diagnosis, upon which, in turn, depends a reliable prognosis and treatment.

The history, as far as possible, should be obtained directly from those who have been most intimately associated with the patient just previously and subsequently to the development of the disease, and from those having the most thorough knowledge of his entire life. Friends are sometimes less prejudiced than blood-relatives, and young persons are seldom as reliable as adults, or even as old persons, in the statement either of facts or of opinions. If the case is one of much doubt or difficulty of diagnosis, and if differences of opinion and ill-feeling exist among the relatives, it is well to hear their statements separately, and, if need be, to cross-examine them as to conflicting accounts. A knowledge of the laws of evidence, as well as of human nature, will stand the physician in good stead on these occasions.

The points to be elicited in the history of the case, upon which the diagnosis must largely rest, are: First, hereditary predisposition to insanity, either direct or indirect, and allied neuroses in the ancestors are to be taken into consideration. Second, the physical history of the patient from earliest childhood, including the manner in which were passed all the physiological crises and all diseases—acute or chronic—or traumatic accidents, and the general state of the constitution and health previously and subsequently to the first symptoms of the mental affection. Third, the history of the mental and moral development of the patient from earliest childhood, and especially any sudden changes in the intellectual or affective nature, whether spontaneous or due to adequate surrounding influences; the general disposition, temperament, and character of the patient; his occupation, habits of life, peculiar likes and dislikes, social relations, and general personal bearing. Fourth, the exact nature of the changes which have been observed in the patient's manner of thinking, feeling, or acting which have led to the belief in his insanity; the presence of delusions, either with or without a basis of fact, and also of hallucinations and illusions, or of violent impulses and morbid propensities, and, finally, the supposed causes of the mental disorder, with searching inquiries as to any previous like affection in the patient. It is also well to learn some exact dates of past and recent occurrences in the patient's life, with a view to testing his memory.

If the physician has been thorough and successful in obtaining the personal history according to the above outline, from which much of theoretical interest is necessarily omitted, he will feel that he already has a comprehensive idea of the case, which he is prepared to examine understandingly and promptly, and without exhaustion of the patience or strength of the patient. If he meet a suspicious and doubtful case, he will still be able to conduct the examination to a final issue, at a single sitting, in all probability; and if the case prove more easy and self-evident than he had anticipated it would, he will still have the satisfaction of having performed his duty to the patient, the family, himself, and to the profession, in having followed some rigorous method in obtaining the personal history in a complete manner.

The personal examination is next in order, and its object is to detect any psychical or somatic signs of mental disorder, and to confirm by direct observation such points as have been obtained in the history of the case.

If the patient were only as ready and willing as the physician, there would soon be at this stage of the proceedings an easy issue in the case; but, with a few exceptions, the patient is averse to the examination, and occasionally he is suspicious and decidedly hostile. The relatives and friends, as is their wont in these cases, have probably put their heads together to plan things for the benefit of the patient, and, as always happens, except in stuporous or demented cases, their devices and benevolent plottings have completely unsettled the patient's confidence, and greatly heightened the natural suspicion of the disease.

It should be understood that it is not possible to create,

for the benefit of the patient, an artificial environment which in all its details will exactly correspond with past, present, and future occurrences, and that the deception will give rise to doubts, fears, and anxieties long before it is openly denounced by the patient, and it will exert a most baneful influence in any case.

The physician should take no part in the deception of the patient, and the cases in which he is justified in resorting to any trick to accomplish the personal examination are so rare that they may be practically excluded. In some cases the suspense of mind in which the patient has been kept is so much more painful than the reality, that the plain statement of the object of his visit will afford positive relief to the patient and a useful surprise to his kind deceivers. In other cases he may simply insist on the performance of his professional duty on the ground of the general anxiety felt as to the patient's health, or as a medical necessity for his welfare; and he may find, from the nature of the case, that it is best to leave the *éclaircissement* until the close of his visit, or, if the patient is going to an asylum, to allow the friends to explain their good intentions in past deception as they best may. Some explanation or truthful statement of affairs should always be made before the patient is removed to an asylum, and in the vast majority of cases the proper person to make this statement to the patient is the physician, and the proper time for it is at the personal examination.

No set rules are practical for the conduct of the physician in the presence of an insane patient. The same traits of mind and body that influence minds in health serve to control them in disease, and if the physician has not presence of mind, self-possession, firmness, quickness of perception, and tact, he will not be successful in his personal relations with the insane; and if he have these qualities, he naturally adapts himself to the emergencies that arise in the personal examination of cases that differ so widely among themselves. The physician should have in his mind a scientific and comprehensive formula for the personal examination of patients, however he may see fit to abridge or to depart from it in each case. The personal examination as relating to the physical state comprises: First, the general condition of nutrition and of the muscular system, and the main bodily functions of circulation, respiration, digestion, and sleep, and the special condition of the skin, capillary circulation, pulse, and temperature. Second, the general appearance of the patient as to size and shape of head or of limbs, and personal deformities or peculiarities of features; the state of facial innervation, and the general physiognomy; the condition of the organs of special sense and of sensation in general; the looks, gestures, speech, gait, and general manner of the patient.

The personal examination on the psychical side should embrace: First, the state of perception, consciousness, memory, and reason; the presence of illusions, hallucinations, or delusions; the time-rate of mental processes, as shown in ready comprehension or in retarded answers; confusion of ideas or mistakes in time, place, and identity; incoherence of words or ideas. Second, the prevailing emotional tone, whether depressed or exalted; the chief emotions manifested or most easily aroused; the altruistic sentiments, and especially the social feelings toward relatives and old friends; the religious sentiments; the appetites, desires, impulses, and the general condition of self-control as regards thoughts or actions.

This may seem a somewhat formidable array of points to canvass in a single personal examination, and yet the skilful examiner, accustomed to sound mental depths, may test not only these but many others within an hour's time, and it is seldom best to prolong a visit beyond this limit, and usually a much shorter time is sufficient if the physician has been thorough in gaining the personal history.

In exceptional cases the examination may not yield all the results desirable, and the case should then be seen a second time. If there are very marked alternations or remissions, it is well to see the patient at the extremes of greatest lucidity and disease, and in any case, if the physician is to sign a certificate of insanity, he should repeat his visits until he is completely satisfied as to the essential points of the case. The physician having completed the personal history and personal examination, is in full possession of the essential elements of diagnosis, and the judicious interpretation of the facts before him is all that remains to render the diagnosis differential.

He must distinguish the mental disorder of the patient from the various forms of fever with delirium; from the immediate effects of alcohol or of other toxic agents; from acute meningitis, and from the mental disturbances that sometimes attend acute inflammations of thoracic or abdominal organs; from traumatic delirium after surgical operations; from the mental effects occasionally following concussions of the brain; and from violent passions or emotions adequately provoked by the actual events of life.

There are two standards of comparison for the mental phenomena presented by the patient in whose case the diagnosis is to be made. One is the average manner of thought and feeling of mankind in general, and the other is the particular mode of intellect and feeling presented by the patient when in health. Prolonged departures from the patient's customary mode of thinking and feeling are among the surest signs of insanity; and still it is to be remembered that great changes in these respects are sometimes accomplished in a comparatively short time by decided alterations of the circumstances of life. One of the earliest occurrences in mental alienation is a decline of moral tone and a loss of the finer social feelings; and yet this may result likewise from vicious habits and associations. The same erroneous belief may be the result of ignorance and prejudice, or of brain disease, and there may be a basis of fact for the delusion in either case; but in the one instance it is a symptom of insanity, and in the other it is not. Hallucinations and illusions are found in the sane as well as in the insane.

There is, therefore, no crucial test of insanity, and it simply becomes a question whether the symptoms observed are the products of a brain diseased, and not such natural results as follow in sane persons from certain adequate external influences. In difficult cases, therefore, the physician will need a knowledge of human nature as well as of the medical laws of mind and body, and he must base his diagnosis, not on single facts or on isolated signs, but on the life-history of the patient, and on all the symptoms, viewed collectively as to their sequence, course, duration, and general relations. Before speaking of the differential diagnosis of the various types from one another, something will be said of the cases in which it is difficult to establish the prime fact of insanity.

In the aberrant conduct of children it is very difficult to decide how much is due to native defect or to active disease, to lack of organization or to disorganization of mind. The rational faculties are so slightly developed that the expression of their functional derangement in delusions is seldom to be found, and neither the general standard nor a fully formed individual standard of thought and feeling has ever been reached; so that the only comparative measure for the degree of mental obliquity in the young sufferer is the average psychical state of children of the same age.

In the earnest school of life man finds the study of his fellow-man absolutely essential for success, but the study of juvenile psychology is not likewise compulsory, and expertness in this branch is a rare attainment. The physician who has viewed the actions of children, not in the playful mood of a pastime, but in studious consideration of their motives of conduct, will deem himself fortunate and amply rewarded for his pains when he is first called upon to determine the exact mental status of a child that has become the despair of anxious parents. The child may be gloomy, taciturn, averse to play, troubled with frightful dreams and visions at night, and with morbid fears in the daytime; or noisy, disobedient, destructive, and violent in temper, and made worse in these regards by every resort to punishment, which may provoke something like a maniacal paroxysm; or there may be great cunning, cruelty, and sexual precocity, and absence of

natural affection; or, again, there may be simply unaccountable stupidity, so that the child, while appearing to comprehend what is said to it about simple things, is incapable of gaining knowledge from books, or of advancing in the primary studies of school.

Now, if the physician fails to recognize mental disease and awaits the full group of symptoms of melancholia, mania, moral insanity, and imbecility, as found in the adult, the diagnosis will not be made, for such manifestations are only exceptionally present in the insanity of children.

A diagnosis can only be reached by a systematic procedure as above described under personal history and personal examination, by which an opinion is based, not on isolated facts, but on the collective body of data detailed under the above terms. It is to be understood that the mental conditions attending hydrocephalus, scrofula, rickets, chorea, epilepsy, and other diseases, though peculiar, are often less pathological than the psychical state developed by moral causes, such as fright or other violent emotions, in children strongly predisposed to insanity, and that the temporary disturbance of mind thus occasioned does not in itself constitute insanity.

In old age, again, it is difficult to distinguish the normal decline of faculties from the pathological failure of mind in certain cases. Loss of memory and of attention, social indifference and a diminution of affection for relatives, extreme penuriousness and narrow-minded selfishness, great suspicion and conservatism, are so often found in senility that they cannot be regarded as necessarily proofs of insanity, except in cases in which they appear suddenly as a part of a symptom complex caused by some active pathological process.

As trophic convolutional changes and atrophy of the ganglionic elements advance in senility, there is a gradual loss of all the higher moral qualities, even though the outer practices of morality may be automatically observed from force of habit, just as the childish dotard may utter words of wisdom in a purely automatic way. The moral decay should proceed gradually, however, like the intellectual decline, and the diagnosis of insanity may be based with much more certainty on a sudden outbreak of immorality than on rapid mental failure. Sexual immorality is especially diagnostic when it appears in an old person, in whom desire had long been extinct, and in whom previous habits of libertinism had never existed.

Dementia may follow gross organic brain diseases, which are so frequent in senility; but simple diminution of functional power in these cases is not insanity.

The differential diagnosis of eccentricity from insanity is often an arduous task. There are two kinds of eccentricity, which differ widely from each other. One class of eccentric persons have strong and original minds; they are bold and independent characters, and they are usually extremely self-reliant and indifferent to external events or to adverse criticism; and they are farther removed from insanity than the average man, and they retain a perfect self-poise under the most trying circumstances of life.

The other class of eccentric beings are born weak and peculiar, or have some hereditary strain of madness in their composition, or through diseases or mental shocks the eccentric condition has been acquired as a species of neurosis which is nearly allied to insanity. These persons are ordinarily sensitive and dependent characters, and they differ from others, not of their own free choice, but from necessity, and they more frequently conceal than assert their inherent eccentricities. The insanity in these cases is often of very gradual development, and the practical difficulty in the way of a diagnosis arises from this fact.

There are many unhealthy states of mind and body, caused by the excessive indulgence of an artificial appetite for drugs or alcoholic stimulants, but these morbid conditions cannot be legally or medically regarded as insanity on account of the loss of self-control alone, or of the personal damages resulting to the patient's health or fortune. There must be some formal and permanent disturbance of the mental powers, or of the affective faculties, before the diagnosis of insanity can be made.

The diagnosis of insanity, after the stage of apparent convalescence from a previous attack, is often extremely difficult, and in general it is more difficult to determine the fact of complete recovery than to make the diagnosis of mental alienation in the first instance. The patient, seemingly well, but really concealing his insanity, is often an adept in deception, having learned by experience what ideas and actions are to be suppressed. The state of recovery varies greatly in different patients. It is not to be expected that previous erroneous beliefs will always disappear on recovery, for they may be retained, just as false conceptions are held by sane persons in the absence of contradictory evidence, by mere force of habit. The disagreeable feeling, or actual antipathy, which certain persons may have aroused in them during their sickness, also often tends to persist after recovery in the same manner, and time alone may efface it. These insane antipathies that remain after recovery are analogous to the unfounded dislikes among the sane that are sometimes exchanged for friendship after long acquaintance.

In comparing the patient with his former self, it is to be remembered that, after a severe attack of insanity, many months elapse before the original strength of the mental and moral faculties is restored, and that this full restoration, at any time, is the exception and not the rule.

The diagnosis of feigned insanity has important legal bearings, inasmuch as simulation is ordinarily for the purpose of escape from the obligation of contracts, or from the responsibility for criminal acts committed. For the discussion of this question reference may be made to the special article on Feigned Insanity.

The differential diagnosis of the various special types of insanity is best accomplished by the systematic observance of a few general principles. The first principle is to determine to which main group the case belongs—whether to states of stupor, of mental weakness, of mental depression, or of mental exaltation. Secondly, to decide whether it is of primary or of secondary origin. Thirdly, to make such farther differentiation as the etiology of the case renders possible. Fourthly, to complete the diagnosis of the special type of insanity by means of the actual psychical and somatic symptoms presented by the case, and interpreted by the light of the personal history. Let it be supposed, for instance, that the physician is called to a case of a young woman, who is found sitting with downcast eyes and with expressionless face, giving no response to questions, and no heed to anything that occurs about her. The first inquiry, as to whether there has been previous emotional disturbance, depression, or exaltation, being answered in the negative, excludes all kinds of melancholia or mania, and limits the condition to a state of mental weakness or of stupor. The second question decides that the case is not the sequel of any acute form, and that it is of primary origin, and terminal dementia is thus excluded as the only form of mental weakness that, in any way, corresponds to the general appearance of the case. The case is, therefore, some form of stupor.

The etiology of the case is next invoked in aid of the diagnosis, and alcoholic, epileptic, and all other kinds of stupor are excluded by the fact that the condition followed immediately the shock of a severe fright some days previously. The somatic and psychical appearances, the personal history, and the origin of the case, all accord with the special type of acute primary dementia, and other forms have been excluded, and the diagnosis is, therefore, complete.

If the first inquiry had revealed acute exaltation of feeling as the original affection, and the mental torpor as the sequel of the maniacal outbreak, the diagnosis of sequential stupor would have been made; or if acute mental depression had attained so great a height as to eventuate directly in a similar condition of anenergy, melancholia attonita would have been diagnosed.

It would be easy in like manner to illustrate the application of these principles in the diagnosis of every case that the physician is liable to encounter.

If an occasional case of great difficulty arises, it will

simply necessitate a more thorough personal history and a more exhaustive study of the physical and mental phenomena by instruments of precision and by psychical tests and by prolonged and patient observation.

Prognosis.—The prognosis of insanity tests to the utmost the skill and technical judgment of the physician. It is too complex a subject to be satisfactorily answered as a single inquiry, and it will be viewed from some of its most salient points of practical interest by a brief numerical and analytic method.

The subject naturally falls into two divisions, which are —first, the chances of life or death ; second, the chances of loss or recovery of mind.

The urgent question of the prospects of life will first be considered.

Insanity is shown, by numerical comparison on a large scale, to diminish very decidedly the expectation of life at any given age, and death occurs at a much earlier average age among the insane than among the sane. The annual death-rate among the insane is four times greater than among the sane population. In asylums for the insane the annual mortality for males is about nine per cent., and for females it is about eight per cent., when based on calculations for a long series of years.

The percentage of deaths is greatest during the first month of the disease, and it diminishes with each succeeding month during the first year. The more acute the form of insanity is, the greater is the danger to life. General paresis ends in death so uniformly that most authors question whether there has ever been an authentic instance of survival. Although the average fatal limit is about three years, it must be admitted that, in very exceptional cases, life may be indefinitely prolonged.

Typhomania stands next in point of mortality ; and the chances of life and death are, in the writer's experience, about equal in this malady, though most authors give a still higher death-rate.

Other types of mental alienation having a high mortality are certain varieties of organic dementia, especially those with intra-cerebral hemorrhage and softening, and some diathetic forms, such as pellagrous and tubercular insanities. More than five per cent. of cases of acute mania die from exhaustion, or from some affection resulting from the insanity ; but if the first storm of the disease is survived, the chances of life are comparatively good.

In a general estimate, based on the careful study of a large number of cases by Dr. Thurman, a very unfavorable conclusion is reached, viz., that of every ten persons attacked by insanity seven die—five during the first attack, and two during subsequent attacks. This alarming prognostic view is somewhat relieved by the further observation that the life of certain cases of insanity has been prolonged, for variable lengthy intervals, from twenty-five to fifty years from the date of the first attack. So far as seasonal influences are concerned, it appears, from statistics of both European and American asylums for the insane, that the greatest number of deaths occur during winter and early spring, and the fewest during summer and early autumn.

The prognosis in each individual case, as to the chances of life, must take into account the age, constitution, and complicating diseases of the patient, as well as the severity, duration, and type of the mental disorder. Senility and complicating diseases of the vital organs are unfavorable, especially affections of the brain and lungs.

Cardiac failure, extreme inanition, convulsions, pareses, incoördinations, and persistent trophic and vaso-motor disturbances are all evil omens. Among the psychical symptoms, great disturbances or obliteration of distinct consciousness and memory point to the depth of the pathological process.

The prognosis as to the chances of the recovery or loss of mind is necessarily qualified by a variety of circumstances, which are to be closely studied and carefully estimated in each case of insanity. The chief elements of prognosis in individual cases are the age, sex, general physical condition, and hereditary tendencies of the patient, and the form and duration, as well as the special causation and course, of the mental disorder.

The age during which the greatest number of recoveries occur is, as shown by numerical inquiries, between twenty-five and thirty-five. The prognosis is never favorable in very young persons, in whom insanity is almost always hereditary. Senility also presents an unfavorable prospect of recovery, which follows only, in exceptional cases, when involutional changes have actually taken place prior to the first attack of mental disease. Old age is not absolutely unfavorable, so far as mere lapse of years is concerned, and the only measure of the chances of recovery is the extent of the organic senile changes.

Sex has general numerical relations to prognosis, which may be briefly summed up in the statement that more females than males recover from the first attack of mental alienation, as well as from subsequent attacks ; that among a given number of females there would be both more relapses and more recoveries than among the same number of males, during a series of years embracing the same period of life.

The duration of the attack is a most important element of prognosis.

From seventy to eighty per cent. of cases of insanity are curable if placed under proper treatment within the first month, and fifty per cent. of cures are to be expected from first attacks treated within the first six months. A longer duration than six months is attended by a rapid decline in the rate of recoveries, which does not average more than ten per cent. after the first year. Occasional recoveries occur, however, during the first few years, so that a guarded prognosis is always to be made, and no case is to be pronounced hopeless in the absence of organic brain-lesions. Extreme exceptions have been recorded of recoveries from attacks of twenty and thirty years' duration.

In certain cases of traumatic insanity, and in climacteric cases, cure not infrequently follows after a series of years.

The relative curability of the various types of insanity can only be stated approximatively. Mania and melancholia are the most curable forms, and general paresis and terminal dementia are hopeless. Other very unfavorable forms are typhomania, organic dementia, epileptic, circular, and senile insanity, and primary monomania. Of hereditary cases in general, it may be said that their chances for recovery from a first attack are as good as in the non-hereditary types, but that relapses are very constant. The prognosis is absolutely bad in that class of hereditary cases in which all the psychical and somatic symptoms of degeneracy are present, and the insanity is only an intensification of natural morbid traits of character. Mental alienation originating in trauma capitis and insolation, or resulting from the gradual transformation of the major neuroses (epilepsy, hypochondriasis, hysteria), is of unfavorable prognosis. Insanity from prolonged moral causes, such as anxiety and business worry, is not apt to terminate in recovery ; while mental disorder occasioned by sudden violent emotions not infrequently has a complete convalescence.

Post-febrile insanity is not a very curable form, but recovery follows in some cases due to the anæmia and malnutrition of the general system rather than to permanent nutritive lesions in the cerebral centres.

Mental disease from venereal and alcoholic excess does not often recover when organic changes in the nervous centres have resulted, but in cases of simple functional exhaustion from over-indulgence there is every hope of recovery, but an equal probability of a relapse.

Puerperal insanity furnishes a large percentage of recoveries—probably not less than eighty per cent. of cases that meet with prompt treatment from the inception of the disease ; and it is at the same time one of the most acute and most curable forms.

The prognosis is favorable in all cases that have as their causation simple anæmia or functional disorders that are capable of removal, and this is true of sympathetic insanity dependent on local irritations for which there is a remedy.

Toxic insanities are only favorable before organic le-

sions have occurred, and there often remains some permanent mental defect after apparent recovery; and this is especially the case in lead-poisoning and in chronic alcoholism.

Insanity in connection with the tubercular, cancerous, and scrofulous diatheses does not often admit of a cure, and permanent mental weakness is a common sequel after recovery in luetic cases and in organic dementia. In states of arrested mental growth the only hope is for improvement through systematic methods of training, and the only result in any case will be to render the native defect somewhat less obvious. The only exception to this is in cretinous cases which, when removed while young from the region in which the disease is endemic, may in a measure be educated in the use of all their mental faculties.

There are certain of the psychical and physical symptoms that are useful aids in prognosis. Fixed delusions, perversions of natural affections and of instincts and appetites, homicidal and suicidal tendencies of long duration, suspicions of poisoning, and prolonged refusal of food, are unfavorable signs. Other symptoms that forebode an evil result are trophic and paræsthetic disturbances, that cause the patients to bite their fingers, to rub themselves until the skin is abraded, and to pull their hair out; coprophagy and other filthy habits, and loss of all sense of modesty in women; deep disorders of consciousness, and great confusion of memory and ideas except at the height of acute mania; the impulse to accumulate worthless things; the peculiar use of words and sounds, or the invention of new words, and multiple or fixed hallucinations.

Favorable psychical symptoms are a return of the natural likes and dislikes, and of peculiar habits of thought and speech, an appreciation of the past illness, desire for customary occupations and social relations, gratitude for personal services rendered, and a revival of tastes for old amusements or special pursuits of a literary or social nature.

Physical phenomena that betoken a bad prognosis are paralyses and motor incoördinations, especially of speech and gait; apoplectiform attacks, and all convulsive seizures; masticatory spasm, cardiac failure with vaso-motor paresis, progressive loss of weight, except in the acute stage of an attack; prolonged anæsthesias and paræsthesias, persistent cephalalgia and myosis, loss of facial innervation and of all expression of countenance, and the drooping of the head and lower jaw.

The relation of bodily weight to the progress of the mental disorder is very constant, and one of the physical signs that always augurs ill is the renewed activity of vegetative functions and the increase of bodily weight without any improvement of mind.

Physical signs that promise well for the final result are the gaining of flesh and strength along with the return of mental equilibrium, natural expression of face, normal gestures, speech, and gait, and the renewal of personal peculiarities of manner; normal sleep and appetite, and the return of the catamenia after improvement in the mental and physical condition; and the restoration of a healthful general sense of well-being.

A sudden onset and an acute course of the mental disease is more favorable than a gradual development and subacute symptoms, and the shorter the malady the better the prognosis. On the other hand, a sudden recovery is incomplete in most cases, and is ordinarily followed by a relapse. The most trustworthy recoveries are very gradual, with constant lengthening of the lucid intervals, and parallel advances toward health of both the mental and bodily functions.

The prognosis of insanity in its fullest range naturally extends to the probability of a relapse after recovery. Statistical information shows that there is no predisposing cause so powerful as a previous attack of mental alienation, and that, of those who have recovered from a first attack, a percentage varying from twenty to fifty suffer relapses. Dr. Thurman's estimate is still more unfavorable, viz., that of ten attacks five recover, and of these five, three have relapses and only two remain well for life. This estimate is, in the writer's experience, about the result to be expected in strongly hereditary cases, and in patients free from inherited taint not more than twenty per cent. of relapses are to be expected. The question of relapse in individual cases is largely one of the etiology of the disorder, and of the surrounding influences of the patient after recovery.

If the cause of the first attack has been the intense excitement of business speculation, excesses "in Baccho et Venere," domestic trouble and childbearing, a too arduous and responsible position, and similar influences which, from choice or necessity, become active again after recovery, a relapse will follow in the majority of cases.

The wisdom of prophylaxis is never greater than in these cases, and it is a part of the physician's duty to determine the kind and extent of modification of life required after recovery in each case.

A final point in prognosis is the opinion which the physician is occasionally called upon to give as to the probability of the appearance of insanity in persons whose parents were insane. It is only possible to prognosticate according to general facts in these cases. Insanity is almost sure to follow in one whose mother was insane throughout gestation, or whose parents were both afflicted previous to the date of birth. The chances of an attack are also great in one that closely resembles a parent who has inherited insanity that has descended in direct line from grandparents. The influence of the mother is greater than that of the father in the transmission of the disease, and the daughter is more apt to inherit it than the son. There is always a last hope, however, of reversion to a healthy type, or of life-long latency of the inherited tendency.

Therapeutic.—The therapeutic principles of psychiatry are not different from those of general medicine. A glance at the first group of insanities, as classified in this article, will at once suggest the vast variety of the pathological conditions which the alienist may have to treat. Insanity in its widest relations is a disorder, not only of the whole nervous system, but of the whole organism; and, during an acute attack, trophic, sensory, motor, vasomotor, secretory, excretory, and all other functions of the economy become involved. Affections of the thoracic and abdominal viscera, of the organs of special sense, of the skin, muscles, and even of the bones, are not uncommon.

All views of the specific treatment of the various types of insanity by special remedies are as narrow as they are unpractical. The alienist has to treat patients, and not types of aberration, and his treatment must be based on the etiology and pathology, and not on the form, of the mental alienation. In exceptional cases of idiopathic insanity the causation and pathogeny may remain problematical, and, upon the failure of those fundamental indications, the physician should employ the broadest principles of symptomatic treatment. In any case, the general course which he has to pursue is clear. Attention must first be given to the relief of urgent symptoms, such as obstinate constipation, prolonged insomnia, cardiac failure, præcordial panic, great inanition, and dangerous exhaustion of vital powers. The physician must next deliberately shape his plan of treatment according to the etiology of the case, and it is needless to say that it will differ widely in epileptic, alcoholic, syphilitic, apoplectic, and choreic insanity; and that no zealous trial will be made of the latest approved remedy for melancholia in cases due to widely different and undiscovered causes, such as basilar meningitis of tubercular origin or lead-poisoning, organic lesions from trauma capitis or malarial intoxication. When the physician has administered to the most pressing symptoms, and directed his efforts to the discovery and treatment of the cause of the disease, he will seek further therapeutic indications in general systemic morbid states which may be present, in the form of anæmia, or in a gouty, rheumatic, scorbutic, or phthisical diathesis, or in general malnutrition and chronic gastro-intestinal disorders. An exhaustive physical examination should be accomplished as soon as possible, without fatigue or distress to the patient, and no

organ should escape notice; for the objective signs of organic disease are often obscure in the insane, and the symptoms of lung diseases are especially latent, so that "walking cases" of pneumonia and advanced stages of phthisis pulmonalis, without cough or expectoration, are common. The weight of the patient should be taken from time to time, as it is one of the most valuable guides to the vital status of the patient, and the differences between the morning and evening temperature should be noted, and the examination of the urine may be significant as to the course of treatment. When the physician has complied with the above suggestions he will have fulfilled the main indications, and his further plan of treatment will be modified by the course of the affection and by the complicating diseases which may arise.

The intercurrent diseases will not be treated, or even discovered before death in many cases, if the greatest care is not exercised, and if repeated physical examinations are not made; for the insane, owing to anæsthesia or analgesia, may make no complaint, and pneumonia as well as phthisis may pass through its various stages without cough or expectoration, and the symptoms of other affections may be likewise latent. The common impression that the insane are not subject to the same variety of intercurrent diseases as the sane is a mistake. They have impaired powers of resistance, and they suffer more than the sane both from epidemic and from ordinary diseases. Another erroneous idea is that very large doses of medicine are borne with impunity by the insane; but the fact is that they do not support powerful drugs as well as the sane, and they suffer from them in large doses, even though they may not complain.

Of the chief pathological conditions of fully developed insanity, and of the remedies best suited for their relief, some general suggestions will now be made.

Intense cerebral hyperæmia is one of the most common of these conditions, and it appears in two essentially different forms. In exceptional instances the patient is robust and of full habit, and there is general plethora. The face is flushed, the conjunctivæ congested, the head hot, the pulse rapid and bounding, and the general temperature above the normal. It is probable that judicious blood-letting would be the most prompt remedy in these cases; but as it is a procedure that is pernicious in the vast majority of cases of mental disease, it has been dismissed from the list of remedies. The most efficient treatment is, after acquiring the certainty that the heart and lungs are sound, to place the patient in a graduated bath (thermometers mounted in wooden handles for this purpose are to be had) at 85° F., and to gradually reduce the temperature to 70° F. or to a greater or less degree, according to the effects produced and judged by the heart's action, respiration, and general physical condition. Local applications of cold to the head, by means of rubber-tubing coils for the flow of water or the ice-cap, do not compare in efficacy with the graduated bath, which equalizes the whole circulation through its effects on general vaso-motor innervation. The bath may be continued from five minutes to a quarter of an hour, and be repeated several times in the course of twenty-four hours. In acute cases of sthenic mania, with all the signs of cerebral hyperæmia, its effects are often remarkably good. The best drug is bromide of potassium. The other condition of cerebral hyperæmia is asthenic, and due to distention of the vessels from vaso-motor paresis. The ice-cap and mustard foot-baths can be here employed, and digitalis and ergot will be found useful; also spinal hot-water bags and hot stupes over the epigastrium sometimes give decided temporary relief, but quinia and tonics must be used in many cases.

Cerebral anæmia, which is so constant a symptom in states of mental depression, may be so great as to call for active means of relief. The condition of the vessels is one of contraction from vaso-motor spasm, and the most immediate and powerful remedy is nitrite of amyl, inhaled in doses of a few drops several times within a few hours. Alcoholic stimulants and hot-air baths are often good and prompt remedies. Another pathological condition that is very constant, and often urgently demands a remedy, is insomnia. Powerful narcotics should always be a last resort, and all drugged sleep is so bad as to be justifiable only after the failure of all other means. The irritability of the brain that causes wakefulness is often due in the insane to lack of blood and nourishment, and a warm and generous meal before bedtime will frequently be followed by a few hours' sleep. A tepid bath is also sometimes successful, and should be one of the first resorts in all cases; and if cold is applied to the head and warmth to the feet, sleep may follow more quickly. Heat over the spine or epigastrium, or even a glass of hot water taken at bedtime, will occasionally procure sleep. An exclusive milk-and-cream diet for a day or two will sometimes have a remarkable soporific effect, if pushed to the full extent of the tolerance of the stomach. If such means fail, alcoholic stimulants should next be tried. Good lager-beer at bedtime will sometimes answer the purpose, or mulled wine, or milk-punch made with whiskey. If stimulants are contra-indicated, then hypnotic drugs must be used, and it is often difficult to decide which is best in any given case. In sthenic mania, hydrate of chloral and bromide of potassium, either alone or combined, are the most efficient remedies. If the latter will suffice it is better not to use the former, and single large doses are better than repeated small ones.

In melancholia these drugs are not apt to be so well borne, and morphia will prove preferable, and it should be given in single large doses; and if great anæmia is present it should not be used, and in all states of physical as well as mental depression it is best administered in combination with quinia or digitalis. Occasionally, a case will not yield to morphia unless a little chloral is given at the same time.

Drugs should not be used to compel sleep more than three or four nights in succession, and, as a rule, it is better to give them on alternate nights in cases requiring their prolonged use.

General motor excitement is a phenomenon that is distressing to witness, and that may lead to complete exhaustion of the patient. The danger in this latter regard is not so great as it may appear, and it becomes a nice point to decide when it is best to put the patient under chemical restraint. Motor activity is a safety-valve in many maniacal cases, and it serves to equalize the circulation, to derive from the hyperæmic brain, and to favor sleep. It is a part of the natural course of the disease which it is worse than useless to attempt to suppress, so long as there is no sign of cardiac failure or of general exhaustion. If there come a time at which the motor restlessness is a greater evil than the drug that will restrain it, and if the patient is at the same time destructive and violent, an old and reliable remedy will be found in small and repeated doses (beginning with gr. $\frac{1}{4}$) of tartarized antimony. It interferes less with digestion than other drugs used for the purpose, with the exception of an occasional patient who will not bear it in any dose. It is certainly preferable to hyoscyamin, and in chronic maniacs it is better than conium. The latter drug is effective and useful in many cases, and perhaps to be preferred for a first trial in an acute case, but its continued use is by no means without deleterious effects on the general mental condition. The motor restlessness of melancholia agitata, and also that of præcordial panic, is best controlled by subcutaneous injections of morphia, beginning with one-fourth of a grain.

Mental excitement and psychical hyperæsthesia in rare cases attain such a degree that sedatives are desirable, and here again opium in some of its forms is the most reliable medicine. It is especially indicated for this purpose in the early stages of melancholia, while bromide of potassium acts equally well in mania.

General anæmia is a pathological condition found in more than half of the cases of mental depression. Iron, of course, is here the main reliance, but small doses of arsenic sometimes prove of service; and opportunity will often be afforded for the use of both drugs, as anæmia in the insane is not readily removed by medication, and in many cases it would seem to be symptomatic of trophic disease of the brain, and it then persists until death.

Hallucinations are to be regarded as a part of the routine symptoms of the disease, and they seldom call for active interference by means of drugs. In rare cases, however, they are multiple, and very constant and distressing. They may be relieved temporarily by placing the patient in a darkened room, and by the administration of large doses of bromide of potassium. If illusions and hallucinations are unilateral and persistent, it is well to examine the special organs thoroughly for local disease, which, in exceptional cases, may be the origin of the troubles.

Delusions also are, of necessity, allowed to pursue their natural course in the great majority of cases. In rare instances it is possible to relieve the illusion on which they are dependent, or the sympathetic source whence they spring, as in local irritations of the sexual organs or in gastro-intestinal disorders. Painful delusions of a vague character, like general forebodings of evil, may sometimes be relieved by changing or blunting the acute emotional tone through the use of opium in small and continued doses.

The medicinal treatment of insanity in all the toxic and diathetic varieties does not call for detailed description here. The syphilis, gout, rheumatism, chorea, malaria, epilepsy, and all causative diseases are to be treated according to the usual methods, and by the customary remedies, in the hope that when the physical malady has been removed the mental disorder will also cease.

General debility and nervous exhaustion may be somewhat benefited by quinia, strychnia, and various tonics. The long list of complicating symptoms and diseases must be treated on rational principles as they arise.

There is a turning-point in most cases of insanity that should be watchfully anticipated, as it affords the most precious opportunity for decisive measures of treatment. This critical period follows the acute stage in mania and melancholia, and it is usually a state of partial exhaustion of mental and bodily powers, and it may be one of great lethargy. Active treatment is requisite to prevent the patient from passing into secondary dementia. Tonics, stimulants, counter-irritants, electricity, Turkish baths, and out-door life and diversions are now in order, and medical interference is never more necessary than at this time. The general hygienic treatment of insanity is of the utmost importance, and, without underrating drugs, it may be pronounced to be the main hope and the main stay in all acute cases.

Without good food, good air, good nursing, and appropriate surroundings, the hope of recovery is indeed small.

There is nothing that promotes appetite and sleep among the insane like fresh air, and patients should be out of doors as much as possible at all seasons; and in cold weather they require unusually warm undergarments, and they should have frequent short outings and brisk walks in keeping with their physical strength. The most universally useful form of exercise is walking, because it is automatic and already an acquired means of muscular activity, and it does not, like unaccustomed modes of action, call for efforts of will or create muscular soreness. Gardening and other light occupations are also beneficial, and if the patient's strength will admit it, even laborious work is often followed by most favorable results.

Horseback-riding, driving, and out-door sports are useful resorts in some cases. Hydrotherapy has a wide application in insanity. Warm, cold, hot, and graduated baths, salt- and shower-baths, wet packs, and douches, all answer good purposes occasionally, and with their skilful use the physician will often be able to work a cure without drugs. The Turkish bath is also a curative resource of great value. The writer, while physician in charge of the New York City Asylum for the Insane, reported the results of the first extensive trial of this remedy among the insane in America, and the following extract is from his second annual report:

"During the year past there have been prescribed and administered to our patients two thousand two hundred and eighty Turkish baths. The effects of this treatment have been carefully noted in the various forms of insanity, and they have been so favorable as to forcibly suggest the conclusion that the Turkish bath is a remedial agent of great efficacy in mental diseases. The direct result of this treatment is to stimulate the functions of the skin, to strengthen and equalize the circulation, and to hasten secondary assimilation. The direct effect is often a slight loss of flesh, followed by an increased appetite and subsequent gain in weight.

"From our experience with this remedy, we consider it especially applicable in the following class of cases: In melancholia, with the skin dry, harsh, and of furfuraceous aspect; in primary dementia, in which the capillary circulation is greatly impaired, the excretory functions of the skin are suppressed, and the whole surface has a cyanotic appearance; in alcoholic mania, with organic weakness of the liver or kidneys, and with tendency to anasarca; in epileptic mania, where the physical disease is masked, and exacerbations of mental disturbance take the place of the convulsions; in cases in which there is restless excitement, with hyperæsthesia of the skin, tactile illusions, and perverted sensations of the peripheral nerves; in acute and chronic mania, as an effectual sedative to violent excitement where narcotics are contra-indicated; in a numerous class of cases in which the manipulations of the bath afford an admirable passive exercise, which is a substitute for the more active exertion which the patient is unwilling or unable to make either in-doors or in the open air; in cases of organic disease of the brain, heart, or lungs, it is a valuable adjuvant in palliative treatment, but it must be used very guardedly. The same caution is not required in cerebral congestion due to functional derangement, in which its use is followed by marked relief."

Diet is a subject of great importance in the treatment of the insane. The food should be of the best quality, and abundantly given; and in acute cases it is impossible to nourish the patient too well. Feeding in frequent and small quantities must be employed if the patient will not eat at stated intervals, and in many cases it is well to let the patient eat as often as food is craved. There is an enormous waste of tissues in the acute stages of insanity, and this must be replaced by a generous supply of nourishment in the form of milk, eggs, fresh meats, and vegetables and fruits in season, if the patient will eat them; but the first three of the above articles should form the staples of diet for the insane. In states of exaltation food is usually taken in sufficient quantities, but in states of depression inanition is a constant danger that is to be combated by every device. The patient should be urged, commanded, entreated, and tempted; and if left unobserved with food, he may take it; and, finally, forced alimentation is to be used. The time for intervention with forced feeding varies in each case, but it is best to lose no valuable time after the second day's refusal of food by a patient who is not strong and well nourished.

The œsophageal tube, stomach-pump, or nasal tube, may be used with a funnel held above the head of the patient, who is best fed seated in a chair, with a rest for the head and with straps for the arms and legs, so as to prevent slipping out of the chair. The clothing about the neck should be loosened, and the patient's head should be carefully held by an assistant. Milk and cream, eggs, and beef-tea, or raw beef scraped fine and beaten into the fluids, are the best articles for use in these cases. Rectal alimentation may become a resort under certain circumstances. In all cases of inanition or of exhaustion, from any cause, the patient had better be kept in bed. If the exhausted patient will not remain in bed, and is wearing himself out by incessant activity, and if drugs are contra-indicated, mechanical restraint may become necessary to keep the patient in bed. The question of non-restraint will not be here discussed, for, after all that has been said and written on the subject, it remains a simple matter of common-sense as to what is best to be done in each case. Nobody doubts the necessity of restraining patients from doing injury to themselves or others. There are only three ways of control—by drugs, by the hands of at-

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tendants, and by mechanical restraint—they are all evils; sometimes one and sometimes the other is the lesser evil, and the choice between them must be made according to the nature of each case.

The question of home treatment or of asylum treatment is one of the most responsible which the physician has to decide. If the patient is treated at home and recovers, it is usually a source of congratulation to him and to his relatives that he was not sent to an asylum, and, practically, it is better for him in his social and business relations. On the other hand, there are the interests of those about him to be considered, and great practical difficulties in the treatment of the case at home, unless there are abundant means at the patient's command. Home treatment, in fact, is largely a question of expense. If the patient has money to hire a house or apartments, nurses, and a skilful physician, there is no reason why he should be sent to an asylum. If he is a married man, of family, it is often best that he should be separated from his wife and children, and in many instances a change of scene and surroundings is best. In most cases, therefore, the patient cannot afford the separate rooms and the day attendant and the night attendant, without whom the physician would not venture to undertake the responsibility of an acute case of insanity, and the asylum becomes the only resort. Unquestionably, asylums have great advantages for the treatment of patients, who are often favorably influenced by the regularity, order, and general weight of authority there arrayed; and when these institutions are well appointed, and conducted by fully competent physicians, they afford the most reliable means of cure in the majority of cases of mental alienation.

The general management and the moral treatment of the insane is too broad a subject to be fully considered here. In acute cases the principal measures are to remove all irritating influences, and to substitute quiet and agreeable surroundings, and to show kindness and truthfulness of conduct while firmly enforcing the necessary measures of treatment. The use of rewards and of the deprivations of privileges demands the most delicate discrimination, and it accomplishes more harm than good if the patient fails to fully understand the reasons for the action taken by the physician. Intimidation and the infliction of physical and mental pain may repress certain symptoms, but they are ruinous to the patient's chances of recovery. The object of moral treatment is to divert the patient's thoughts into new channels, to change the feeling from which his delusions spring, to employ the force of repetition, to establish healthful habits of life, to occupy his mind constantly with new things. Occupation and amusements must be varied to suit the social and literary tastes of the patient. Direct personal influence, the action of a strong and genial spirit on a mind diseased, is the most powerful means of moral treatment, and there comes a time in every convalescent case when the society of sane persons is required to hasten and confirm the cure. If the patient is in an asylum when that time arrives, he should be restored to his family and friends, and, if he has been treated in private, he should gradually resume his social relations.

Finally, the physician, having conducted the case to the happy issue of a perfect recovery, has a final duty to perform in the advice of such wise prophylactic measures as will most effectually prevent a return of the insanity.

Theodore H. Kellogg.

INSANITY, CLIMACTERIC. The process of functional cessation through involution as manifested by the menopause is, like the processes of development and decay, liable to be attended with mental and even physical disorder.

These conditions represent transitional states in human life; but while youth and old age, or growth and decay, affecting as they do the organism generally, offer each a fertile and abundant soil for mental disturbance, the climacteric change, representing the decline and close of sexual life in one sex, and the degeneration and disuse of but one set of organs, is naturally a less powerful factor in the production of insanity.

Normal signs.

The normal signs of the menopause are largely confined to nervous and mental change of a minor kind, and, in varying degrees, are present in all women. At the ordinary menstrual periods the susceptibility of the nervous system to various, and even slight, stimuli is considerably increased. Most women, it is well known, are at those periods unduly sensitive, perhaps inclined to be irritable or dispirited. They are also more or less whimsical, and lose their control at slight occurrences.

Similar conditions are noticeable during pregnancy and the early puerperal state. At the climacteric, however, these or similar manifestations, when not intensified, as frequently happens, become more noticeable owing to the increased frequency and abundance of the uterine flow at this time, and the length of time elapsing before complete cessation of the uterine action has taken place. Tilt enumerates among mental and nervous states short of insanity occurring at the menopause, nervous irritability of all shades, headaches, apoplexy, hemiplegia, pseudo-narcotism, prolonged fits of unconsciousness, and various hysterical phenomena. Even epilepsy, either as fresh cases or aggravated old ones, has in his experience occurred at this time.

Change of life as a cause of insanity.

While the manifestations which characterize the menopause are almost exclusively confined to slight mental and functional nervous disturbances, actual insanity in the form of new cases, and attributable to the change of life, is far from frequent. It seems as though the limited and special nature of the change precluded to a great extent the possibility of profound mental disturbance, and was perforce confined to a set of less pronounced disorders.

B. de Boismont received into his asylum, in one year, eight patients in whom insanity could only be accounted for by this cause. Sutherland[1] considers cerebral disorder amounting to actual insanity to be extremely rare at the change of life. Merson,[2] whose paper on this subject is very thorough and exhaustive, considers that the history of the cases which he has investigated points to the conclusion that the change of life is not of itself the immediate cause of insanity. The outbreak of disease is generally determined by some other influence, most frequently of psychical character, but sometimes also by bodily disease not connected specially with the climacteric age.

It is one matter to attribute disease to the climacteric, and another to trace the connection between the two of cause and effect. This is especially the case when we endeavor to ascertain the relation of this change to insanity. The multitude of morbid influences—mental, moral, and physical, direct and indirect—to which women are exposed at this age are seldom effective singly, and differ both as to quantity and quality in different cases. As to the climacteric as a cause of insanity, then, we can only say that it turns the scale from sanity to insanity in a limited number of cases, in which a bad heredity, with or without other accepted influences, has been heretofore inoperative. Our experience coincides with that of alienists generally, that insanity may result in a still larger proportion of cases in which one or more previous attacks have occurred. In other words, when the hereditary mental taint is strong, and previous attacks of insanity have been undergone, it may be justly feared that the menopause will give this tendency to mental disturbance increased activity, and will precipitate another attack. This liability is especially strong when the previous attacks have occurred exclusively during the puerperal state. It is a matter worth considering, whether this can be accounted for by any analogy in the involutional processes of the uterus in the two states.

Cases of acquired insanity are occasionally met with in which the menopause has been the chief causative factor, but they must be looked upon as unusual in view of the large proportion of the hereditarily predisposed found among this class.

The cases of mental disturbance which can most properly lay claim to the title of climacteric insanity, viz., those in which there is a minimum of the usual di-

rect morbid influences and yet a decided mental change appearing at this time of life, are almost always those of melancholia or hypochondria. They follow no uniform or separate course that would distinguish them from the same mental states at other times of life. In short, they do not form a definite clinical group.

Prevalent forms.

A group of symptoms is attributed by Skae to the climacteric condition, viz., "a monomania of fear, despondency, and remorse, hopelessness passing occasionally into dementia." Maudsley states that when positive insanity breaks out at this time, it has the form of profound melancholia with vague delusions of an extreme character, as that the world is in flames, that it is turned upside down, that everything is changed, or that some very dreadful but undefined calamity has happened, or is about to happen. The countenance has the expression of vague terror and apprehension. In some cases short and transient paroxysms of excitement break the melancholy gloom. These usually occur at the menstrual periods, and may continue to do so for some time after the function has ceased.

There is no doubt that states of this sort are common enough at the menopause, but we find them frequently also at other times of life; particularly do we find cases answering to this description of Maudsley's in older people. It seems to us profitless to attempt to group the cases of melancholia occurring at this time, to find a thread of distinguishing color. In our opinion, all that can be said is that a collection of cases of so-called climacteric insanity will illustrate melancholia in all its various shades—for example, undelusional depression or marked insanity with delusions of suspicion and persecution, or else profound melancholia with hallucinations and outbreaks of frenzy. Interwoven with this groundwork of depression will be found a large hypochondriacal and pseudo-hysterical element, the only feature of insanity at this time of life which can be called at all characteristic of it. When the disorder is manifested by maniacal symptoms, it is also apt to be modified by those of an hysterical nature.

The following cases exhibit most of the features of climacteric insanity—using the term in its accepted sense, but making due allowance for the operation of other influences, and keeping in mind the possibility of another classification.

Cases.

The first represents a recurrence of insanity at the menopause after a very long interval of sanity, melancholia being the predominant state. The second, also one of melancholia, is noticeable for the false interpretation of the anomalous sensations incident to the menopause.

The patient, a married lady, fifty-four years of age, comes of a highly nervous family. She had an eccentric aunt, and one sister was a victim of the morphine habit. Had always been strong physically. She had her first and only attack, previous to her present one, eighteen years before; this was a severe one, and required asylum treatment. It was of a maniacal nature, and complete recovery took place in eight months. Her menses ceased suddenly to appear about Christmas, 1883. At about this time, also, the death of a brother, causing her great grief, coincided with the beginning of a period of depression lasting about three months, during which she had little or no appetite, fell off in flesh greatly, and grew weak. She had no delusions or appreciable insanity of any sort, but a constant gloom which she could not shake off. This was attended with a fear of returning insanity. In the following May she passed through another but shorter attack of depression. About September, 1884, she was brought to me in a somewhat maniacal condition, with a recent history of peculiar, flighty, and finally violent conduct and unmanageableness, attended with insomnia. She had eaten scarcely anything for a week, and was badly constipated. After a week of great excitement, with hallucinations, refusal of food, slight destructiveness, etc., she became fairly rational; but, while free from delusions, acted extravagantly, dressed in a disorderly and fantastic fashion, was irritable, flighty, unreliable, and whimsical. She was ingenious and persistent in her attempts to make others uncomfortable about her; in fact, in many ways her conduct resembled that observed during the excited stage occurring in cases of *folie circulaire*, and in certain of the so-called morally insane. At this time she complained of various anomalous sensations common at the menopause, such as of pins and needles pricking her, numbness of different parts of the skin, hot flushes, sensations of sinking and faintness. In about three months she went home apparently recovered. About four months afterward she quite suddenly became depressed, having fears and forebodings to which she could not give a name—a state of constant, inexplicable dread. She again came under my care, and during the first week of her stay this condition rapidly increased, until melancholic frenzy with the most distressing hallucinations set in. A somewhat quieter state soon followed, in which she would writhe and groan much of the time, believing herself tortured by the freemasons for some trivial act she had once committed. Convalescence was again established in about two months, and she returned to her home. Since that time, twelve months ago, she has had no return of mental trouble, with the exception of slight and transient depression of the nature of the initial symptoms of the last attack. This was fortunately of diminished intensity, and succumbed to tonic and invigorating measures and regulation of home surroundings.

The second case occurred in a married lady, forty-seven years of age, of strong hereditary predisposition to insanity. She was naturally of a sensitive, anxious nature, but always active, energetic, and practical. Certain domestic matters had long been a distress to her. For several months previous to June, 1885, her catamenia had been irregular in frequency and very variable in amount. At this last date she began to have frequent and rather profuse uterine hæmorrhages, and she took to bed early in October. During this period she was troubled a good deal with insomnia, which persisted for a good many months afterward. In the last week of October one or two very small uterine polypi were removed, and at the same time the hæmorrhage ceased, to reappear, except as a slight show, at the next regular monthly period. Shortly after this operation she began to complain a great deal of epigastric distress, which she described as a general feeling of weakness and great prostration, all centring at this spot. Perspirations, chilly sensations, nausea, and loss of appetite were also present. She could take only Mellin's food, milk, and other liquid food, and occasionally a chop. From this time onward she grew more and more sad. Her feeling toward her family and friends changed; she thought she was distressing them, and refused to listen to their messages. "All was dark before her." When she came into my hands, in January, 1886, she was unable to take other than liquid food, and paroxysms of nameless fright disturbed her. Her sleep was poor. Her digestive symptoms soon improved, but her melancholy increased. Delusions of utter worthlessness, of having led a debased life, of the harm she has brought upon herself and family by her supposed evil practices, became more and more troublesome. Irresistible impulses to use profane and obscene language, owing to her "depraved" condition, became constant, and she frequently gave way to them. She was sometimes noisy and violent, biting and striking others; was "so in the clutches of the Evil One that she delighted in her conduct." She talked constantly of some unseen power urging her on, and her mental distress was almost constant. At other times she would put her hand on her head or chest, saying that she felt something at work in her brain—something inside of her that felt like "all emptiness." She "felt like two persons," like "a piece of chalk." Her face felt "like a mask which she could pull off, and her eyeballs like lumps of lead." She menstruated but twice in six months.

For several months she was very reticent, endeavoring to avoid others and preferring to sit by herself, talking in a whisper of her degraded state and repeating improper words. From this condition she gradually emerged, and began to grow interested in the life about her and to seek the society of others. At the time of writing, convales-

cence is apparently becoming established, as evidenced by a marked change for the better during the past month. Recovery is indicated within about a year from the appearance of the first symptoms.

Although melancholia is the chief mental state at this time, many others are met with. The peevishness, ill-temper, and ungovernable anger of previously amiable and reasonable women, occasionally amount to a condition resembling moral insanity. Sudden repugnance to the dearest members of the family has led women at this time to tyrannize over and hate others of the household, and even to desert their husbands. Incapacity for work, loss of self-confidence, despondency, morbid fears, chronic indecision, are not infrequent conditions.

A craving for stimulants may manifest itself, possibly through a desire to meet or appease the anomalous sensation at the epigastric region so common at this time. Tilt, like B. de Boismont, has several times seen temperate women have a craving for spirits only at the menstrual epochs, the craving subsiding with the flow, and the same desire has been noticed in pregnant and puerperal women. Esquirol and St. Royer-Collard, quoted by the same author, had met with women in good circumstances, who all through life had been temperate, but who at the change were suddenly seized with an irresistible desire for brandy, which again became disagreeable to them when the critical period was passed. This impulse is akin to the well-known longings of pregnancy, and those who yield to it know they are doing wrong, and struggle against it, but are sometimes overcome.

The climacteric undoubtedly modifies the symptoms of already existing insanity, particularly the epileptic variety and general paralysis, but the recorded examples of this influence are too meagre to allow a satisfactory opinion to be formed concerning it.

Stage of climacteric at which insanity appears.

Mental disorder may arise at any stage of the menopause. In many cases it has occurred about a year after the cessation, but the great variation in the time of the appearance of the latter, and the difficulty of obtaining accurate information, both as to the limits of the change in individual cases and the time of the first symptoms of mental trouble, leave this point also unsettled.

Sudden cessation of menstrual periods.

Sudden cessation has not been, in our experience, attended with serious mental or other derangement, with the single exception above instanced. The current belief in the dangers of sudden cessation is probably due to the fact that serious complications have arisen, in exceptional cases, at this time, but from the operation of other causes.

"Male climacteric."

There is no climacteric period in man, unless the years in the neighborhood of the age of sixty be considered critical ones. Men often break down in health at this time, and when the change is mental, as is not infrequently the case, it takes the form of melancholia or hypochondria. This "period" is very variable, both as to time of appearance and duration. While the change of life in women does not by any means imply, necessarily, incipient old age, this supposed critical epoch in men, on the other hand, attended as it is apt to be with the appearance of diseases of body and mind, is merely the signal that these powers are waning and that senility is at hand. In short, there must be some time for the system to break down, and its occurrence at this age has led to the adoption, by some, of the somewhat fanciful term, "the male climacteric."

Pathology.

The liability of the occurrence of mental disease at the change of life, as at puberty, although to a less extent, is due to the peculiar susceptibility of the nervous system existing at this period. The condition of nervous irritability attending ovarian changes at this time does not depend upon increased or deficient blood-supply, or upon a change in the quality of the nutritive material. The conditions of cerebral anæmia or hyperæmia, as well as of blood-poisoning by supposed retention of material which should have been eliminated by the menstrual flow, are either rarely present or may be accounted for on other and more probable grounds. The most rational explanation of the changed nervous condition of the period lies in the reflex influence of the ovarian changes upon the cerebral functions, through the medium of the nervous supply. In this way, it would appear, the nervous susceptibility is produced which allows ordinarily slight causes to result in disordered mental and nervous action.

Prognosis.

The prognosis depends largely upon the amount of hereditary neuropathic taint, and of previous mental disorder in the individual; but, as a rule, it is decidedly favorable in the uncomplicated cases.* Here, again, we see the comparative harmlessness of a local physiological change as a cause of permanent mental disease. This law, if such it may be called, is also exemplified in the case of puerperal insanity, which, it is well known, is one of the most favorable forms of mental disorder.

In patients whose previous attacks have only occurred during the puerperal state it is safe to conclude, owing to the permanent stopping of the uterine action and consequent loss of morbid stimulus from the reproductive organs, that insanity is not likely to recur after the menopause.

Frequency.

As to the frequency of this form of insanity few statistics are available, for the reasons already mentioned. Merson finds, out of 333 cases of insanity occurring in women between the fortieth and fifty-fourth year, 147 in whom the attack was referable to the change of life. In a table by Tilt is a list of 1,261 cerebral complications in 500 women at the climacteric. Insanity comprises but sixteen of these states.

Duration.

The duration is, as a rule, somewhat longer than that of other forms, owing to the protracted nature of the physiological change underlying it, the length of the climacteric period being often a question of years. We should, therefore, be less surprised to find no evidence of improvement under a year than in other cases of insanity which terminate favorably. Short attacks of hereditary insanity in an individual may, however, be grouped together at this period, with months of lucidity intervening, only to cease recurring at the cessation of menstruation.

Treatment.

The insanity of this period is, in many cases, more amenable to change of surroundings than are other forms of mental disorder. Removal from home to quiet and cheerful quarters, before the antipathies or hypochondriacal fancies bred by nervous irritability have become pronounced, is the best treatment. This step, however, is rarely effective unless combined with judicious management under medical supervision—not necessarily of the nature of asylum care. This is especially the case also with patients who have developed a want of energy, indecision, morbid fears; who have become possibly capricious or apathetic—in short, the mixed cases with hypochondriacal or hysterical and melancholic tendencies. Such patients as these soon contract habits of self-neglect and indolence. They sleep by day and lie awake at night, avoid seeing their friends, and eat insufficiently. Medicine is powerless to help such cases. Another will must be substituted for the patient's, to supply the strong guiding influence that is in abeyance. Travel, when advisable, should be recommended very early in the disease; the patient should be accompanied by a congenial and judicious companion; a quiet route should be taken, and haste discouraged. When, however, uncomplicated and pronounced symptoms of melancholia have become established in this and other forms of insanity, travel is harmful, as it bewilders rather than pleasurably distracts the patient. Instead of obtaining the rest for brain and body so necessary at this stage, the disquiet and insomnia are increased, new delusions are engendered by the new scenes and experiences, and possibly an attack of melancholic frenzy may be precipitated.

But home treatment is often the only course open; in that case a quiet but not uneventful life must be secured for the patient. Regular habits as to meals, sleep, and

* Statistics of Sutherland and Merson place the number of recoveries at 40 and 44.7 per cent.

exercise must be, as far as possible, insisted upon by the medical adviser and carried out by a judicious nurse.

The power to control the patient's actions and to enforce her adoption of a proper mode of life is, under these conditions, necessarily very limited, and it is only when the eyes of the patient's family are open to the futility of their exertions, and the patient's caprice and irritability have become unendurable, that the patient's removal, a step up to that time considered impossible, is accomplished.

Should the mental state be less pronounced, taking the form of mental perversion of the nature of ill-temper, fits of ungovernable anger, or more scandalous conduct, it is well to avoid allowing the patient to be considered a case of confirmed insanity, as under well-directed management she may resume her natural rectitude of life after some months, or when the change of life has passed.

Henry R. Stedman.

[1] West Riding Asylum Medical Report, vol. iii. [2] Ibid., vol. vi.

INSANITY, EPILEPTIC. The inference is at once natural and correct that so grave a disease of the nervous system as epilepsy would, in a certain proportion of cases, be attended by those symptoms which we term insanity. Indeed, it is not beyond the bounds of truth to say that, of all cases of epilepsy commencing before or at puberty, there are very few which escape without some mental deterioration. This change is often in the direction of what may be termed the quality of the mind. The mental faculties are blunted, the finer sensibilities lose their edge, and the interdependence of the receptive, perceptive, moral, and other faculties of mind is "like sweet bells jangled, out of tune."

These conditions—for their manifestations are in manifold directions—seldom, unless associated with, or leading to, more marked mental disturbances, become classified under what is commonly termed insanity. They belong to what Clouston ("Clinical Lectures on Mental Diseases") calls "states of defective inhibition."

The proportion of insane epileptics to the general epileptic population cannot, with any degree of accuracy, be obtained, and no statistics on the subject have been published. The number of the insane whose condition is dependent upon or associated with epilepsy, as compared with the insane as a whole, can only be approximated by a study of asylum statistics.

Bucknill and Tuke ("A Manual of Psychological Medicine," fourth edition, p. 97, London, 1879) calculate epilepsy to be the cause in about six per cent. of the cases admitted to asylums. In this calculation care is taken to distinguish between epilepsy as a cause and as merely a complication.

Reynolds is of the opinion that at least one-third of those who suffer from epilepsy pass through life without mental disturbance. He is also of the opinion that the number of convulsions has no influence upon the degree of mental disturbance, if any results. In common with other writers, he concludes that rapidly recurring seizures are quite apt to produce mental impairment. Attacks of *petit mal* are as harmful to mental integrity as are open seizures, and this fact explains to some extent the cases which have been reported of maniacal seizures occurring without any antecedent or subsequent convulsion. In many of these reported instances it is more than probable that the vertiginous attack constituting the fit escaped, by reason of its brevity and the absence of convulsive movement, the notice of bystanders.

Clouston (*op. cit.*, p. 397) says that epileptic insanity occurs in relation to the fits in six different ways:

1. After them, which is the most common method, the mental state being subject to paroxysmal disturbances.

2. Before the fits; in these cases the mental disturbance is manifested by irritability, suspicion, impulsiveness, and restlessness. When the seizure occurs these symptoms usually give place to either active maniacal disturbance, or a condition of stupor which may gradually merge into mania, or pass into the condition present before the ante-epileptic state of excitement. A case will be cited in a subsequent portion of this article illustrative of this as well as other conditions.

3. Mental disturbance may occur in place of the anticipated convulsion. Hughlings Jackson is inclined to think that in supposed cases of this kind there is a transitory epileptic paroxysm. He says: "I believe there is in such cases during the paroxysm an internal discharge too slight to cause obvious external effects, but strong enough to put out of use for a time, more or less, the highest nervous centres. . . . The automatism in these cases is not, I think, ever epileptic, but post-epileptic" ("West Riding Asylum Medical Reports," 1875).

4. A slowly increasing failure of mental power, commencing not uncommonly with loss of memory, supervenes upon long-continued epilepsy, and terminates in dementia. Most insane epileptics tend to dementia, but in some it occurs, as above, without intercurrent active mental disturbance.

5. Occasionally, and usually at the climacteric period, insanity occurs, passing rapidly into a chronic form, which takes the place of the epileptic convulsions, which then cease.

6. In some cases of chronic insanity epilepsy commences and continues for the remainder of the patient's life, recurring periodically. This condition is seen more often in chronic dementia than in any other form. Echeverria expresses an opinion directly the contrary to this. He says (*American Journal of Insanity*, July, 1873, art. "Epileptic Insanity"): "I have, of course, frequently met with epileptiform convulsions as the epiphenomena of general paresis, melancholia, dementia, and acute mania, yet, I repeat it, that in no instance have I recognized the epileptic disease as following insanity." While the subject is worth much attention, especially in a medico-legal aspect, we cannot in the limits of this article enter into a discussion of its various aspects. Suffice it to say that we see no reasonable ground for doubting the possibility or the probability of such changes occurring concomitantly with the pathological processes of chronic insanity as shall result in true epilepsy.

Epileptic insanity manifests itself in a multitude of forms—melancholia, mania, and dementia, all may result from epilepsy. The melancholia usually partakes of a profound sense of self-debasement, associated at the same time with a degree of egotism which is frequently observed in epileptics.

The melancholic, while declaring that he is unworthy of attention, that he is condemned by God and despised by man, is not infrequently very tenacious of his supposed rights, and seems to take pleasure in being the subject of attention and discussion. Hypochondriasis is not an unusual associate of epileptic insanity, especially of the melancholic type. Clouston is of the opinion that suicidal attempts in epileptics are more commonly the result of hallucinations, voices commanding or suggesting the act (*op. cit.*, p. 406), rather than the outcome of great depression or a weariness of life. Dr. C. W. Pilgrim has reported at length a case (*American Journal of Insanity*, April, 1884) which came under the writer's observation. This patient, during a portion of the time he was under care, was very depressed, and not infrequently expressed a desire to kill himself, as he was not fit to live.

This case possesses many interesting features, and we take from Dr. Pilgrim's excellent clinical history some of its salient points. The patient first appears on the records of the State Lunatic Asylum, at Utica, at the age of twenty-six. Two years prior to admission he was badly beaten in a house of ill-fame, and thrown out of doors, where he nearly perished of cold. He had been for some time a man of dissolute habits. He was ill for some time, and for a long while after convalescence he sat in the house, moody, depressed, and listless, refusing to go out. He finally resumed his old habits, but so conducted himself that he was seen to be insane and committed to the asylum. He remained in the asylum fourteen months, and was subject to frequent paroxysms of violence, but no convulsions were then observed. Toward the close of his stay in the asylum these paroxysms were less marked; but he was indolent and irritable. He was removed by his friends while in this state. At the end

of five and a half years he was readmitted. He had been able in the interim to maintain himself fairly. About two months prior to his second admission he saw a sudden death in a saloon. Soon after this he became seclusive and controlled by depressing delusions and apprehensions that he would be in some way charged with the death. On the day of admission he was sullen and morose, manifested little apparent recollection of recent events, answered questions slowly. He was for some time after admission depressed, untidy in his habits, and suicidal, as related above. At the end of three months he was in a condition to do some work, and, though still depressed, had ceased to speak of his unworthiness, was apparently not suicidal. Four months after his admission, while at work in the garden, he had an epileptic convulsion. He had fifteen seizures within the next twenty-four hours. He then became comatose, and so remained for three days. From this state he gradually emerged, but never afterward reached the mental condition which he was in before the convulsions. This patient had his first attack of mental disturbance about nine years before his first open convulsion. He was never considered by his friends to have recovered from the effects of the beating and the exposure to cold. During his first residence in the asylum his condition was one of irritability, with paroxysms of violence, which was not inconsistent with, and in the light of subsequent events points to, epilepsy. At that time the condition was one apparently of masked epilepsy (l'épilepsie larvée). Two months after his first observed seizure he had another, though less severe. After the first convulsion a condition was observed which had not manifested itself before, the "echo sign." The following is a specimen of his conversation: "You want to keep keep me alive as long as you can, as long as you can. I've been here seven years, and I'll have to come here to the asylum, if I live fifty years, fifty years, one year after another. It don't cost me a cent, cent. . . . What's the use of being born, born? Man's got to die, die, die. You can't take anything with you, and what's the use of being born, born, born, I say? . . . I'm better, and I'm glad of it, thank God, God, God."

As he emerged from the epileptic attacks he was observed to be smiling, which was, after each seizure, the first sign of returning consciousness. After two or three hours he would suddenly burst into loud laughter, which he continued for some time. The laughter gradually subsided, and, after a period of incoherent talking, he became quiet. His convulsions occurred at intervals of about three months, with one exception. During the intermediate state the echo sign was quite frequently observed. For instance, on leaving the table, after satisfying an almost inordinate appetite, he would say: "I ain't had anything to eat, eat, in six months. You may not believe it, but it's God's truth, truth." His seizures always began in the morning, and the attendant in charge of the ward observed that they were always preceded by a night of wakefulness and constant talkativeness, during which he would repeat his words more than usual. On this account the attendant was able always to predict the occurrence of a seizure. Thirteen months after his second admission he died during an epileptic seizure. No autopsy was permitted.

The "echo sign," which has been referred to and illustrated in the above case, was considered by Romberg as an evidence of cerebral softening, but Echeverria regards it as the result of "perverted will," impaired or defective inhibition. The writer has observed it in several epileptics. One at present under his care, a case of chronic dementia with periods of mild excitement, manifests this peculiarity not infrequently. Its value is wholly in confirming a doubtful diagnosis, in which event its presence either in speech or writing should have some weight.

Epileptic melancholics refuse food for the same reason as do melancholics generally. They have no stomach; their bowels are grown up; they fear poison; they cannot pay for what they eat; they are unworthy. Refusal of food and medicine, however, is not confined to the melancholic among epileptics. Cases of mania with hallucinations not infrequently hear voices which command them not to eat, and occasionally in melancholia the refusal is because of some delusion of this character. One patient whose "aura" was always a sensation of something alive in his stomach, after a convulsion invariably developed the delusion that his food only went to feed the animal which he believed his stomach contained, and for three or four days during the attack of post-epileptic excitement it was necessary to feed him, as he proposed to abstain from food in order to get rid of the animal by starving it. Another patient believed that he went to heaven after each convulsion and was fed with sacred food, and refused for that reason to partake of what was prepared for him. This patient's period of "unconsciousness," as it has been unfortunately termed, frequently lasted several days, and it usually became necessary to feed him by means of a tube, though occasionally he took food under protest. His usual remark on occasions when it became necessary to feed him, was: "I beg you not to touch me. My body is sacred. You will instantly be struck dead. I do not desire that you should bring such punishment upon yourself." During the interval between his seizures, which were sometimes accompanied by most furious mania, he was quiet, affable, but somewhat demented, and very much given to "religiosity." His time was divided between discussions upon religion, with expressions of great pleasure in religious exercises, and telling obscene stories. Epileptic mania forms the *bête noir* of the asylum physician. No other cases give him so much anxiety, none need so much watchful care, and none are so hopeless. In dealing with patients of this class he feels that he is handling an infernal machine, liable at any moment to an explosion, with homicidal or suicidal attempts, and a paroxysm of mania so fierce that it can be compared with nothing.

In view of the paroxysms of furor indulged in by these patients, it is not surprising that they were at one time believed to be the subjects of demoniacal possession. No other form of insanity is at all comparable to the bodily and mental perturbation observed in these cases. Maudsley ("Pathology of the Mind") says: "Most maniacs yield something to the show of authority when it is great enough, or evince a transient appreciation of what is said to them, but the epileptic maniac takes not the least notice of remonstrance, entreaty, or control; he yells and shrieks, knocks his body about violently, rushes furiously, strikes whatsoever or whomsoever is in his way, destroys blindly —is in truth sometimes a mere embodied fury; and when he comes to himself he is not conscious, or has only the haziest memory, of what he has done."

The paroxysm is usually of short duration, but it may last for days. It usually passes into a stage of stupor, sometimes extremely profound. Not all attacks of mania are of this active type. Many are of a subacute form, easily disturbed, controlled by delusions or hallucinations, or both, and liable to be excited by very slight causes. Many of these cases have fixed delusions of persecution; some believe that attempts have been made to poison them, others that they are subject to some obscure influence which causes either mental or physical discomfort. These delusions render such cases positively dangerous, as they often attach them to those about them—physicians, nurses, or fellow-patients—and not infrequently meditate and attempt revenge.

At this point a few words may be permitted concerning premeditation in the insane, and among the epileptic insane in particular. A not uncommon opinion prevails that an act, to be an insane act, must not possess the element of premeditation. Some of the worst acts committed by the insane are not only premeditated but deliberately planned. The writer has in mind a man with positive delusions, one who believed himself to be the archangel Michael, who received messages from God, and had other hallucinations; who, having determined to shoot an individual who, he believed, had attempted to poison him in some obscure way, made deliberate preparations for the act, and as deliberately refrained from committing it, because of a fear of injuring the bystanders, taking another opportunity to accomplish the deed

This man was not an epileptic. Echeverria (*Journal of Mental Science*, April, 1885, article "On Epileptic Violence") considers the following propositions, whether:

First, the mental derangement attending the epileptic attacks precludes the existence of animosity in any post-epileptic act of violence.

Second, if it is true that in the most clearly marked cases of epileptic mania there is generally an entire absence of motive or cause of anger. After bringing to the subject a thoroughness of analysis and a repleteness of illustration, drawn as well from his own extended experience as from the published observations of others, the author says: "There is no essential difference between the automatic sudden impulses which occur after an ordinary fit of epilepsy, and those committed by an epileptic lunatic during a frantic paroxysm. In either case the psychical condition that underlies the act is the same; in both instances the violence is automatic. Sudden impulsive acts, related to the psychical manifestations of epilepsy, very often evince in their automatic execution a coherent planned purpose, and a deliberation which can be disclosed even in the coördinate intellectual operations during the development of the fit, and in those instances that might, at first glance, appear motiveless; while the outburst or unconscious violence is again by no means so abrupt and instantaneous as to render, as hitherto generally thought, deliberation impossible."

The following case is illustrative of one phase of the propositions propounded above.

S. L——, aged eighteen, came under the writer's care as a patient in the State Lunatic Asylum at Utica; her mother had been insane, and was brought to the asylum while pregnant. She went home to be delivered, and the child is the subject of this note. As a child she was irritable, peevish, and wilful; at the age of eight epilepsy manifested itself, and gradual mental deterioration commenced. When admitted to the asylum, after a series of epileptic seizures, she was in a state of stupor, was thin and chlorotic; her menstruation was irregular, and she was said to be more disturbed during the menstrual flow. Under treatment she improved physically, and became active mentally. She was given to fancy-work, and occupied some of her time sewing and doing light work. She was of an erotic disposition, and, during the delirium which immediately followed her seizures, was exceedingly obscene, attempted to denude herself, and indulged in immodest and indecent gestures. Usually after convulsions she passed into a state of active mania; but occasionally this gave place to a mild degree of excitement, during which she was vivacious, active, and extremely mischievous; her mischief was usually directed toward some attendant or patient who had been unfortunate enough, *before the convulsion*, to incur her displeasure. Her favorite pastime was to creep up quietly behind her intended victim, and, seizing her by the hair, pull until her hands were forcibly released. At times she did not content herself with such simple acts of revenge, but seized upon the first weapon at hand, and used it with vigor. In this manner she nearly succeeded in committing a homicide on one occasion. She pleasantly asked one of her nurses to be permitted to pass into an adjoining room to obtain some water from the cooler. This nurse had aroused the patient's anger by not complying with a request for some finery in dress, with which she desired to decorate herself. The nurse permitted her to pass into the room, and followed to watch her, but her attention was distracted by some other matter, and while it was thus distracted the patient seized a large dinner-bell standing near the cooler, and struck the nurse a severe blow upon the head, knocking her down, and repeated the assault after she had fallen. The nurse's cries and the ringing of the bell used as the weapon, summoned assistance before serious harm resulted, but the patient, who passed into a state of maniacal fury, declared her intention to have killed the nurse.

Attacks of mental excitement, occasionally of depression, with undefined but harassing presentiments of approaching evil, fear of death, etc., sometimes, as in the second class of cases mentioned by Clouston, lead up to the culminating point of an epileptic convulsion. This was the case in a patient of the writer, a nurse-maid, who, after rapidly recurring convulsions, became violently insane, necessitating her confinement in an asylum. After being for some time under observation, it was noticed that her seizures and attacks of mania which followed were preceded by periods, varying from a day or two to a week, during which her condition was as follows: She was pale, lips blanched, pupils dilated, pulse rapid and compressible. From being companionable and sociable with her fellow-patients, she secluded herself; she refused to talk, answering questions in monosyllables. She apprehended death, and was constant in her religious duties; as the time for the seizures approached she became irritable and talkative, walked up and down the ward, scolding and demanding her discharge. Her attacks, which were nocturnal, were followed by loud singing and shouting, and incoherent raving upon religious topics. She had hallucinations of sight and hearing. At times she declined food, and declared that the Virgin came to her room and fed her. As the post-epileptic excitement went off she became semi-cataleptic, from which condition she passed into sleep, and awoke with some mental confusion, but quiet. She had no recollection of any unusual act on her part, either before or after the convulsion, beyond a vague remembrance of being excited.

Echeverria, whose investigations in the field of epileptic insanity have resulted in several valuable and suggestive contributions to medical literature, divides cases of epileptic mental disturbance into three classes, viz., intermittent, remittent, and continuous. The first class was characterized by cases in which the mental disturbance was, as its name indicates, paroxysmal, occurring between intervals more or less prolonged of apparent sanity.

The second class comprised cases of continuous mental disturbance, with periodic outbursts; and the third embraced those cases in which the mental disturbance was continuous and not influenced by the attack. This would include the cases of dementia, which in asylums is the largest class of epileptic cases. Echeverria ascribes to nocturnal attacks, and to the conditions described by Trousseau ("Lectures on Clinical Medicine") as epileptic vertigo, the most serious mental effects, and is of the opinion that they are more frequently productive of mental disturbance than the violent convulsions. These conclusions are reached after an analysis of 207 cases of unquestionable epileptic insanity.

Hallucinations of the senses form in epileptic insanity a most important element, leading, as they so often do, to deeds of violence. Of the 207 cases referred to above, eighty-six per cent. had hallucinations, sixty-two per cent. had hallucinations of hearing, forty-two of sight and hearing, and six of smell.

Seventy per cent. had disturbances of general sensibility, anæsthesia, hyperæsthesia, etc.

The rôle played by hallucinations in the development of violent assaults will be illustrated by cases referred to in the following remarks.

Of 783 epileptics examined by Echeverria (*Journal of Mental Science*, January, 1879, art. "Nocturnal Epilepsy," etc.), 111 had nocturnal attacks, and of these seventy-five per cent. had, in consequence, unmistakable mental disorders of a more or less permanent nature.

Of the whole number of cases (207) referred to in the preceding paragraph, over twenty-nine per cent. had nocturnal seizures.

No consideration of epileptic insanity would be complete without reference to certain phases of mental disturbance recognized long ago, but first clearly set forth in their importance, in a clinical as well as medico-legal point of view, by Echeverria (*American Journal of Insanity*, July, 1873, art. "Epileptic Insanity"). We refer to what the author first quoted, and others, before and after, have termed epileptic unconsciousness, but which in all of its relations is better defined by the term "mental automatism," used by Hughlings Jackson ("West Riding Asylum Medical Reports," 1875).

From time immemorial it has been known that epileptics were, after the seizure, given to periods of violence, that they performed complicated acts, and with apparent purpose. The following, translated by Echeverria from Josat ("Recherches historiques sur l'Épilepsie," 1856), who copies it from Euripedes and Seneca, exhibits a very early and accurate delineation of epileptic violence and automatism. "One day, as Hercules was offering a sacrifice to Jupiter, he suddenly stopped, rolling his eyes bloodshot in a hideous manner, the saliva ran down his beard, his smile was convulsive and strained, and laying aside his garments, he became very much agitated. They thought he had returned to his senses, when he suddenly rushed to his weapons, ran after his father, his own children, and everybody, till finally he slew his wife and children. He was about slaying his father when Pallas appeared and checked him, throwing him on the ground. Then he quickly fell into a profound sleep. As he awoke the sight of all the slain around him terrified him, and his despair became extreme when the news was broken to him that he alone was the author of all this slaughter."

It is not to be inferred that these states of epileptic unconsciousness or automatism are always characterized by acts of violence. The case so often quoted from Trousseau, of the judge who left the tribunal, and, passing into an adjoining room, urinated in the corner, and then returned to his seat with no subsequent recollection of having left it, belongs as much to this class as does the man who commits the most overt act while in the state of unconsciousness. Gowers ("Epilepsy and other Chronic Convulsive Diseases," London, 1881) says: "It is indeed often not easy to convince observers that these actions are not deliberately volitional and intentional, so apparently conscious are the patients; but consciousness is in an abnormal state, for the memory retains no recollection of these actions." To this last assertion some exception must be made. While these cases frequently have no recollection of any unusual behavior on their part, they sometimes have a vague impression of having done something out of the ordinary way, and occasionally they have some idea, as of a dream, of what has passed.

Gowers describes some of the acts which may be undertaken during this automatic period: "A very common action is that of undressing, and it occasionally has serious practical inconveniences. One of my patients, for instance, was in the habit of giving lessons in music, and had to relinquish his occupation because, while giving a lesson to a young lady, after an attack so slight as to be unnoticed by his pupil, he suddenly began to take off his clothes. The act of undressing is, perhaps, the result of a sensation of illness which suggests going to bed. Another occasional action which may be the result of the same suggestion, is an attempt to walk up a flight of stairs which the patient thinks is before him. Thus one man, who had his fit in a kitchen, thought that the shelves of a dresser were stairs and tried to walk up them. Another patient had a slight fit at dinner, and immediately stepped on to the table and made movements as if going up-stairs. Usually, as in this instance, the action is a simple and natural one, only rendered equivocal by the surrounding circumstances. Another similar action is to put into the pocket anything that may be near, irrespective of its ownership. A young man who presented this symptom was a draper's assistant. He had minor attacks, consisting only in brief loss of consciousness, preceded by an olfactory aura—a nasty, indescribable smell in his nose and mouth, a sort of combination of smell and taste. After the attacks he constantly found in his pockets any object which had been near him when the attack came on, such as scissors, reels of cotton, etc. This patient had always a sensation of hunger after the attacks, and he occasionally only discovered that he had had a seizure by finding, to his surprise, that he was cutting bread and butter and eating it as fast as he could. It is a very common thing for patients in the hospital, after slight attacks, to go to other patients' lockers, take things out, and put them in their own pockets. One woman, whose general conduct suggested no suspicion of dishonesty, after an attack went to the locker of another patient, took out a purse, and pocketed it.

"Occasionally the actions performed are extremely complex. I have known, for instance, a carman, after an attack, to drive through the most crowded parts of London for an hour, without an accident, and retain no recollection of it afterward."

Unfortunately these acts of automatism are not always free from violence. A patient under the writer's observation for some years, subject to attacks of *petit mal*, in one of these periods of unconscious action, while engaged in her household duties, put her infant child in the fire. She was tried for the act and acquitted on the ground of insanity. The attacks, while under observation in the asylum to which she was committed, were always of a vertiginous character. She would be observed to grow suddenly pale, her features assumed a staring expression, eyes fixed, and pupils dilated.

Sometimes she sat down for a moment, at other times, pausing but a moment in what she was doing, she would proceed, as soon as the attack passed, with her occupation or conversation, with no knowledge of any interruption. As time progressed she became somewhat demented.

A clergyman, who also came under observation after a trial for larceny, at which he was acquitted on the ground of insanity, had, in brief, the following history: At the time of admission he was fifty years of age. There was no neurotic heredity. One brother died suddenly from an accident, another was executed for murder. While at college he had an attack of typhoid fever, which left him quite debilitated. During the fever he was very delirious, and part of the time required restraint to prevent him doing violence to his friends. For several years after assuming the duties of a clergyman nothing unusual was observed in his character or health, until eleven years prior to his admission to the asylum, when he had an epileptic convulsion while attending a public meeting of clergymen. In a year he had another. The second convulsion is thus described by his wife. He arose one morning. His limbs were rigid and his eyes rolled very far back in his head, and saliva ran from his mouth. He fell on the bed and became of a livid color. At another occasion he had, at a watering place, a series of convulsions. His wife detailed quite circumstantially attacks of *petit mal* which her husband had in the church, at home, and on the street. One of the most important points in this history, which she and others gave, was the steadily increasing irascibility manifested by the patient. To such an extent was this carried, that he found it necessary to make frequent changes, seldom remaining in charge of a church more than one or two years. About four years before his trial his wife noticed that he purchased many unnecessary, and, for his use, worthless articles. He ordered sent home large quantities of tea and coffee, which articles were not used in the family; bought candy in large quantities, but never used it; he purchased knives and forks by the dozen, and, placing them away, was unable to recall the transaction. Shortly before his arrest he went into a drug store and took from the top of a showcase some bottles of perfumery. The act for which he was arrested was committed in a town near his residence, and occurred on Monday, after a sleepless night following his duties in church the day before.

The act consisted in taking a vase from the counter of a fancy-goods store, and was committed openly. When questioned by his wife, who, it seems, had visited this same store with him shortly previous to the act under consideration, and who had declined his offer to purchase a similar vase for her, he said "he thought he must have it." On asking what he intended to do with it, he again replied, "Well, I thought I must have it." His state on admission was one of mental enfeeblement. He had the appearance of an epileptic, and he seemed dull and indifferent to his position, due, perhaps, to the fact that he had, two days previously, an attack of *petit mal*. It was not until two weeks after his reception at the asylum that he said anything to show that he appreciated the position in which he had been, and was at the time. He then became

quite emotional, and for two days he spent much time in tears. Two months after admission he stated, one morning at the medical visit, that he had found himself lying on the floor at night, and had no recollection of getting out of bed. He had some headache and slight sub-conjunctival ecchymoses, but no bruises upon his body. Two days following the above statement, he received a call from his wife, to whom he stated that one of the physicians had visited his room, at about two in the morning, with a light, and said to him, "You will never get out of this place alive," and then vanished. This gentleman had also hallucinations of hearing. He evinced great timidity on one occasion concerning a fellow-patient, who, he imagined, had said to him that he had a commission to kill him. On another occasion he desired to be excused from walking out, having, as he believed, heard the attendants and others plotting to throw him under a railroad train. This patient gradually became demented, and at the end of two years a motion was made in court permitting his wife to assume his care outside of the asylum.

A point of diagnostic value in this case was the hallucination of a bright light. Echeverria says that the visions of the nocturnal epileptic are of a red color, or surrounded by flames. Reference has been made to the ecchymosis beneath the conjunctiva. Petechiæ, often very minute, are one of the strongest confirmatory evidences of epileptic seizures. Trousseau lays considerable stress upon them, and quotes from Van Swieten, who called attention to their presence. In the case above narrated they were noticed on occasions about the face, and were the only evidence, at times, of the recent recurrence of a nocturnal seizure.

The hallucinations that occur in these cases are not uncommonly the direct incentive to some sudden act of violence. A patient recently sitting quietly near the writer, who was conversing with another patient, suddenly started from his chair, and, with an expression of fierce anger, struck at him, and almost immediately fell in convulsions. On recovering he had no recollection of the event, and the hallucination or delusion which led to it could not be ascertained. In another and very similar instance, however, the patient exclaimed, "He was about to hit me!" and gazed about in an anxious and frightened manner as if to discover his supposed assailant. In an article on "Homicide in Insanity," Dr. John P. Gray reports (*American Journal of Insanity*, vol. xiv., 1857) the case of a man who had on several occasions, while sitting alone in his room, distinct sensations as of some one striking him a blow on the head, when he would at once commence a contest with his enemies. Echeverria, in his article on "Violence and Unconscious States of Epileptics" (*American Journal of Insanity*, April, 1873), narrates several remarkable examples of the long duration of the periods of automatism, and the complicated acts which may be performed during their continuance. In some respects the following case, quoted by the same author, while not unique, is strikingly illustrative of the points under consideration: "An epileptic who had been fourteen months in the State Asylum at Utica, was subject to maniacal attacks, and for some time had been in the convalescent ward. One evening, when about to retire, he refused to take his medicine, alleging that it was poison, and looking at his watch, said, "I have only half an hour to live." He refused also to undress and go to bed. Dr. J. B. Andrews (then the attending physician, to whom I am indebted for these details) being called, found him sitting by the bed with his watch in his hand. He instantly accused the doctor of poisoning him, and persisted in his assertions, and finally seized a chair and struck at one of the attendants who was sitting in the ward. He became boisterous, and when asked to go to another ward he vehemently declared he would not go. Several attendants were called, and on seeing them he calmly and deliberately acknowledged that it was a useless attempt to oppose so many, but that, on submitting himself against his will to their superior strength, he would have to be carried, which was done. He continued more or less excitable through the night, but appeared quiet the next morning. The next day, when the doctor was in the ward, the patient referred with regret to the occurrence of the previous evening, and apologized for his conduct, then started down the ward and fell in a convulsive fit, fracturing the right ulnar bone. For three succeeding days he was quiet but moody, even made some pertinent suggestions as to the dressing of the fracture, took his medicine and food regularly, and seemed to appreciate his surroundings and condition. On the fourth morning, upon awakening, without any noticeable change or recurrence of fits, he inquired why his arm was bandaged; the attendant told him because it was broken. When the physicians came in the ward he asked them when and how his arm had been broken, declaring that he had no recollection whatever of any of the events from the first evening of excitement preceding the convulsive fit to that date, and was thereafter never able to recall any of the incidents happening during those four days" ("Criminal Responsibility of Epileptics," *American Journal of Insanity*, January, 1873).

Falret ("De l'État Mental des Epileptiques," 1861), discussing similar cases, says: "We think, therefore, that, generally speaking, in a doubtful case we ought to incline the scale in favor of validity of action whenever the point at issue is a civil case; whereas in criminal cases it should be inclined in favor of irresponsibility." This rule is a good one to follow when the proceedings in the matter at issue have been undertaken calmly, have been such as might be expected in the ordinary conduct of affairs, and were not directly in connection with a convulsion and observable mental perturbation. These principles governed an opinion given by the writer, adverse to the testamentary capacity of an "epileptic" aged eighty, whose will was made under the following circumstances: After a convulsive seizure early in the morning, he had, in the irritable state which followed, had a quarrel with a favorite daughter residing at home. He, immediately following breakfast, drove to his attorney's office and in great excitement desired to make a will at once. The attorney, recognizing his condition, declined to draw the will, at which his client became more excited and had a convulsion in the attorney's office. After recovering somewhat he visited another attorney, who drew a will at his dictation, which practically disinherited the daughter. Returning home, his irritability had subsided, he said nothing of the will, and nothing was known of it until his death. In the meantime the cordial relations with his daughter had been re-established, and he showed his affection for her in many ways, making her presents of money, and at one time of a mortgage held against her husband. The will, so unjust to the daughter, was sustained by the surrogate, and largely, we believe, because an attempt was made to prove general and continuous insanity, rather than a state of mental disturbance and automatism, into which had been carried the irritation of the breakfast-table quarrel, giving direction to acts undertaken during its continuance.

From the foregoing, and from the teachings of well-known authorities and authentic cases, it may be concluded that following attacks of epilepsy, more frequently *petit mal*, and not uncommonly nocturnal epilepsy, the subject of the attack may pass through a period varying from a few moments to hours, and even days, during which the inhibitory power of the will is in abeyance, the individual moving about as usual, perhaps, or suddenly starting upon a purposeless journey, or committing some act of violence, with no recollection of the nature of the past events, when consciousness has resumed her full sway, beyond what may be gained by the immediate surroundings at the time of returning consciousness. Whether attacks of this character, in connection with which no seizure is known to occur, be termed masked or larvated epilepsy, or cerebral epilepsy, is of little importance; they invariably are found to occur in patients with an epileptic history, or if none exists, in cases which, if kept sufficiently long under observation, will develop symptoms of epilepsy in some form.

Attention may at this point be directed to the influence of sleep in warding off attacks of mental disturbance after

epileptic convulsions. In attacks of *grand mal* followed by sleep mental disturbance seldom follows, and so also with frequently recurring attacks of *petit mal*; if a series of these be followed by sleep, the patient usually awakens quiet and in no worse mental state than immediately preceding the seizures. Without sleep, either of these conditions results in mental confusion—stupor or actual mania.

The dementia of epilepsy is of all grades, from simple weakened intelligence to profound fatuity. When this last stage is reached there accompanies it a change in the features which renders the victim frequently but a caricature upon human nature, hideous in aspect. The eyes have a vacant, listless look, the lips are thick, the features are swollen and distorted, the whole aspect of the face is changed, and all resemblance to its former appearance is lost. One of the marked features of epileptic insanity is the religious tendencies observed in its victims. They are extremely devotional, delight to talk upon religious matters, and, with egotistic complacence, regard themselves as the special subjects of the Lord's care. A case now in the writer's care almost invariably answers the usual inquiries about his health with the remark: "I am as well as I want to be. All I want is to have God take me when He is ready. I don't want anything done for me. God takes care of me." This patient is extremely punctilious in his religious observances, and is very irritable if in any way interrupted. He masturbates and delights to talk upon sexual subjects. It is not at all uncommon to find an incongruous association of religion, or rather religious profession, profanity, untruthfulness, and petty thieving in these cases.

Of treatment, little can be said beyond what has been laid down in the article on Epilepsy. In cutting short a paroxysm of epileptic violence, chloral, either alone or in combination with sodium bromide, has been found of great value. Attention to diet and digestion, and to a proper amount of exercise in the open air, will sometimes be of greater value than any direct application of drugs. The removal from home, or from business and other cares, regular hours, and the withdrawal of stimulating drink or food, will not infrequently, before other measures are adopted, result in a subsidence of active mental disturbance and a diminution in the number of seizures. These cases require, as has been intimated, constant care and constant watchfulness. In England the Lunacy Commissioners require special provision in asylums for night care of epileptics. To prevent death from smothering by the turning of the patient's face into a pillow during a fit, special pillows of hair with loosely woven covers have been suggested, but nothing can be relied upon save the constant presence of a night attendant.

The writer has had some success in the treatment of incipient mental disturbance from epilepsy from the use of a seton in the neck. The special indications that arise in attacks of mania or melancholia are to be met by special measures. Patients subject to hallucinations of sight or hearing are to be looked upon as specially dangerous. The statement of Delasiauve is *à propos*: "It is certain that on passing an epileptic we elbow one who might be an assassin, and that epilepsy, through the delusional ideas it originates, furnishes a considerable share of the crimes ascribed to mental alienation" (*Journal de Médecine Mentale*, tm. ix., p. 245). The sight of a weapon of offence not infrequently, in paroxysmal cases, is suggestive of its use, and great care should therefore be exercised to prevent knives, razors, etc., being placed convenient of access to epileptics subject to mental attacks. Suicide must be guarded against, not only in the melancholic cases of this character, but in those who are given to impulsive acts, and those who receive directions through the medium of hallucinations. In cases of melancholia nutrition must be insured—*e.g.*, tonics, nutritious food, cod-liver oil, etc., are required—and, if necessary, artificial feeding should be resorted to without delay or hesitation.

The pathology of epileptic insanity is intimately associated with the general pathology of epilepsy, and any discussion of its special features, as far as known, would involve a discussion of the whole subject; the reader is therefore referred to the article Epilepsy.

Edward N. Brush.

INSANITY, FEIGNED. Almost the earliest historical allusions to insanity tell of attempts to simulate it to avoid responsibility for action. King David feigned madness when "sore afraid of Achish, king of Gath," and Ulysses did the same to escape the Trojan war.

The total number of feigners is not very large, however, because nothing less than the prospect of extremely severe punishment or injury is likely to tempt one to take the consequences that follow the public recognition of mental unsoundness. Insanity is most frequently feigned by convicts in prisons, who wish to be transferred to asylums for the insane, where life is more comfortable and the chance of escape better; and by those of the criminal class, charged with crime, who in previous confinement have had opportunity to observe the insane among their fellow-prisoners and to learn various malingering artifices.

First offenders do not often feign insanity, except when accused of very grave crimes, though Krafft-Ebing says it is sometimes done on the Continent of Europe to escape unhappy marriage ties. It is also true that very few of those who make the attempt are sufficiently successful to deceive, even temporarily, a physician who is qualified to give an opinion concerning a case of insanity.

The inherent difficulty of their task is enormous, as appears when one recalls that insanity is a disease, is varied in its forms, and that each form has its definite course and grouping of symptoms, and, therefore, requires an unremitting consistency of speech, conduct, and even facial expression and attitude.

If an actor, for half an hour upon the stage, with all its accessories to aid him, can play the madman successfully in a single, carefully studied part, we deem it wonderful, but the feigner must improvise his part and play continuously, in open daylight, without accessories.

For detecting the feigner the physician must rely on the accuracy of his own knowledge of the symptoms of the various forms of mental disease. He must know the genuine in order to detect the spurious. There is no touchstone which will decide for the non-expert, and even the expert must be ready to confess his inability without full opportunity for observation.

A most frequent error of feigners is overdoing the matter. Ulysses yoked a horse and bull together, ploughed the sea-shore, and sowed salt instead of corn; and the usual attempt is to appear as unreasonable as possible, and to imitate those symptoms of mental disease which most attract and impress the ordinary casual observer, and, to secure conviction of the sceptical, the feigner exhibits as many of these as possible, and associates them in a manner unknown in genuine disease.

The diverse symptoms of acute mania and profound dementia are often thus associated. The keen-eyed prisoner, whose glance follows you furtively in every movement about his cell, and whose quick and ready manner of response shows an intelligent appreciation of the questions put, will answer, "I don't know," or with absurd incorrectness, when asked his name, age, residence, or occupation. He may also pretend ignorance of the use of ordinary articles of dress, or eat with the wrong end of the spoon, not realizing that these semi-automatic acts usually continue to be performed properly by patients much demented.

With absurd incongruity he often attempts to combine this profound dementia with the mental exaltation, the motor activity, the variety of delusions and hallucinations, and the incoherence of speech which characterize acute mania.

He sings, shouts, denudes himself, tears clothing, destroys furniture, shows violence to himself or those about him, is indecent in speech and conduct, smears himself with fæces or urine, possibly has hallucinations of sight or hearing, and talks of his food being poisoned or some similar delusion. This is, more or less accurately, the picture of the ordinary unskilled feigner, and his

sure detection is seldom difficult if the physician has patience to wait; as, aside from the inconsistency of the symptoms, and if the mimicry were perfect, continued acting of this character is absolutely beyond human endurance.

But sometimes the feigners have had better opportunities for observing the insane, most often from having been prisoners in jails where they were confined, and are in some degree experts. If they have learned to avoid the dramatic symptoms which present the greatest difficulties, detection is much less easy. They may preserve composure of manner and speech, and only claim fixed delusions that they have learned from genuine cases of insanity, or tell of hallucinations of sight, or more often of "hearing voices," as hallucinations of hearing are not infrequent among prisoners, and therefore more likely to be familiar to them.

The only proper course for the expert in such cases is to recognize the difficulty of his task, and not give an opinion without full and repeated opportunity for examination. And here accurate knowledge of the working of the insane mind in the various forms of the disease, and of the previous history of the person, will stand the physician in particularly good stead, since the entire personality of the individual must be studied, as to its consistency with the suspected delusions and with his previous life. The value of a complete previous history of a suspected feigner is always very great, and the examiner must not fail to exhaust every source of information as to inherited peculiarities, mental capacity, character, disposition, and habits. Unfortunately, the result of such investigation, especially in medico-legal cases, is often very unsatisfactory, because those most familiar with the accused are as anxious to mislead as he is.

Though general physical symptoms may be of the greatest importance to the physician treating mental disease, they have little value in determining the existence of insanity, as changes of temperature, circulation, and respiration existing in the insane, more often than not, are caused by physical disorders not connected with the mental disease; and those forms of insanity likely to prove most perplexing to the examiner are not usually accompanied by any constant physical symptoms. Symptoms of progressive paresis, structural abnormalities, or gross lesion of the brain, and evidence of systemic disease of the nervous system, may have great value, and should be carefully sought.

Insanity associated with epilepsy, either the *grand* or *petit mal*, is not infrequently feigned by convicts, or offered as a legal defence by the counsel of those charged with crime.

The *grand mal* is usually the form attempted by convicts, and the bungling imitation of the convulsions usually exposes them, though some thieves carefully train themselves to feign epileptic convulsions for the purpose of attracting the attention of bystanders while confederates pick their pockets. These are rare in this country, but, in English thieve-parlance, are known as "dummy chuckers." One of them, shown the writer by Dr. Carlos Macdonald, superintendent of the asylum for insane criminals at Auburn, N. Y., had deceived many experts.

He imitated with astonishing fidelity the genuine epileptic convulsion. There was the characteristic cry, the tonic and clonic convulsions, the arrested and then stertorous breathing; froth tinged with blood (previously prepared by the use of soap and a penknife) flowing from the mouth, and the final somnolence. A variety of scars gave his visage the well-known battered look of a confirmed epileptic, and the marks made by the penknife upon the tongue caused it to look as if frequently bitten in convulsions.

In the cases charged with crime who plead larvated epilepsy as a defence, only the experienced expert is competent to give an opinion; and he will need much acumen and skill as a cross-examiner to reach a conclusion satisfactory to himself, as the mental disorder claimed to have existed has disappeared, and he must often gain his information from very untrustworthy sources.

It may properly be remembered that the very striking cases of larvated epilepsy, in which the patient mingles among his fellows without attracting special attention by peculiar speech or conduct, though unconscious of his surroundings and practically an automaton, are rare, except as related by counsel in courts of law; but yet they do exist, and proof of a rational motive for an act does not exclude the possibility that it was performed in this automatic and irresponsible state, as it seems probable that thoughts most frequently projected in the brain during its normal activity become the most automatic, and therefore most likely to occupy it when in the epileptic trance.

There are also persons actually insane who feign insanity. This is usually done by cases with fixed delusions, from the same motives which influence the sane; but occasionally a lunatic will feign insanity to escape from dangers purely imaginary, as did a man treated by the writer, who entertained the insane delusion that the police were seeking to arrest him for a very serious crime. He therefore feigned acute mania, was incoherent in speech, entertained exalted delusions, showed marked excitement and violence in public, and wantonly destroyed property. He was adjudged insane because of the feigned symptoms and sent to a hospital, where attention was first called to his true condition by the inconsistency of the exalted and happy delusions he expressed with the appearance of abject terror which he could not conceal.

That insane persons accused of crimes sometimes feign insanity has long been recognized, and the examiner must remember that the discovery of *deceit* on the part of a suspected feigner is not proof of sanity.

The previous history is of unusual service in deciding these cases, as the genuine insanity of the lunatic who feigns is very rarely, if ever, of recent date or acute form.

William B. Goldsmith.

INSANITY FROM ARREST OF DEVELOPMENT; IDIOCY. The word idiot, by a curious change in its application, has come to have a meaning almost opposite to that which it originally possessed.

Looking at the idiot, as we now recognize the person to whom the term is applied, one would see nothing in him to suggest ἰδιώτης, the private individual, as distinguished from the man of public affairs of the Greeks. From being applied to the private person of any degree of education, the term came to be used to signify an unlettered individual, as the educated were those who conducted affairs of state, and finally the appellation was used to designate those alone who were supposed to be incapable of instruction.

The term idiocy has several synonyms which have, from time to time, been used by writers; the more important of these are: Amentia, Anoia et Apathia, Blödsinn, congenitale or angeboren; Démence innée, Dummheit, Fatuitas, Idianoia, Idiotisme, Imbécilité, Moria, Μείωσις, Stultitia, Stupiditas. The word was used until Esquirol first clearly applied it, in the present medical significance, in connection with both amentia and the terminal stage of chronic insanity, sometimes called the grave of reason, dementia. Reil, for instance, as quoted in Feuchtersleben ("Principles of Medical Psychology," Vienna, 1845; London, 1847), says: "Almost one-fourth part of the inmates of lunatic asylums are idiots who were formerly insane, and still bear about them the tincture of former disease." Though Feuchtersleben seems to have a fairly clear comprehension of idiocy, as will be shown by his definition, noted farther on, he does not correct the misapplication of the word "idiots" here made; and subsequently shows that he does not differentiate between idiocy and dementia when, on page 310, he says, quoting from Ideler: "The transition of these (other forms of mental disease) into idiocy is usually indicated by increasing corpulency, and by the regularity of the bodily functions previously disturbed by the violent paroxysms." A better picture of terminal dementia could hardly be drawn in as few words. This same misapplication of the term is made by Pinel, who, under idiotism, includes what is now recognized by writers on

psychological medicine as dementia. Esquirol was the first systematic writer who clearly distinguished between amentia and dementia, and who used the word *idiot* in its, at present, accepted signification. He defines an idiot as one whose "intellectual faculties are never manifested, or have never been developed sufficiently to enable the idiot to acquire such an amount of knowledge as persons of his own age, and placed in similar circumstances with himself, are capable of receiving." He very graphically distinguishes between idiocy and dementia, as follows: Of a case of dementia, he says, "He was a rich man who has become poor." "The idiot, on the contrary, has always been in a state of want and misery."

Seguin says of idiocy: "It incapacitates mostly the functions which give rise to the reflex, instinctive, and conscious phenomena of life; consequently the idiot moves, feels, understands, wills, but imperfectly; does nothing, thinks of nothing, cares for nothing (extreme cases); he is a minor legally irresponsible, isolated, without associations; a soul shut up in imperfect organs; an innocent." Ireland, in his excellent work ("Idiocy and Imbecility," London, 1877), defines idiocy as follows:

"Idiocy is mental deficiency or extreme stupidity, depending upon malnutrition or disease of the nervous centres, occurring either before birth or before the evolution of the mental faculties in childhood."

Feuchtersleben, whose work is quoted above, says: "Idiocy proceeds as a psychopathy, proximately from *anæsthesia*, weakness of attention, *amnesia*, and want of images. It represents, in some measure, an approximation of the human character to that of animals, and is characterized by an incapacity of judging, or even, in its higher degree, of contemplating."

The terms idiocy and imbecility are used by many writers synonymously, and they are so employed in this article; an imbecile being regarded as an idiot less profoundly affected. What has been said in the following applies alike to each.

Idiocy is usually associated with bodily deformities and malformations. There is, in many cases, a marked lack of co-ordination. The movements are irregular, the grasp is feeble and uncertain, and the tongue and lips give expression to rudely formed, harsh, frequently wholly unintelligible sounds when attempts to speak are made by those having sufficient intelligence to undertake the formation of words or sentences. Some of the malformations associated with idiocy will be referred to in the course of this article.

None of the statistics of idiocy thus far obtained are at all complete. The latest English statistics, the census of 1881, returns 32,717 (16,105 males, 16,612 females) persons, in England and Wales, as idiots and imbeciles, a proportion of 1 to 794 of the population. In commenting on these statistics, Dr. Shuttleworth, Medical Superintendent of the Royal Albert Asylum for Idiots, Lancaster, says: "Of these, no fewer than 9,183 were forty-five years of age and upward, of whom many so-called 'imbeciles' were probably the subjects of dementia."

On the other hand, parental reluctance to recognize mental defect in the case of young children is evidenced by the fact that the whole number of imbeciles and idiots "under five years of age is returned at 451 only; and it is probable that a considerable increment, estimated by the commissioners as at least one-fourth, should be added to the census returns, which would bring up the ratio at all ages to one in about six hundred and twenty of the population." In the United States the census of 1880 returns a population of 50,155,783, of whom 76,895 were enumerated as idiotic, a ratio of 1 to 652 of the population. Of these the native white population are accredited with 63,311, the foreign white with 4,007, and the colored races with 9,577; 45,309 were males, 31,586 females. These statistics are doubtless to some degree incorrect, but they probably approximate the truth.

As illustrative of the often misleading character of statistics upon subjects of this kind, it is only necessary to call attention to the fact that the United States census for 1870 returns but 24,395 idiots, of whom 22,766 were native-born. If these statistics were assumed to be correct, the census of 1880 would show an increase of over two hundred per cent.

European statistics show that the number of male idiots is larger than that of females. This difference is explained, in part at least, by the greater size of the male head at birth and its consequent greater liability to injury from forceps delivery, long exposure to pressure in the maternal parts, etc. The most prolific cause of idiocy is doubtless heredity, and in the variety known as cretinism it and the environment are almost the sole factors which need be taken into account in its production.

In the consideration of the heredity of idiocy, it need not necessarily be inferred that the idiot has an ancestry imbecile or idiotic. In many instances male idiots are agamous and the females sterile; nevertheless, numerous instances are on record, and the unwritten histories of almshouses and poor-relief-offices could furnish many more, of the fruitful union of idiots, either with idiots or with persons of normal intelligence. Haller, quoted by Ribot ("Heredity"), speaks of two noble families, among some of whose members idiocy was present for five generations.

The following table (on p. 90) is from an article by Dr. F. Norton Manning, Inspector-General of the Insane for New South Wales, entitled "A Contribution to the Study of Heredity" (*Australian Medical Gazette*, August, 1885). He says, introductory to the table: "Some time ago, I commenced an inquiry into the family and life history of the idiotic and imbecile patients in the Hospital for the Insane at Newcastle, turning my attention to the cases in which there were two or more of a family afflicted with mental weakness; cases which possess a peculiar interest, as more likely to be constitutional and congenital in origin than accidental. From 21 families, with a total of 82 children—48 males and 34 females—I found under care 50 idiot and imbecile children—29 males and 21 females. I have divided these into four groups. In the third group are 26 children—11 males and 15 females—all imbecile or idiotic, and belonging to 12 families, in which up to this time the total number of children is 44—25 males and 19 females. Unhappily, some of these families are still increasing, but so far we have 11 out of 25 males, and 15 out of 19 females, so far imbecile or idiotic as to need hospital care. Of the mental condition of the children not under care, I have no means of judging, but I have information that 4 are badly deformed—one is a dwarf and is being exhibited as such in a show, and three have supernumerary fingers and toes. In none of these 12 families, as far as I can learn, are the parents closely related, but in all there are insane relations more or less close, and in 5 of them there has been a veritable intermarriage of the disease, there being insanity on both sides. In these 5 families there are 18 children, and 12 of these are imbecile and idiotic, so that two-thirds of the total and every female are afflicted, and among them are to be found all the badly idiotic patients in this group. In the 7 families in which insanity has been traced only on one side, there are 26 children; of these 14 are imbecile, the proportion being one-half, and the females, as in the other cases, showing a larger proportion than the males."

The table of Dr. Manning naturally suggests the subject of consanguineous marriages and their influence in the production of idiocy. There exists a wide-spread, popular, and to some extent, a professional, opinion, that the marriage of cousins, or persons nearly related, is in many instances productive of idiocy and other degenerative conditions in the offspring.

Mr. Alfred Huth has made some elaborate inquiries into this subject, which are published in his work entitled "The Marriage of Near Kin." Of the statistics thus far published upon the subject, he says they "are, when not absolutely false, miserably misleading and defective." His views may be thus epitomized. Consanguineous marriages, by the mere fact of consanguinity, and irrespective of any inheritance, are not injurious to offspring.

Group	No.	Relationship of parents.	Number of children in family.	Number of imbecile or idiotic children.	Insane relations.	Remarks.
Group I.	1	Nothing known.	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Nothing known.	Imbecile only in slight degree.
Group I.	2	Nothing known.	2 (2 m.)	2 (2 m.)	Nothing known.	Imbecile only in slight degree.
Group I.	3	Nothing known.	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Nothing known.	Imbecile.
			6 (4 m. 2 f.)	6 (4 m. 2 f.)		
Group II.	4	None.	8 (3 m. 5 f.)	3 (2 m. 1 f.)	None as far as could be ascertained.	All badly imbecile. (Attributed by the mother to an accident during each of the three pregnancies.)
Group III.	5	None.	4 (2 m. 2 f.)	4 (2 m. 2 f.)	Insanity on both sides: Paternal grandmother and uncle, and maternal uncle.	Imbecile. All three insane relations were in Gladesville, one for sixteen and one for twenty-two years.
Group III.	6	None.	3 (1 m. 2 f.)	2 (2 f.)	Father insane, mother weakminded and epileptic.	Imbecile. Father a cripple, brother a dwarf.
Group III.	7	None.	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Father insane, mother weakminded.	Imbecile, slightly.
Group III.	8	None.	4 (3 m. 1 f.)	2 (1 m. 1 f.)	A paternal cousin, two maternal uncles, one maternal cousin.	Imbecile, badly.
Group III.	9	None.	5 (3 m. 2 f.)	2 (2 f.)	A paternal cousin, mother imbecile.	Imbecile, badly. Both sisters and three brothers have supernumerary fingers and toes; two of brothers are somewhat weakminded.
			18 (10 m. 8 f.)	12 (4 m. 8 f.)		
Group III.	10	None.	6 (4 m. 2 f.)	2 (2 m.)	Insanity on one side only: Maternal grandfather.	Imbecile.
Group III.	11	None.	3 (2 m. 1 f.)	2 (1 m. 1 f.)	Mother.	One idiotic, one imbecile, mother in Gladesville.
Group III.	12	None.	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Mother.	Imbecile.
Group III.	13	None.	3 (2 m. 1 f.)	2 (1 m. 1 f.)	Father.	Imbecile.
Group III.	14	None.	5 (3 m. 2 f.)	2 (2 f.)	Mother.	Idiotic.
Group III.	15	None.	5 (3 m. 2 f.)	2 (2 f.)	Maternal grandmother, and six maternal uncles.	Idiotic. Five uncles incurably insane, one uncle several times under treatment.
Group III.	16	None.	2 (1 m. 1 f.)	2 (1 m. 1 f.)		Idiotic.
			26 (16 m. 10 f.)	14 (6 m. 8 f.)		
Group IV.	17	Brother and sister.	7 (4 m. 3 f.)	3 (3 m.)	....	Badly idiotic. Father and mother and remaining members of family described as very simple-minded.
Group IV.	18	Brother and sister.	7 (3 m. 4 f.)	3 (2 m. 1 f.)	....	Badly idiotic. Father a drunkard, mother bedridden and paralyzed, both described as dull in intellect.
Group IV.	19	Brother and sister.	3 (3 m.)	3 (3 m.)	....	Badly idiotic. Parents described as uneducated, low in type, and below par in intellect.
Group IV.	20	First cousins.	4 (3 m. 1 f.)	4 (3 m. 1 f.)	Maternal cousin.	Imbecile.
Group IV.	21	First cousins.	3 (2 m. 1 f.)	2 (2 m.)	Several cousins.	Idiotic. Parents not noticeably peculiar.
			24 (15 m. 9 f.)	15 (13 m. 2 f.)		
		Total.... ...	82 (48 m. 34 f.)	50 (29 m. 21 f.)		

Dr. Manning, in his article (*vide supra*), gives the following interesting facts as bearing upon consanguineous marriages: In 1858 two families named Young, numbering sixteen in all, descended from the mutineers of the Bounty and their Otaheetian wives, returned from Norfolk Island to their old home at Pitcairn. The children were all first cousins on their fathers' side, and their parents were all closely related. In 1863 a further migration of the Young family, with a family named Christian and one individual named Buffet—in all, thirty persons—took place from Norfolk Island to Pitcairn, all these being closely related to each other and to the former swarm. In 1882 the number of inhabitants at Pitcairn had risen from forty-six to one hundred and four, the increase being, with two or three exceptions, due to births on the island; and Captain Bouverie Clark, who then visited the place and specially examined the children at my request, reported that there was no case of idiocy, imbecility, or weakness of intellect, or deformity among them."

Aside from the neurotic diathesis, the presence of certain constitutional diseases—scrofula, syphilis, or phthisis—in the ancestry seems to exercise a strong influence in causing idiocy. Of scrofula Dr. Ireland says: "It may be said that the scrofulous diathesis seems to favor, or at least to accompany, the production of idiocy."

Next to heredity, which, as a causative element, is most frequently observed in the class of idiots called, in Ireland's excellent classification, genetous, may be placed injuries to the fœtal head during the period of utero-gestation. Following this would come injuries to the head at delivery, from prolonged second stage of labor and consequent pressure, and occasionally from the use of forceps. In two thousand cases examined by Dr. Down, twenty per cent. were born with marked symptoms of suspended animation. In a recent clinical lecture by Dr. Shuttleworth, Superintendent Royal Albert Asylum for Idiots (*British Medical Journal*, January 30, 1886), he states that prolonged labor without instrumental interference is the assigned cause in twenty-nine per cent. of the cases admitted to the Royal Albert Asylum. He is of the opinion that the judicious use of instruments will, in many cases, avert the terrible consequences of too prolonged pressure.

Dr. Crichton Browne has published, in the "West Riding Lunatic Asylum Medical Reports," vols. i. and ii., two articles upon protracted and abnormal labors and their agency in the production of idiocy and other mental diseases. He is strongly of the opinion that the preponderance of idiocy in civilized races is due to some extent to the greater size of the head, and a non-proportionate increase of the pelvic diameters.

The following case, illustrative of the mischievous effect of prolonged pressure upon the fœtal head, is taken from Dr. Browne's article:

"M. R——, one of a large family of intelligent and healthy children, was born, after a tedious labor, with a huge *caput succedaneum*, testifying to the pressure to which he had been exposed. He was not expected to live, did not cry for some hours after birth, could not suck for several days, had twitchings of the limbs for a fortnight, and then spasms for about three months. Did not walk until he was three years old, and then with a tottering, unsteady gait; and only acquired a few monosyllables a year afterward. He grew up a typical example of that kind of idiocy which generally results from tedious and abnormal, but non-instrumental, labors, and which is not altogether of the baser sort. Although exceedingly feeble in his mental powers, ineducable and unable to articulate distinctly, he could still pick up and

Insanity.

play upon the piano any tune which he might hear, and manifested some vigor of memory in certain directions. He had a small, conical head, badly shaped features, and a convergent strabismus, and was at times distressingly dirty and mischievous in his habits."

In a paper upon the "Obstetrical Aspects of Idiocy" ("Trans. Obstet. Soc. of London," vol. xviii., December, 1876), from which quotations have already been made, Dr. Down reports that in twenty per cent. of the cases of idiocy collected by him, there was disturbance of the mother's physical health to a degree during pregnancy. There were histories of severe falls, followed by alarming uterine hæmorrhages, in four per cent; in six per cent. prolonged ill health; and in ten per cent. sickness had occasioned anxiety. Dr. Downs regards persistent vomiting during pregnancy as a factor in the production of idiocy deserving attention.

In thirty-two per cent. of the cases a history of fright, great anxiety, and emotional excitement was given.

It would be interesting to know in how many of these last, the great anxiety or emotional excitement was the expression of a nervous instability which was transmitted to the child.

In connection with the subject of fright and anxiety, the following, quoted from Carpenter's "Principles of Human Physiology," Philadelphia, 1876, p. 921, is of interest, as bearing upon the subject: At the siege of Landau, in 1793, "in addition to a violent cannonading, which kept the women for some time in a constant state of alarm, the arsenal blew up with a terrific explosion, which few could hear with unshaken nerves. Out of 92 children born in that district within a few months afterward, Baron Percy states that 16 died at the instant of birth; 33 languished for from eight to ten months, and then died; 8 became idiotic, and died before the age of five years, and 2 came into the world with numerous fractures of the bones of the limbs, probably caused by irregular uterine contractions. Here, then, is a total of 59 children out of 92, or within a trifle of two out of every three, actually killed through the medium of the mother's alarm, and the natural consequences upon her organization."

Intemperance in one or both parents, especially drunkenness at the time of conception, is by some authorities considered one of the prominent causes of idiocy.

Maudsley ("Pathology of the Mind") cites an example of this kind: Seven idiotic children were born to a man who "was a desperate drunkard, and, as he kept a public house, was always drunk, or had just been so, or was about to become so." An eighth child, born to him after he became of sober habits, was "perfectly sane." The occasional occurrence of idiocy in the children of drunken parents must be admitted. In a certain proportion of cases the idiocy may be dependent upon causes wholly distinct from intemperance in the parents, but in some cases the excessive use of alcoholic stimulants by the parents is probably directly operative.

Ireland is of the opinion that idiocy is by no means the "ordinary legacy which drunkards leave to their children."

The diseases of childhood, infantile convulsions and epilepsy, and various traumatisms which may affect the developing brain of the child, may be reckoned among the causes of idiocy. Under the heads of eclampsic, epileptic, and traumatic idiocy, some of these will be discussed, as will other causes operative in producing other varieties, under appropriate heads.

The classification of Dr. Ireland, in his standard work, seems to be as practical as any that has been attempted. He views the matter from the standpoint of pathology, and groups his cases under various headings indicative of the causes operative in their production. The classification is as follows:

Genetous, microcephalic, eclampsic, epileptic, hydrocephalic, and paralytic idiocy, cretinism, traumatic and inflammatory idiocy, and idiocy by deprivation.

The various groups in Ireland's classification, of course, run into each other. For instance, an idiot may be genetous, and at the same time microcephalic or epileptic, or a case may be of inflammatory origin and be paralytic.

Dr. Ireland recognizes the difficulties in the way of making a classification. Some writers view the defect

FIG. 1829.—Mongolian Idiot. This illustration is taken from a patient under the care of Dr. I. N. Kevlin, at the Pennsylvania Institution for Feeble-minded Children. His cranial circumference is 20¼ inches; antero-posterior, 10½ inches; calipers, 6⅞ inches; transverse, 10½ inches; calipers, 5¾ inches.

from the mental side alone, and a classification, based in a measure upon the degree of mental deficiency, would result. Others, teachers rather than pathologists, having in view the educability of the idiot, would base a classification upon practically the same foundation—the psychical—and group the cases according to their receptivity of impressions. The classification employed by Dr. Kerlin, Medical Superintendent of the Pennsylvania Institution for Feeble-minded Children, is an illustration of this method. He has four grades:

I. Idiocy: (*a*) Apathetic; (*b*) excitable.

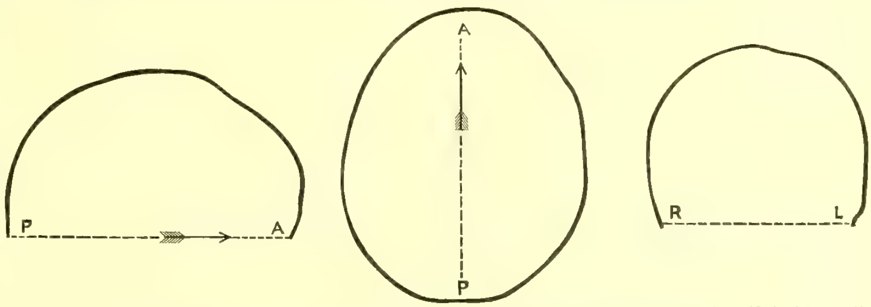

FIG. 1830.—Mongolian Idiocy. Measurements: Circumference, 19½ inches; antero-posterior, 12 inches; calipers, 6½ inches; transverse, 13 inches; calipers, 5⅞ inches; age, thirteen.

II. Idio-imbeciles.

III. Imbecility: (*a*) Lower grade; (*b*) middle grade; (*c*) high grade.

IV. Juvenile insanity.

The classification proposed by Esquirol was founded upon the degree of capacity for speech exhibited by the idiot.

Dr. Down some years ago having observed, in common

with others, the resemblance of certain idiots to the various races of men, proposed an ethnological grouping into Caucasian, Ethiopian, Malay, and Mongolian types.

His description of the Mongolian idiot, a type included by Ireland in his group of genetous idiots, is quoted as follows: "The hair, not black as in the real Mongol, but of a brownish color, straight, and scanty; the face flat and broad, and destitute of prominence; the cheeks rounded and extended laterally; the eyes obliquely placed, and the internal canthi more than normally distant from one another (the epicanthic fold often abnormally large); the palpebral fissure very narrow; the forehead wrinkled transversely, from the constant assistance which the levatores palpebrarum derive from the occipito-frontalis muscle in the opening of the eye; the lips large and thick, with transverse fissures; the tongue long, thick, and much roughened; the nose small; the skin has a slightly dirty, yellowish tinge, and is deficient in elasticity, giving the appearance of being too large for the body."

"This type occurs in more than ten per cent. of cases; they are always congenital idiots; they have considerable power of imitation; they are humorous; they are usually able to speak; the co-ordinating faculty is abnormal, the circulation is feeble; the improvement which training effects is greatly in excess of what would be predicated, if one did not know the characteristics of this type; the life expectancy is, however, far below the average, and the tendency is to tuberculosis." ("Observations on an Ethnic Classification of Idiots.") (Figs. 1829–1830.)

Dr. Shuttleworth, in a classification proposed by him in a clinical lecture on idiocy (*British Med. Journal*, January 30, 1886), makes the divisions and subdivisions quoted below. He meets and recognizes in this the same obstacles that prevent in Dr. Ireland's grouping a perfect division, and, it will be observed, indicates parenthetically that a subdivision may be included under two or more headings. He makes a broad general division into congenital and non-congenital cases. The subdivision "developmental," which he places under non-congenital, might, he remarks, with some propriety be retained in the congenital group. It seems questionable whether these cases should form a subclass under the congenital or non-congenital heading; for, though the imbecility may not be developed till the first or even second dentition, the tendency to mental catastrophe is, no doubt, innate.

Dr. Shuttleworth's grouping is as follows:

CLASS A.—CONGENITAL.

Type.	*Type.*
1. Microcephalic.	5. Primarily neurotic.
2. Hydrocephalic (also non-congenital).	6. Paralytic (also non-congenital).
3. Scrofulous—"Mongol type."	7. Choreic (also non-congenital).
4. Sensorial (also non-congenital).	8. Cretinoid: (*a*) sporadic; (*b*) endemic.

CLASS B.—NON-CONGENITAL.

a. Developmental.

9. Eclampsic.	11. Syphilitic.
10. Epileptic.	12. Post-febrile (also *accidental*).

b. Accidental or Acquired.

13. Toxic.	15. Emotional.
14. Traumatic.	16. Mixed causes.

No reference to classification would be complete without some mention of the ingenious attempt of Hoffbauer to mark the degrees of mental deficiency. He distinguishes two marked varieties in the phenomena of mental weakness, *Blödsinn* and *Dummheit*. Blödsinn, Hoffbauer divides into five degrees, and Dummheit into three. Space will not permit such a synopsis of his description of these degrees as would do the subject or the author justice. His classification is chiefly interesting as the first, and probably only, serious attempt to mark degrees of mental deficiency for medico-legal purposes, with respect to the responsibility of the affected individuals.

The classification of Ireland will be followed, and the various forms described.

1. GENETOUS IDIOCY.—The conditions producing idiocy have, in the genetous form, completed their work before birth. In this class the force of heredity is more strongly felt than in others. Occasionally the condition is due to apparent diminution of the vital force in the parents—the idiot being the youngest of a large family, the parents of whom are of advanced years. Phthisis, scrofula, syphilis, and rickets are to be found in children of this class. The bodily condition is usually below normal—the circulation is sluggish and feeble, the skin cold, and sensibility is impaired.

It is in these cases that the vaulted palate is most frequently observed. The height of the arch of the palate is increased, while the width between the bicuspids and molars of the opposite sides is diminished. When the narrowing is marked, the alveolar processes are crowded forward and the upper front teeth are given an oblique direction outward, in consequence of which they are protruding.

A girl, twenty years of age, was recently presented at the writer's service at the out-patient department of the Pennsylvania Hospital for the Insane, who presented the peculiarities above described in a marked degree. The palate was highly vaulted, the arch was sharper behind than in front, forming almost an angle, and the posterior molars of the opposite side approached each other, giving the line of the teeth a horse-shoe shape with the heels of the shoe sharply drawn toward each other. The teeth were irregularly set and decayed. The wisdom-teeth had not appeared.

The patient had possessed sufficient intelligence to work as a mill operative until some two years prior to her visit to the dispensary, when, after an attack of "typhoid fever," she became mentally disturbed—thought men were in the attic above her bedroom preparing to "cut me legs right off," that she heard voices in the wall, etc. These and other evidences of active mental excitement subsided in about nine months, as she gained strength, but she has never reached her condition of mind prior to the attack of fever. She is now untidy, disobedient, irritable, destructive. She presented the mental state of a mischievous child of about four, and is a good example of mental failure in an imbecile following an attack of post-febrile insanity. Reference will be made later to the development of attacks of mania and melancholia in idiots. Genetous idiots are rarely physically well made. They appear to have received, in many instances, with the heritage of a defective brain, an enfeebled, dwarfed, often crippled, body. The more common deformities are hernia, wad-shaped fingers, shortness of one or more toes, club-foot, strabismus, rolling of the eyes, absence of eyelashes and eversion of the lids, and coloboma iridis. Occasionally the ears are misshapen; sometimes one or both testicles are wanting.

Defective vision, as also blindness (congenital cataract, etc.), is not uncommon, and the connection between deaf-mutism and idiocy has long been observed. The relation of blindness and deaf-mutism to idiocy will be considered more in detail in connection with the class of idiots by deprivation. The teeth appear late, are irregular, and decay early.

Dr. Ireland finds it difficult to understand why bad teeth should be so common in idiots, an occurrence which he has noticed in all classes.

Connected with defective teeth are thickened and often fissured lips. The salivary glands are enlarged, and dribbling of saliva occurs. The muscular control over the lips and tongue is defective, and stammering results. Occasionally hare-lip and cleft-palate are observed.

In 517 cases examined by Dr. Howe, 21 were blind, deafness was present in 12 cases, 23 had some deformity of the mouth and nose, 54 had deformed hands or feet, and in 96 cases paralysis of some one or more muscles was observed. The statement of Dr. Down is easily accepted, after reading this list of deformities, that idiocy and imbecility are "profound diseases, involving almost every organ and system of organs in the body."

The number of genetous idiots, as would be expected, when the powerful influence exercised by heredity is considered, is largely in excess of that of the other classes.

It is from this group that those who are most suscepti-

ble to training and education are obtained. The following illustrative cases are taken from Ireland (*op. cit.*, p. 60):

"I had once an opportunity of observing two congenital idiots, a boy and a girl, who were twins. It might, therefore, be presumed that their mental deficiency was owing to the same causes. The father's mother had been insane, the father himself was much addicted to drinking, and the mother attributed the idiocy of the twins to his coming in drunk and threatening to kill himself when she was in the fifth month of gestation. The wife's mother died of epilepsy, though long after the birth of her daughter. The mother of the twins has had five children, one of whom, the youngest, is feeble-minded.

"These unfortunate twins were both well made, without any peculiarity of appearance, save that the girl was very short for her age. When nine and a half years old she was only three feet seven and a half inches in height, while her brother was nine inches taller. Neither of them had a vaulted palate. The size of the head was much alike in each; but the frontal portion was larger than the portion behind the ear in the boy.

"The boy was fair-haired, while his sister was red-haired. He appeared to be of the phthisical, while she was of the scrofulous, diathesis. They were both subject to attacks of bronchitis, and when the one caught cold the other rarely escaped. When between five and six years of age, he had frequent epileptic fits; his sister never had any. Notwithstanding this, the boy was one of the most improving cases in the house, while the girl was one of the least so. She remained a mute, of short stature and infantile appearance, her intelligence about equal to that of a child of fourteen months. All that she could do was to go simple messages and string beads; but the boy learned to read and write and count, to sew and knit, and improved so much, both in general intelligence and in bodily growth, that, if it could have been managed to have kept him two or three years beyond his term of five years, I think he might fairly have been discharged as passed out of the stage of imbecility. He was only thirteen years old when he left us."

2. Microcephalic Idiocy.—There is a not uncommon impression, both in the professional and lay mind, that the average size of the idiot head is less than that of persons of normal mental development. Excluding hydrocephalic idiots, this impression would be borne out by the facts, but the actual difference in size would be found to be but slight even after this exclusion. The mass of idiots cannot, therefore, be regarded as microcephalic.

Gall, Spurzheim, Combe, and a few others of the phrenological school viewed the subject of mental defect almost wholly from their peculiar standpoint, and found, they thought, in certain classes of idiots demonstration of the truth of their doctrines.

Spurzheim, for instance, relates ("Observations on the Deranged Manifestations of the Mind; or, Insanity") that Gall and he "saw, in Hamburg, a young man, sixteen years of age, the inferior parts of whose brain were favorably developed, but whose forehead was scarcely one inch in height, and in whom, consequently, the improvement of the superior parts of the brain was impeded; he had only the functions of the inferior parts—he recollected names, numbers, and historical facts, and repeated them in a mechanical manner, but the functions of the superior parts of the brain, such as comparison, reflection, penetration, and induction, are utterly wanting in him." In treating of acquisitiveness and destructiveness in his work on phrenology, Spurzheim quotes several instances of "idiots" who were destructive, or who had habits of acccumulation, and whose cases he explains on phrenological principles. These theories have long since been set aside. Seguin ("A Report on Idiocy to the General Assembly of Connecticut") summarizes the conclusions of the opponents of the phrenological school. From these we quote: "First, no constant relation exists between the general development of the cranium and the degree of intelligence; . . . fifth, the different degrees of idiocy are not measurable by the weight of the brain; sixth, a cranium perfectly formed often encloses a brain imperfectly formed, irregular, etc."

The ancient Peruvians, who, according to Wilson ("Brain-weight and Size," etc., Daniel Wilson, LL.D., etc., Toronto, 1876), belong to the microcephalous races, were far advanced in the arts, engineering, architecture, agriculture, etc. Morton found, in an examination of one hundred and fifty-five Peruvian crania, that their average capacity was for a brain of 40.1 ounces. Nearly the entire number of crania mentioned above were deformed artificially. It is agreed by all observers that there is a limit of cranial measurement, below which the result is necessarily idiocy. Voisin says that the proper exercise of the intellectual faculties is impossible with a head whose circumference is from eleven to thirteen inches, and which has a measurement of eight to nine inches from the root of the nose to the posterior border of the occipital bone. Ireland considers a cranial circumference below seventeen inches incompatible with active intellectual powers. He says, however, that heads of this small scale are not common among idiots even, as idiocy is generally the result of defect and not due to smallness of the brain. In the majority of instances the skull of microcephalous idiots is oxycephalic, and the occiput is imperfectly developed. Few cases reach ordinary stature, and in many instances they are dwarfed. Judging from the published cases, male microcephales exceed the female. In general, the deficiency in the brain in microcephaly is at the expense of the hemispheres. The cerebellum is relatively larger than in the normal brain. In the case of a microcephalic idiot reported by Dr. J. H. Lock, superintendent of the asylum at Bareily, India, the cerebrum weighed six and a half ounces, the cerebellum three and a half ounces, and the pons and medulla oblongata one-fourth of an ounce. This case could not articulate; walked very feebly with a half-running gait, and could only be made to understand about his ordinary wants. An attempt has been made by some evolutionists, notably Vogt, to explain microcephaly upon the theory of a reversion to ancestral types, the brain size and contour being inherited from some remote ancestral "ape." Dr. Ireland translates from Gratiolet his conclusions from the study of the brain of microcephales. We quote them entire, as bearing not only upon this question, but upon the period at which microcephaly appears. "The study of the brain of microcephales has furnished me with other reasons for proving through anatomy the absolute distinction of man. On comparing attentively the brain of apes with that of men, I found the arrangement of the central convolutions to be the same in adult ages in both groups. If one went no farther there would not be sufficient ground to separate man from animals in general, but the study of development gives us a real distinction. The temporo-sphenoidal convolutions appear first in the brain of the ape, and the frontal lobe last; but exactly the opposite takes place in man—the frontal convolutions appear first, the temporo-sphenoidal last. Thus the same series is repeated in the one case from alpha to omega, in the other from omega to alpha.

"From this fact, which was rigorously verified, there flows a necessary inference: no arrest of development can make the human brain more nearly resembling that of the ape than it is in the adult; far from that, it will differ so much the more the less developed it is. This inference is completely justified by the view of the microcephalic brain. At first it might be taken for the brain of some new and unknown ape; but the slightest attention is enough to save one from this error. In the ape the parallel fissure is long and deep, and the sphenoidal lobe is marked by complicated furrows. In the microcephale, on the other hand, the parallel fissure is always incomplete, and sometimes wanting, and the sphenoidal lobe is almost entirely smooth. That is not all; in the microcephale the second bridging convolution, between the parietal and occipital lobes, is always superficial—a character peculiar to man. In the pithecæ, on the contrary, the convolution is constantly hid under the operculum of the occipital lobe. Thus, in the depth of their degradation, the brain of the microcephales presents human

characters often less voluminous and less convoluted than those of the ourang or chimpanzee ; they do not become similar. The microcephale, however low he may be, is not a beast, but a diminished man.

"I have examined the question, Does microcephaly precede birth ? Of this there can be no doubt. In one of the cases of microcephaly which I have studied the general form of the brain and of the fissure of Sylvius showed me that the monstrosity was at least contemporary with the fifth month. It is probable that this state depends upon some cause : early under the influence of some primordial generative weakness (astheniogenie primordiale) forms are produced which differ from all normal states. Moreover, in the new-born child, in its normal condition, the arrangement of the cerebral convolutions is complete in all its parts. If microcephaly were after birth, these convolutions would remain, and the volume of the brain alone would be diminished ; but it is not so, the growth has languished from the beginning, its fold is shortened, and has stopped growing too soon." Ireland is not aware of any anatomist who has, after examination of microcephalic brains, espoused Vogt's theory. Virchow has been quoted as considering microcephaly due to premature cranial synostosis. Dr. Shuttleworth, who has studied this subject with great care, is inclined to differ with Virchow, and to conclude that the premature synostosis is a result rather than a cause of microcephaly. In one case observed by Shuttleworth, the anterior fontanelle seemed but imperfectly ossified, and there was an adhesion of the dura mater to that locality and all along the interparietal suture ("Trans. Internat. Med. Congress," 1881, vol. iii., pp. 6–10). Through the kindness of Dr. Shuttleworth we are enabled to present here the cranial contours of this case. (Fig. 1831.) The writer is also under obligations to Dr. Shuttleworth for the contours of a Mongolian and of an hydrocephalic idiot which appear in this article.

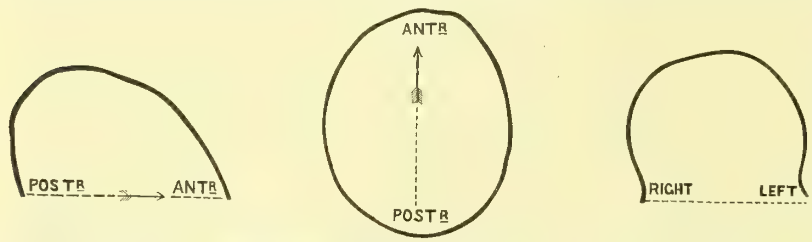

FIG. 1831.—Microcephaly. Measurements : Circumference, 14⅛ inches : from nasal notch to occipital protuberance, over vertex, 9½ inches ; calipers, 4½ inches ; from ear to ear, over vertex, 10 inches ; calipers, 3 inches. Age, ten years.

We abstract from the *Journal of Mental Science*, October, 1878, an article by Dr. Shuttleworth, upon microcephalic idiocy, in which are careful details of a minute autopsy. The case, M. X——, was admitted to the Royal Albert Asylum in April, 1874, at the age of twelve. She was at the time a girl of slender build, but of fairly developed physique, with the exception of a remarkably small head. She was five feet one and a half inch tall, and weighed eighty-seven pounds. Her head, in its greatest circumference, was a little less than seventeen inches. In outline the head was oxycephalic, but this was disguised by a profusion of hair. The features were regular, the eyes clear, the teeth good. The palate was "saddle-shaped," and the voice high pitched, and articulation slow, though fairly distinct. She could dress and undress herself, was not fond of play, but enjoyed music. Her education was nil. Her family history, so far as neuroses were concerned, was good, but her parents were cousins. She was the first child ; the second was a boy, healthy and intelligent ; the third and fourth, twin boys, one healthy, the other microcephalic and an imbecile. Under instruction the subject of the article improved slowly, but perceptibly. Her vocabulary and articulation improved. She could read a few words and form letters in a copy-book. She learned some domestic occupations, and became proficient in calisthenics.

In May, 1877, she began to have pain in her limbs, and shortly developed symptoms of phthisis, from which she died in August, 1877.

The body was much emaciated ; height, sixty-seven inches ; chest measurement on level of mammæ, twenty-four inches.

The head measurements were : Circumference, 16¾ inches ; antero-posterior, over vertex, 10½ inches ; by calipers, 5¾ inches ; transverse, over vertex, 11 inches ; by calipers, 3⅞ inches. The cranium showed some asymmetry, which was especially noticeable at the base. The sutures were all closed except the coronal, and ossification of that was well nigh complete.

There was some fulness of the superficial vessels of the brain and slight subarachnoid effusion. In the anterior lobes of the brain, the right side slightly exceeded the left in size. The cerebral hemispheres were absolutely and relatively abnormally small, so that when the brain was viewed from above the cerebellum was uncovered over the greater portion of its upper surface.

The island of Reil was uncovered, and the two limbs of the Sylvian fissure separated by nearly half an inch at their origin. The frontal and parietal lobes were comparatively well developed, and their convolutions, though coarse, were well defined and normal in arrangement. The temporo-sphenoidal lobes were small and deficient in front, and the convolutions and fissures not well marked. The occipital lobes were quite rudimentary. The island of Reil presented a flat surface, and the radiating gyri were wanting.

The corpus callosum was normal in extent ; the fissures and convolutions on the inner surface of the hemispheres were somewhat rudimentary.

The cerebellum was relatively large and well developed. The pons presented no peculiarity of structure.

After being kept in spirits for a year, the entire encephalic mass weighed but 12¾ ounces, the cerebral hemispheres weighing but 9¾ ounces.

We are able, through the kindness of Dr. Kerlin, to present here a cut taken from a patient under his care.

FIG. 1832.

The boy is fifteen years of age, and is one of five similar births to a woman of very low intelligence, with a small dolicho-cephalic head. This case, under Dr. Kerlin's care and instruction, has made excellent progress in industrial

training. His cranial circumference is 16⅝ inches; antero-posterior diameter, 6¼ inches; bi-parietal diameter, 4⅝ inches.

Numerous cases could be cited in which the sutures have been found open, even in somewhat advanced childhood. It would appear, therefore, that while it cannot be disputed that premature synostosis is observed in microcephales (Bailarger reports several instances, three occurring in one family, in which the fontanelles were closed at birth), it cannot be regarded as a cause of the condition. The only explanation which at present can be advanced is that of arrest of development due to some inherent weakness in one or both parents, or to other causes operative in the earlier periods of fœtal life.

The so-called Aztec children were examples of microcephalic idiocy; the degree of microcephaly was extreme. The following description of these children was quoted by Seguin from Professor J. C. Dalton's "Treatise on Human Physiology." "They were a boy and girl, aged respectively about seven and five years. The boy was two feet nine and three-quarter inches high, and weighed a little over twenty pounds; the girl was two feet five and a half inches high, and weighed seventeen pounds. Their bodies were tolerably well proportioned, but the cranial cavities were extremely small. The antero-posterior diameter of the boy's head was only four and a half inches; the transverse diameter less than four inches. The antero-posterior diameter of the girl's head was four and one-third inches, the transverse diameter only three and three-quarter inches.

"The habits of these children, so far as regards feeding and taking care of themselves, were those of children two or three years of age. They were incapable of learning to talk, and could only repeat a few isolated words. Notwithstanding, however, the extremely limited range of their intellectual powers, these children were remarkably vivacious and excitable. While awake they were in almost constant motion, and any new object or toy presented to them immediately attracted their attention and evidently awakened a lively curiosity. They were accordingly easily influenced by proper management, and understood readily the meaning of those who addressed them, so far as this meaning could be conveyed by gesticulation and the tone of the voice. Their expression and general appearance, though decidedly idiotic, were not at all disagreeable or repulsive; and they were much less troublesome to the persons who had them in charge than is often the case with idiots possessing larger cerebral development."

Microcephales are, as a rule, active observers of what passes about them; sometimes pugnacious. They remember impressions to a limited degree, and are incapable of anything more than a simple train of reasoning.

Professor Owen, who saw the Aztecs, said they showed lively but abrupt movements, without obvious aim. On a visit made a week subsequent to his first examination, they recognized him. Having examined their teeth on his first visit, the boy on the second interview again exposed his for examination. They seemed pleased with, and attracted by, any bright object or toy.

3. Eclampsic Idiocy.—This form of idiocy is, as its name would indicate, due to the convulsive seizures of infancy and childhood; but in this classification epileptic convulsions are excluded, as belonging to and causing another form of idiocy which, by their continuance, they complicate as well as cause.

The most frequent cause to which infantile convulsions are attributed is teething. Intestinal disturbances of various kinds, prolonged constipation or the opposite, intestinal worms, etc., are cited as causative factors in the convulsive disorders of childhood. So, likewise, anæmia, either from acute disease or from some dyscrasia, results in eclampsia. Any and all of these conditions occurring in infancy, and resulting in eclampsia, may produce such a change in, or so hinder the regular development of, the brain that idiocy follows.

In viewing eclampsia as a cause of idiocy, it is well to bear in mind that it may, in certain instances, be concomitant, the result rather than the cause of the lesion which, progressing beyond the convulsive stage, produces the idiocy. It is a happy circumstance that, in proportion to the large number of infants and children who have, during some period of life, convulsions, few become idiots. At the Earlswood Asylum, fourteen per cent. of the cases there were ascribed to convulsions at teething. Trousseau says that, in cases of idiocy resulting from convulsions, "it rarely happens that . . . one half the body is not weaker than the other, the paralyzed side being less developed than the sound one."

In some instances the power of speech becomes lost if it has been established; occasionally sensation is perverted; strabismus and other deformities sometimes occur.

4. Epileptic Idiocy.—Epilepsy, as will be shown elsewhere, is one of the common causes of insanity; and one of the forms of mental disturbances produced by it, dementia, is, in a certain proportion of cases, difficult to differentiate from idiocy. The history of the case, however, ought, in all instances, to permit a distinction being made. Dr. Ireland has stated that, if the epilepsy has induced mental impairment before the age of seven, he would call the case one of idiocy. It is apparent that it is difficult, if not impossible, to fix upon an age at which a line of demarcation can be drawn. We would be inclined to place the line considerably in advance of the age of seven, as the mental faculties can hardly be said to be fully evolved at that age.

For convenience, an epileptic idiot may be said to be one whose mental development was arrested or prevented by the occurrence of epilepsy in infancy or childhood. From this class would, of necessity, be excluded all those idiots in whom epilepsy is developed subsequent to observed mental defect, in whom it becomes a complication increasing, perhaps, but not causing the idiocy. The result of observation shows, and to this there are but few recorded exceptions, that those cases of idiocy in which the epilepsy begins in the first or second year are the most profound and offer the least hope of improvement. As has been shown elsewhere (Epileptic Insanity), epilepsy is a disease largely dependent upon neurotic ancestry, and if we admit the statement of Reynolds, that hereditary epilepsy manifests itself at an earlier age than the non-hereditary, we would expect to find in epileptic idiots a family history of epilepsy or other nervous disorders. Statistics upon this point are wanting.

The varieties of epilepsy known as *petit* and *grand mal* are both observed in epileptic idiots. The observations made in asylums for the insane are borne out by those in charge of idiots, that *petit mal* is as productive of mental defect as the violent paroxysms, if, indeed, it is not more seriously harmful.

Teething seems to be an active exciting cause in developing epilepsy; we cannot regard it solely as a cause, but as a spark, rather, which explodes the mine of an unstable nervous organization.

West ("Lectures on Diseases of Infancy") records 20 cases out of 41, in which epilepsy was developed during teething.

Epileptic idiots are irritable, often intractable, and hence not easily taught. They are apt to retrograde; and when the epilepsy and subsequent imbecility appear after there has been some mental development, this may be either wholly or in a large part overthrown.

The writer has notes of a case in which epilepsy was developed in a child of five, who had previously been bright, active, and intelligent, able to read short words, and to count. At the end of a year and a half of rapidly recurring epileptic convulsions, averaging, in the last six months of the period, over thirteen weekly, the child had forgotten her name; her walk was awkward; grasp, feeble and uncertain; habits, untidy; expression, extremely stupid. This little patient had been subjected to the medically popular treatment for epilepsy, the free use of bromides. She was anæmic and exhibited marked bromide acne; this treatment being at once discontinued, cod-liver oil, iron, a generous diet, and free out-door life were substituted with happy results. The convulsions soon diminished in frequency, and as soon as the depress-

Insanity.

ing effects of the bromides were overcome there was considerable mental improvement. The patient, at the end of a few months, recognized and remembered the name of her physician, and soon reacquired her lost speech. At the end of three years she still continued epileptic, and there was such defect of mental development that, in that respect, she would be classed with children of less than half her age.

Owing to the unpromising nature of these cases, public institutions for idiots, as a rule, exclude all cases compli-

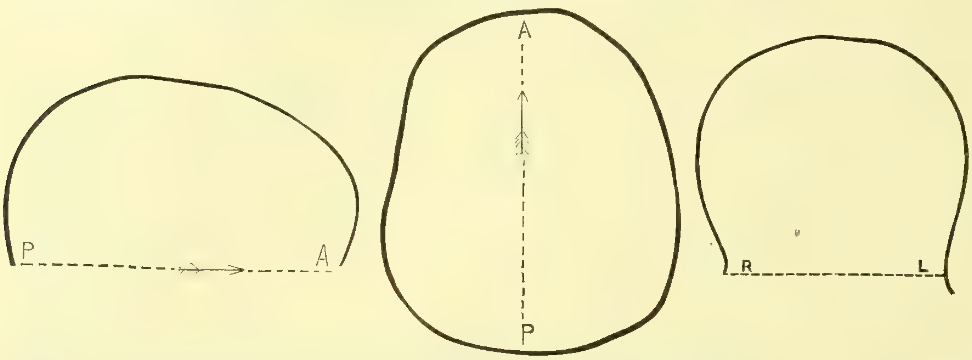

FIG. 1833.—Hydrocephalic Idiocy. Measurements: Circumference, 23½ in.; antero-posterior, 14¾ in.; callipers, 7⅝ in.; transverse, 15½ in.; callipers, 4⅞ in. Age, thirteen.

cated with epilepsy. The prognosis is almost universally unfavorable, and if those in charge of the idiot are successful in maintaining his physical health, and preventing still greater mental deficiency, they will, in most instances, accomplish all that can be expected.

Occasional and rare instances are on record of a recovery from epilepsy, and subsequent mental improvement, sometimes to the degree of apparently normal mental action.

Of the treatment (medical) of epileptic idiots nothing can be said beyond what has already been laid down under the head of Epilepsy. Attention to diet and nutrition usually proves of as much value as any therapeutic measures. In some institutions particular stress is laid upon an abstinence from, or a very sparing use of, meat diet by epileptics. A query occurs to the writer as to whether the ill effects observed to follow the use of meat diet may not, in some instances, be due as much to the irritation from the presence in the alimentary canal of masses of unmasticated meat, as from the supposed injurious effects upon the nervous system of meat *per se*. Epileptics who are not idiots are rapid eaters, who bolt their food in large masses, and frequently suffer from the resulting dyspepsia. When the element of idiocy is added, it may readily be inferred that these habits are not improved upon.

Whatever measures are put forth usually resolve themselves into palliative efforts, beyond which little can be done in the majority of cases. The writer cannot refrain, however, from uttering a warning against the too free use of the bromides. The anæmia and impaired nutrition which are apt to result from the long-continued use of potassium or sodium bromide, is, in many instances, more harmful than the condition for which these drugs are prescribed. They are not, however, as experience has proven, without value, but their action should be watched, and any failure in nutrition carefully prevented.

5. HYDROCEPHALIC IDIOCY.—This term, like microcephalic and epileptic idiocy, is self-explanatory. The majority of cases of congenital hydrocephalus die. In those who survive the mental development is hindered, in some instances almost wholly prevented. In a few cases the hydrocephalic condition does not increase; the brain develops normally, and but little mental impairment is observed in after-life. The hydrocephalic idiot, in many instances, has an ancestry in which the degenerative processes which have terminated in him have passed in his more direct progenitors through the tubercular and scrofulous periods.

In acute hydrocephalus (tubercular meningitis) the termination is so frequently fatal, that it can have little bearing in the production of idiocy. Some few cases, however, survive and pass into the stage of chronic hydrocephalus. These are, as a rule, feeble, rachitic, or tubercular children, whose unfortunate lives soon terminate. Chronic, slowly developing hydrocephalus, is, therefore, the most common form in the production of idiocy. (For a full discussion of these varieties see Hydrocephalus.)

The acquired form of hydrocephalus is most frequently observed from the third to the tenth year. The majority of cases observed in children, according to Steiner ("Compendium of Children's Diseases"), occur before the fourth year. Of 80 cases reported by him 22 were under two years old; 24 were two years old; 17 were three years old; 7 were four years old; 4 were five years old; 2 were six years old; 2 were seven years old; 1 was eight years old; 1 was nine years old. Of these 46 were boys and 34 were girls.

The diagnosis of hydrocephalus is usually easy, but it is to be distinguished from hypertrophy, and its presence is not always determined by an accompanying large cranium, as hydrocephalus has been observed in microcephalic idiots. Griesinger ("Mental Pathology and Therapeutics," p. 358) says the cranium may very often be considerably smaller than normal in connection with marked hydrocephalus. These cases are doubtless congenital, associated with premature synostosis.

In every case of considerable hydrocephalus the volume of the brain is diminished, and frequently that portion which remains is less capable of performing its functions.

FIG. 1834.

We present through the kindness of Dr. Kerlin, a cut of a case of hydrocephalic idiocy under his care (Fig. 1834). The boy is aged fourteen; is a dwarf. He memorises readily, repeating poetry in Latin and English. He is noted for his redundancy of speech. His cranial circumference is 22 inches; antero-posterior diameter, 7¼ inches; transverse diameter, 6½ inches.

Hydrocephalic idiots are, when any intelligence re-

mains, of an amiable disposition, easily guided, and when the cerebral functions are not too seriously impaired by pressure or non-development, are capable of considerable improvement under treatment and training. The size to which the cranium attains is sometimes quite remarkable, but is not by any means, as has been intimated, a measure of the degree of mental impairment. Ireland mentions having met the governess of a school for deaf-mutes who was hydrocephalic, but who possessed marked mental ability. She was deaf, probably as the result of hydrocephalus. Monro, quoted by Ireland, mentions the case of a boy of eight whose memory was active, and whose cranium measured twenty-eight inches in circumference.

Ireland gives in detail another case of hydrocephalus, not suspected before death, as "the head was not enlarged, nor the shape altered." In the front part of the hemispheres there were found two ounces of fluid, and in the lateral ventricles seven ounces. This case was one of complete fatuity. It would seem that in cases of hydrocephalus without enlargement of the cranium, greater mental impairment would be expected than in those in which the bones of the skull had yielded to the internal pressure.

6. Paralytic Idiocy.—Infantile paralysis of centric origin, followed by atrophy or partial destruction of one hemisphere or of some portions of the brain, whether of congenital origin or appearing in childhood, is in a certain proportion of cases followed by mental deficiency.

The conditions which result in paralytic idiocy are of a varied nature. That mental health may be associated with considerable impairment of one hemisphere, has been shown by Van der Kolk. He says ("A Case of Atrophy of the Left Hemisphere of the Brain," etc., New Sydenham Society, 1861, p. 150) "that in atrophy of one-half of the cerebrum the psychical powers should be blunted or paralyzed, might, perhaps, be assumed as generally true (and, in fact, such atrophy is most usually met with in idiots); still, it is far from being universally the case; for, although, in some instances, mention is made of rather blunted mental powers, examples also occur where, with atrophy of one hemisphere, the intellectual faculties appeared to be in their normal condition. Andral reports the case of a man who died in his twenty-eighth year, and, who, when a child of three years, had, after a fall, continued paralyzed on one side; the right hemisphere of the brain was so completely atrophied that the pia mater formed a cyst, in which not a trace of cerebral matter remained. This membrane constituted the upper wall of a large cavity, the floor of which alone was formed by the thalamus, the corpus striatum, and all the parts found on a level with these two bodies; so that, observes Andral, nothing remained of cerebral matter above the ventricles except what was in front of the corpus striatum and formed the inferior wall of the cavity. And yet he testifies that the man had received a good education, had a good memory, a good address, and exhibited as much intelligence as most men."

Van der Kolk further observes (*loc. cit.*, p. 153). "Everything, in my opinion, depends more or less upon the healthy state of one hemisphere of the brain. If, as from the nature of the case seldom occurs, the inflammation and affection of the pia mater has not extended to this hemisphere, if the gray matter under the cerebral convolutions has been continued perfectly sound, there is no reason why this remaining hemisphere should not be able to act without impediment in the exercise of those functions which are necessary to our mental powers, just as one eye sees as sharply though the other be lost. But where the gray matter is injured in both hemispheres, particularly anteriorly, disturbance of the intellectual faculties will be inevitable. I myself possess in my collection one hemisphere of the brain of a man aged seventy-two, which is extensively destroyed by softening superiorly and anteriorly, in consequence of chronic inflammation proceeding from the corpus striatum, and, in this case, although there was complete paralysis of the entire of one side of the body, the intellectual faculties were quite unimpaired up to the moment of death; the patient even assured me, shortly before his decease, that he never had had any feelings of headache. But in this instance the meningitis had not extended over the other hemisphere, and had thus excited no disturbance, while the part that was destroyed could not act, and was, therefore, incapable of giving rise to any confusion. In fact, we cannot apply the measurement of rule and compass to the exercise of the mental powers, and that parts of the brain may be lost without impairment of these powers, is a familiar fact."

The case upon which Van der Kolk's monograph is based is one of "paralytic idiocy," and is briefly as follows: A young woman, twenty-seven years of age, had from her earliest infancy been paralyzed on her right side. Her mental condition was at first one of imbecility rather than of profound idiocy, but by degrees—probably from want of care—she became less and less intelligent. Her manner grew irritable, and if her wants were not at once supplied she became passionate and violent.

In consequence of an attack of mania, she was conveyed to one of the Amsterdam hospitals. On admission

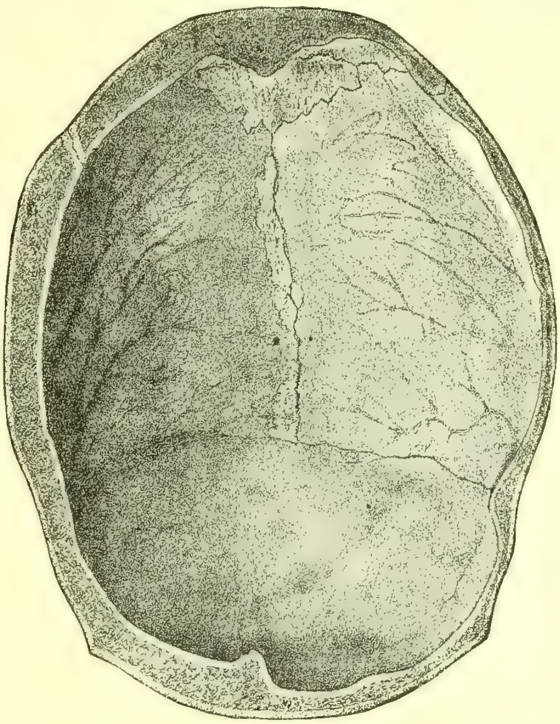

Fig. 1835.—From Van der Kolk.

to the hospital her mental development was at the lowest. She made known her wants—and these were wholly confined to her animal desires—in broken language. She was extremely untidy in her habits, and raved and scolded when washed. She had never menstruated, and exhibited no sexual desire.

At the autopsy the remarkable atrophy of the right half of the body was most marked. On opening the skull it was observed that the left side was much thicker than the right (Fig. 1835). The right hemisphere of the cerebrum was found to be quite healthy, the membranes in a normal condition. The left hemisphere was much smaller, the arachnoid was much thickened, and between it and the pia was a considerable quantity of fluid. The whole left hemisphere was soft and fluctuated like a bladder on account of the fluid contained in the ventricles.

The gray matter was pale and yellowish, the convolutions were thinner than those of the opposite hemisphere, and the pia was very loosely attached, seeming in places detached by effused serum.

The left corpus striatum was shorter but somewhat broader than the right.

The difference between the thalami was particularly observable, the length of the right exceeding that of the left by seven millimetres (Fig. 1836), and differences more or less pronounced extended through other divisions of the brain. At the base of the brain the inequality of the two hemispheres was equally marked. In the cerebellum the difference in the two hemispheres was opposite to that of the cerebrum, the right being smaller in all its measurements (Fig. 1837). The cord was atrophied on its right side.

Professor Van der Kolk's illustrations of this interesting case are reproduced in Figs. 1835, 1836, and 1837.

The author remarks that the unilateral hypertrophy of the skull is not constant in cases of atrophy of one of the cerebral hemispheres. In twenty-seven cases in which the condition of the skull was mentioned, hypertrophy of the skull on the side of the hemispherical atrophy was mentioned in ten instances. In the remaining cases the vacuity produced by the atrophied hemi-

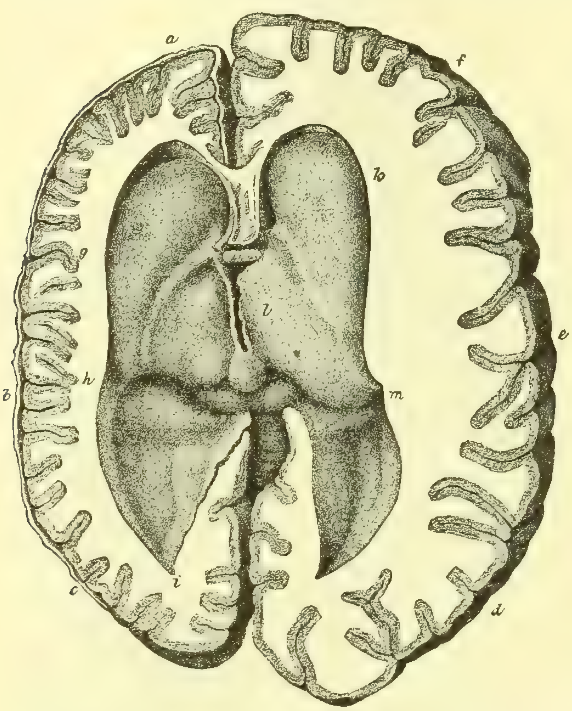

FIG. 1836.—From Van der Kolk. *a, b, c,* left atrophied half of brain. The smallness of the convolutions when compared with the opposite side, *d, e, f,* is very striking; *g, h, i, k, m,* ventricles of the brain; *h, i,* the posterior dilated left ventricle; *l,* the right and larger thalamus.

sphere was supplied by a collection of serum (unilateral hydrocephalus). Cases of paralytic idiocy usually improve under training as far as mental development is concerned, but great patience is required in the treatment of the physical deficiency, and usually with but little reward. Exercise, massage, electricity (the use of supporting apparatus in the event of sufficient intelligence in the patient), all deserve trial.

The contractions and other deformities met with will sometimes tempt surgical interference. The results obtained are discouraging. Tenotomy of the contracted muscle is not followed by activity in its opposing muscle or muscles, and if made on a limb of lowered vitality the wound does not do well, and the last estate is worse than the first.

7. CRETINISM.—The origin of the term cretinism is shrouded in obscurity. The probable derivation of the word seems to be from *Cretina,* stupid, silly. Some writers have endeavored to trace its descent from *Chrétien,* from the popular idea that the cretin is under the special protection of heaven. Esquirol suggests the origin of the word to be *cretine,* alluvial soil, based on the assumption that cretinism flourished in alluvial districts. Other writers discover its origin in *creta,* a sallow, earthy, yellow complexion, commonly observed in cretinism. A definition which will apply to all cases properly enumerated under the term cretinism, is difficult to formulate. That contained in Bucknill and Tuke's "Manual of Psychological Medicine," has the merit of brevity and is sufficiently broad. "An arrested development of the nervous system and bodily organization generally, either before or after birth, due to a local cause, as the condition of the water, soil, air, etc., and marked by characters which, in some respects, distinguish it from ordinary idiocy."

Griesinger ("Mental Pathology and Therapeutics") applies the term to a particular species of idiocy, namely, that in which the subject presents an hereditary defect of physical conformation.

Berchtold-Beaupré ("Dissertation sur les Crétins"), as

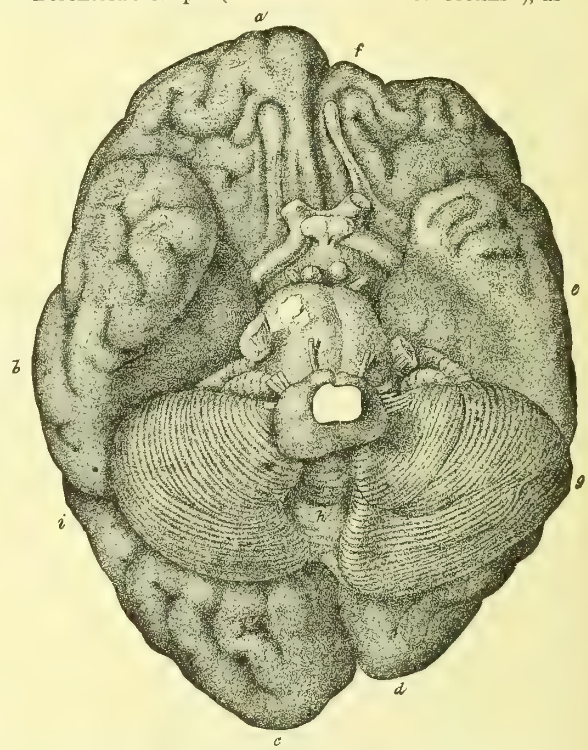

FIG. 1837.—From Van der Kolk. *a, b, c,* right hemisphere of the brain; *d, e, f,* left hemisphere, much atrophied; *g,* left and larger lobe of cerebellum; *i,* smaller lobe; *h,* processus vermiformis rendered oblique by inequality of the two lobes.

translated in Feuchtersleben, gives this description of the cretin:

"Who," asks he, "is this melancholy creature which bears the human form in its lowest and most repulsive expression? I see a head of unusual form and size, a squat and bloated figure with a stupid look, with bleared, hollow, and heavy eyes, with thick projecting eyelids, and a flat nose. His face is of a leaden hue (*blafard*), his skin is dirty, flabby, covered with tetters, and his thick tongue hangs down over his moist, livid lips.

"His mouth, always open and full of saliva, shows teeth which are going to decay. His chest is narrow, his back curved, his breath asthmatic. I see, indeed, arms and legs, but the limbs are short, misshapen, lean, stiff, without power and without utility. The knees are thick and inclined inward, the feet flat. The large head droops listlessly upon the breast, the belly resembles a bag, and its integuments are so loose that they cannot retain the intestines in its cavity; this loathsome idiotic being *hears not, speaks not,* and only now and then utters a

hoarse, wild, inarticulate sound. Notwithstanding his greediness, he is scarcely able to support life. One passion alone seems to rouse him from his usual insensibility, this is the sexual instinct in its rudest brutality. At first sight we should be inclined to take this wretched being for a gigantic polypus, something in imitation of a man; for it scarcely moves, it creeps with the painful heaviness of the sloth. And yet it is the monarch of the earth, but dethroned and degraded—it is a *cretin.*"

In the above the author has associated all the striking features of several cases of cretinism, and applied them to a single individual; the picture is, therefore, overdrawn. There are degrees in cretinism, as there are degrees in the other forms of idiocy, and many true cretins would come far short of the above description.

Cretinism is a disease which is confined to certain fairly defined localities, and its occurrence beyond them is unusual and accidental. Cretinism and goitre are universally associated, but not all cretins are goitrous, though in the large majority of cases some trace of goitre is to be found. The disease is met with more commonly in closed and narrow mountain passes. The history of cretinism is intimately associated with the Alps—to such a degree, indeed, that it has been termed by some writers the Alpine disease.

It is found in Sardinia, Austria, France, Switzerland, and the Pyrenees; in America among the Andes and Rocky Mountains; in China, the Himalayas, Sumatra, and Madagascar. In some of these localities the disease is somewhat rare, while in others it prevails to an astonishing degree. In the province of Aosta, in the commune of Gignod, there were, according to Parchappe, 268 cretins per 1,000. In the island of Niederworth, near Coblentz, of 750 inhabitants 131 were cretins. In England a few cretins have been found in Derbyshire and West Yorkshire, where are also numerous goitrous persons. While most common in mountain valleys, cretinism is not confined to such localities, but occurs in the plains watered by rivers rising in the mountains. It is found along the course of the Danube and the Rhine, in Austria, in the plains of Lombardy, and in India and South America. Much has been written upon the subject of cretinism since it was first given a place and described in medical literature by Plater, in 1500. Höfer, afterward physician to the Austrian Court, made some studies upon the subject in 1675, in the Styrian mountains. Saint-Lager, who has written extensively upon this topic, has collected a list of works bearing upon the subject, which fills over twenty printed pages.

The governments of France, Sardinia, Austria, and Switzerland have appointed commissions of medical and scientific men to examine the subject. The French commission made its report in 1870, and the result of its investigations affords the most reliable information.

The cause of cretinism is evidently some influence residing in the locality where the disease prevails. Heredity has doubtless something to do with its production in families, but healthy individuals moving into the infected (the word is used for want of a better term) region beget children who are, if not pure cretins, goitrous and dull of intellect. The constant association of goitre and cretinism, and the territorial limit of cretinism, within the wider but still limited geographical area of goitre, shows a causal relation between the two. Maffei thus puts it: "Goitre is the beginning of that degeneration of which cretinism is the end." The form of goitre here referred to will, of course, be understood to be the endemic.

Goitrous persons removing from the endemic influence often have children born to them after removal who remain free from goitre. The family relations between deaf-mutism and cretinism, and other forms of idiocy, has been remarked, and these forms of imperfect or arrested development are found side by side, sometimes associated in the same individual, and apparently due to the same cause.

The writer had at one time under his observation a family consisting of a father, two grown sons, and a daughter, natives of Switzerland. The father was dwarfed and misshapen, and of feeble intellect, irascible, and at times vicious. Both sons were deaf-mutes. They were able to read and write, and were good laborers, but were easily imposed upon and very irritable, and when angry, dangerous. One committed suicide. The daughter was goitrous and of less mental power than her brothers. She married in America, and her children were all well formed, healthy, and without observable mental defect.

The specific cause of cretinism, though confined to fairly well-defined localities, has not been determined. Some writers have attributed the disease to the shut-in air of close valleys, but it appears on the open plain, and is unheard of in other equally close valleys. Some have found in this, some in that, mineral constituent of the drinking water the causative element, while others have attributed it to the use of water from melting glaciers.

The soil has been examined for the offending substance, but without success, and poor food and the lack of food has been cited as one of the elements in the degenerative process. It seems probable that no one element is responsible.

Poor living, the condition of soil and water, intermarriage, and heredity doubtless all have some influence. Intermarriage certainly increases the danger; and a region of magnesian limestone is one of the most common habitats of cretinism. Of heredity we can only say that it is one of the adjuncts in the production of the disease, and not the active cause. As has been stated, a family may be cretinous, but leaving the region of cretins, they, in many instances, leave behind them the danger of begetting cretin children. Prichard ("A Treatise on Insanity and other Disorders Affecting the Mind") attempts to draw an analogy between cretins and other idiots, from the physical standpoint. He says: "The idiots of other countries, though not cretins, are deformed in person and have the external marks of imperfect organization." This is true of many non-cretinous idiots, but the deformities are accidental, and not the rule; they are sporadic, and not endemic; they are of any and all the members, and not, as in cretinism, of a specific character which stamps the mark of the disease upon the victim. Cretinism occasionally shows itself during the infantile period, sometimes at birth, but—contrary to the statement of Josias Simber, the historian of the Valais (1574), who says that the midwives of the day were able to declare, by the appearance of a new-born infant, whether it would be a cretin—its appearance may be deferred until the early years of childhood—the fourth, sixth, or seventh year—when it suddenly declares itself. It rarely occurs after the child has passed the seventh year in health. Geggenbühl, the first to attempt to educate and reclaim these unfortunates, states that there are places where men who have come there to live in adult life, have passed into a cretinoid state, with goitre, etc.

In an inquiry made by the Austrian Government, in 1844, at Syrnitz, it was found that the proprietor of an estate in the neighborhood had moved to the estate with his wife in good health. The wife died goitrous and half-cretin, and the proprietor, with his second wife, had passed into a state of demi-cretinism. The five children by the first wife were idiots, with deformed bodies and thick, goitrous necks. The two children of the second wife were, at the ages of one and two, still healthy, though liable to become cretins.

The monstrosity pictured by Beaupré, as has been said, combines the collected deformities of different cases. Cretins have a stupid, listless appearance. The nose is depressed at the root, broad and flaring at the nostrils. The eyes are widely separated, dull, heavy, and expressionless. The mouth is large, lips and tongue thick. The skin is generally loose, and in folds; the teeth poor, and in many instances but one set is developed. The body is usually dwarfed, the limbs and feet are occasionally deformed, and the gait is shuffling and uncertain. The abdomen is protuberant. The voice is harsh and shrill, and articulation is often imperfect, sometimes absent. Some cases are deaf as well as mute. Geggenbühl, who had ample opportunity for observation, says that deafness in young cretins is rare. The appetite is voracious, and they seem to require much sleep. The neck is thick and

short, and in the majority of cases goitre is present, which may be said to be the characteristic, though not universal, deformity of cretinism. It is certainly, in its endemic

Fig. 1838.

form, the characteristic deformity of cretinous districts. Occasionally cretins are met who do not in their personal appearance, with the exception of goitre, differ materially from ordinary people. The vital functions of cretins are not active. The pulse and respiratory acts are slow. The

Fig. 1839.

temperature is lower than normal. They seldom live to old age, and easily succumb to intercurrent diseases.

The Sardinian Commission divides cretins into three classes, viz.:

First, cretins manifesting only vegetative functions, and deprived entirely of reproductive and intellectual faculties, including the power of speech.

Second, semi-cretins, possessing the power of reproduction and some faculty of speech; intellectual faculties limited to corporeal wants.

Third, cretinous, having intellectual faculties superior to the former, and able in some degree to engage in trade and other employments.

Figs. 1838 and 1839, copied, by permission, from Bucknill and Tuke's "Manual of Psychological Medicine," are fairly typical cretins.

Some of the distinctive peculiarities which differentiate a cretin from other idiots have been pointed out. It may be well to make a *résumé* of these and others at this point. In the first place cretinism is endemic; idiocy sporadic, occurring in any locality. The toxic origin of cretinism seems, therefore, one of its most distinguishing features. Secondly, cretinism may not appear until after the age of seven, occurring even after adult life. Idiocy is more commonly congenital, the exceptions being universally classed as accidental (inflammatory, traumatic, epileptic, etc.), and always commences in infancy or early childhood. Thirdly, cretinism is susceptible to treatment to a degree unknown in idiocy. Geggenbühl claimed several cures as the result of his treatment, and his assertions have been corroborated by competent authorities. Moreover, proper prophylactic treatment prevents the occurrence of cretinism in the offspring of parents themselves goitrous or cretinous. What measures have been taken which will insure the non-appearance of idiocy in a family with the best history as to nervous or degenerative diseases?

The French Commission propose the following prophylactic measures:

First, to improve the general hygienic surroundings, and increase the well-being of the exposed population.

Second, to change the drinking-water.

Third, to institute, in all localities where cretinism and goitre abound, gratuitous courses of treatment.

Goitre is considered a germ of the disease, which should be treated at once. Experience points to the use of iodine and potassium iodide as the most valuable medicinal agents in the treatment of goitre. Boussingault found, in the Andes, that the inhabitants of certain valleys were free from goitre, though it was common all about them, and this exemption was associated with the use of salt containing iodine. Baillarger suggests, as remedial and preventive measures, that the following course be pursued:

First, that mothers who have previously borne one or more cretinous children be, during subsequent pregnancies, taken to non-cretinous localities.

Second, to send to high and healthy localities in the mountains, and to special establishments erected for their care, children predisposed to cretinism, or in whom its early symptoms are shown.

Geggenbühl, whose success in treatment has already been referred to, considered as of first importance the effects of the air at the high altitude of the Abendberg. Milk formed a prominent part of the diet. Baths and friction of the skin were freely employed. Internally, iron, both the carbonate and the syrup of the iodide, which latter he found of greater value than other forms of iodine. Great attention was paid to cleanliness and gymnastic exercises.

Pathology.—The pathological anatomy of cretinism is as variable as the cases examined are in the mental or physical manifestations.

The skull frequently shows little or no abnormality as to capacity, though occasionally microcephalic. It is usually more spherical in shape than the normal skull. The bones of the cranium are sometimes unusually thick. The base of the skull is not uncommonly the seat of abnormalities, and unsymmetrical development is more often observed here than in other localities. Premature ossification of the spheno-basilar bone, Virchow claimed to be the principal abnormality of cretinism, preventing the proper growth of the base of the brain. Virchow has shown that this ossification takes place in certain cretins during fœtal life. Griesinger is of the opinion that, in a proportion of cases, this tendency to premature ossification extends to all the bones of the body, resulting in

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the distorted and dwarfed figure so often observed in cretins.

The descriptions of the brain of cretins that have been published are, many of them, unsatisfactory and conflicting. As in idiots, in general, the convolutions are of the most simple type, and the sulci shallow and undefined.

The large fissures, *e.g.*, fissure of Sylvius, partakes of this condition. Serous effusions and infiltration are not unusual.

The basal ganglia are not uncommonly ill-developed and of diminished size.

The lamella of the cerebellum have been counted and found, in one instance, to be about half the usual number. The spinal nerves are occasionally given off irregularly.

Traumatic Idiocy. — The distinction between this and the succeeding class, *Inflammatory Idiocy*, is, at times, difficult, and in some instances impossible. A traumatism may be, and frequently before mischievous results ensue is, followed by an inflammation, and the case becomes one of inflammatory idiocy with a traumatic origin.

There are, however, certain cases in which the mischief is apparently due solely to traumatic influences, without other intervention.

Traumatism may occur at any period of infantile life, or early childhood, and even before birth, and especially is the child exposed to it during delivery.

Statistical observations show that the male infant is more liable to diseases of the brain than the female, and it is probable that this increased liability is due to the larger size of the male infant's head, and the consequent increased pressure during parturition.

This question and the subject of injury to the infantile head in forceps delivery, have been discussed under the general head of the causes of idiocy. The practice among some Indian tribes, and elsewhere, though to a less degree, of producing artificial deformities of the cranium, does not seem to be followed by idiocy in any extended numbers. Among the Indians the question cannot be so well determined, but the practice of some of the French, of binding their infants' heads until the shape of the skull is altered—which practice is still to be observed at and near Toulouse—has not been productive of idiocy to any degree of frequency. Blows upon the head, falls, and wounds of various sorts, are stated by parents to be the causes of idiocy in a proportion of cases, but their statements are not always reliable. It is found, sometimes, that the child, said to be idiotic from a fall, is under-developed, that he did not walk till late, that there is a neurotic family history, and investigation shows that the fall or falls are the result, rather than the cause, of an undeveloped mental and physical organization.

Savage ("Insanity and Allied Neuroses") is of the opinion that it is the sudden injury that produces the harm, and the injuries occurring in the first few years of childhood are more liable to result disastrously than those inflicted during intra-uterine life, or at parturition.

There are, doubtless, in every community and asylum cases of idiocy due to violence; and in a classification such as Ireland's traumatic idiocy deserves a place. In many instances the degree of mental enfeeblement is one of imbecility, rather than of profound idiocy. The prognosis as to educability is fairly good. There are no distinctive features, outside of the history of the case, to distinguish traumatic from other forms of idiocy.

Inflammatory Idiocy.—Instances of impaired and arrested mental development are occasionally met following the diseases common to infancy and childhood. Such, for example, are those cases of chronic hydrocephalus, with resulting imbecility, which are the sequel of the acute meningitis of children. The cases just cited belong, however, to a distinct class, and have been described. We have to do, under the above heading, with a separate class. Of those forms of idiocy from inflammation of the brain or membranes occurring before birth, nothing beyond conjecture as to the cause can be expected during life. Many of the cases ascribed by parents to fever are congenital, doubtless, or due to other causes, the defective mental state not being observed until age advanced, or, in some instances, until it was exaggerated and accentuated by impaired physical health.

The grades of mental deficiency are numerous. Under this class may be included cerebral hypertrophy, which not infrequently results in idiocy. In hypertrophy the cranium is more generally enlarged than in hydrocephalus, and the increase is most prominent above the superciliary ridges, while in hydrocephalus it is observed at the temporal region. The mental conditions vary greatly, and in some instances a precocity in one or more directions is observed. The hypertrophy is largely due to connective-tissue changes. Griesinger quotes a case which was examined by Robin. The child was two years of age. The ventricular walls, the great ganglia, the pons, and peduncles were solid and hard; their tissue was elastic, like caoutchouc, the nerve-tubes in the white substance were almost completely destroyed, and an amorphous granular substance occupied their place. There also existed newly-formed, fibrous connective tissues.

Idiocy by Deprivation.—Idiocy by deprivation is that condition which results when a child, either congenitally or in early life, before the mental functions are developed, is deprived of two or more of its senses, and is thus shut off to a degree from the world. As Dr. Ireland puts it, idiocy by deprivation is like a seed which does not sprout, because it is kept away from sunlight and moisture; while incurable idiocy is like a seed in which the germinal faculty has been destroyed; and the higher grades of idiocy resemble seeds in which the germinal capacity is much impaired and the growth enfeebled, so that they require unusual stimulants.

In early times the deaf-mute was, by law, regarded as an idiot, and was incapable of holding property, executing a contract, or giving testimony in court. Since deaf-mutes have been educated, these restrictions have been removed.

Dr. Howe has made this variety of idiocy famous in the now widely known and quoted case of Laura Bridgman. This case was found by him, when six years of age, blind, deaf, and dumb, and almost totally deprived of the sense of smell. These deprivations resulted from scarlet fever, and occurred at such an early age that, when educated, she had no recollection of having ever used the senses which she had lost. By a slow process of education, which necessarily had the smallest beginnings, and could have but one channel through which to work—the sense of touch—Dr. Howe developed, out of the being so shut out from contact with the world, a pupil who is interested in, and appreciates, all the affairs of life, who reads, converses by the sign-language, writes and receives letters, and who at the death of him, who had done so much for her, paid his memory a glowing and, it may well be believed, heartfelt tribute. Having been educated, she in time became an educator, or rather an assistant, and one case, at least, is recorded, that of a child blind and deaf from infancy, in whose education she rendered valuable assistance.

Nervous and Mental Condition in Idiots.—The mental state of idiots varies with the individuals. Some are in a profound condition of hebetude. They lead a vegetative existence, moving when they are moved, eating when food is placed in their mouths, having no appreciation of anything, having, indeed, no wants which they recognize. In others the mental operations are carried on sluggishly, they apprehend but imperfectly, and from limited experience reason—if it can be called reason—imperfectly. In some degrees of idiocy, called by common consent "imbecility," there may be but a blunting of the mental powers, a feeble rather than an unformed mind.

Among imbeciles are found the so-called *idiot savants*—idiots who show marked aptitudes in certain directions.

Blind Tom is an example of the prominence of the musical faculty observed in some idiots. His case, as described by Seguin (op. cit., p. 404), is as follows:

"He is the fourteenth child of a father who had eighteen children, all healthy and intelligent, except one of the last and himself, the idiotic genius. He is well built,

his head is harmonious in its small, oblong, side-flattened shape. His fingers are remarkably thin, considering the constant use he makes of them on his instrument. He is, from birth, nearly absolutely blind, not seeing enough to direct his walk. He appears first, in his unwritten legend, standing up by supporting his hands on the knees of his young master, and following with the movements of his body the modulations of the flute, with which the lad was whiling away the blank hours of a Georgia plantation. Till five or six years of age, he could not speak, scarce walk, and gave no other signs of intelligence than this everlasting thirst for music. At four years already, if taken out of the corner where he lay dejected, and seated at the piano, he would play beautiful tunes; his little hands having already taken possession of the keys, and his wonderful ears of any combination of notes they once heard."

Some idiots have remarkable facility in mathematics, performing complicated computations without, in many instances, being able to explain their process by which a conclusion was reached. Others remember dates, as is the case with an imbecile now under the writer's observation and care, who can give, without a moment's hesitation, the birthday and age at death of any prominent statesman, poet, or author of the century.

The sensory apparatus in idiots is often defective. The degree of defect cannot always be ascertained on account of accompanying mental dulness.

Some cases are, however, wholly insusceptible to pain. Hearing, as has been said, is not unusually defective. Occasionally the condition is congenital, and the relation between idiocy and deaf-mutism, another degenerative state, is quite close, occasionally the two conditions occurring in the same families.

Scrofula, a not uncommon condition in idiots, results in deafness. The sense of sight is not so often impaired as the sense of hearing. Taste is not fully developed in many instances, bitter and nauseous medicines being taken without complaint. The sense of smell is also impaired in a proportion of cases.

Insanity in Idiots.—Idiots, like persons of normal mental development, are liable to attacks of insanity. These disturbances of the already impaired brain manifest themselves in attacks of excitement or depression. Idiot children are observed to pass into states of great irritability, which have prolonged duration. Their character for the time is changed. From being tractable, affectionate, careful in dress and habits, they become unmanageable, violent, inclined to mischievous damage, untidy in their habits, and destructive to clothing. When such attacks are sufficiently prolonged to differentiate them from mere outbursts of passion, which the enfeebled mind cannot control, they become veritable attacks of mania. The writer had under his care and observation at the State Lunatic Asylum, Utica, N. Y., three melancholics who were idiots. The first case was that of a boy seven years of age. The family history could not be ascertained. The mother died when the lad was four years of age, and the father had been killed in the boy's presence by the cars, about a month prior to admission to the asylum. The boy was a congenital imbecile, could talk, and manifested, it was said, about the mental activity of a child of three. Had not walked until quite an advanced age. He was somewhat under-sized. Palate strongly arched.

On admission he was filled with apprehension, apparently of bodily injury. He cried almost incessantly for some days, and refused all food but milk. His mental condition was said to be due to the shock of his father's death, and to follow almost immediately upon it. He was placed among the convalescent women patients, who made a pet of him, induced him to eat and take medicines, and in four months he was in a condition to be removed.

The second case was one of hydrocephalus; an imbecile able to work, no education. Family history unascertained. The mother was very ignorant, and seemed defective. When admitted he was in a semi-cataleptic state. He refused food and was fed by a tube for some months, gaining in flesh during the time. As he evinced more mental life, he showed symptoms of fear, and subsequently said he feared poison. After some months' artificial feeding he commenced to eat, was given light work, attended the entertainments in the asylum theatre, and manifested great delight in them. He was especially pleased with any commendation of his work about the grounds and garden. At the end of two years and five months, during which time he increased in weight nearly one hundred pounds, he was discharged, and now drives a coal delivery wagon.

The third case was one of melancholia with suicidal tendencies, in a microcephalic idiot. The notes of this case are unfortunately not at present in the writer's possession.

Cases of insanity in children are from time to time reported, but it is questionable, in the writer's mind, whether in most instances there is not an antecedent mental defect.

Idiots may contract, if circumstances permit, the habits which persons of sounder judgment fall victims to, and become intemperate or opium eaters. Dr. Carson, Medical Superintendent of the State Asylum for Idiots at Syracuse, N. Y., read, at the annual meeting of Medical Officers of American Institutions for Idiots, October, 1885, an interesting report of the opium habit in an idiot, eight years of age. The boy was one of twins. The mother, thirty-six years of age, at the birth of the twins had acquired the opium habit, at the age of twenty-eight. She had given birth to four children previous to the twins, all still-born. The mother was seized with convulsions four hours after the birth of the twins, which terminated in her death in two days.

The subject of Dr. Carson's article weighed four pounds at birth, the twin brother two pounds. About six hours after birth the children commenced crying, and could not be quieted. The grandmother, other measures having failed, gave them some opium dissolved in water, and from that time they were quieted, when necessary, in the same manner. At the end of the first month the smaller twin died in convulsions. At five years of age the survivor had pneumonia and convulsions. Subsequent to convalescence he had convulsive attacks lasting a few moments, several times a day; once in four to six months a severe epileptic seizure. At the age of seven the child was taking ten grains of solid opium every twenty-four hours. Soon after this, after several abortive attempts to discontinue the drug, the grandmother reduced the quantity taken by the child to one grain at bedtime, which amount he was taking when admitted to the asylum at Syracuse. Since being in the asylum he has had no opium. For a few nights he was restless and did not sleep, but no ill effects were observed to follow its withdrawal.

Growth and Weight of Idiots.—In a paper read at Frankford, Ky., in May, 1881, before the Medical Officers of American Institutions for Idiots, Dr. G. G. Tarbell, of Boston, reaches, after an elaborate inquiry, the following conclusions:

First, that idiotic and feeble-minded children are two inches shorter and nine pounds lighter than normal children of their age.

Second, that the relative *rate* of growth of the two sexes of idiot children corresponds very nearly to that of the two sexes of normal children, and is subject to the same variations at the age of puberty.

In a paper presented to the same body in 1884, in October, and at the International Health Exhibition, London, 1884, by G. E. Shuttleworth, Medical Superintendent of the Royal Albert Asylum, Lancaster, England, almost exactly the same conclusions are reached. He says: "British idiots are shorter than the general population; at five years, by one inch; and ten years, by two inches; at twenty years, by three inches." "Male idiots are lighter than the general population, at eight years, by four and a half pounds; at ten years, by six pounds; at twenty years, by twenty-three and a half pounds."

The discrepancy in weight is greater in males than in females. In regard to the relative rate of growth, Dr.

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Shuttleworth comes to the same conclusions as does Dr. Tarbell.

PATHOLOGICAL ANATOMY.—The pathological conditions found in idiocy have been referred to in brief under the various forms enumerated, a condition resulting, in the majority of instances, from lack of development, rather than from any pathological change. The morbid states of the brain discovered *post mortem* must, of necessity, be of a varied nature, and bear no constant relation to the mental states observed during life.

In inflammatory, paralytic, epileptic, and hydrocephalic idiocy, as well as in idiocy from traumatism, the morbid conditions observed have been the result of inflammatory processes more or less acute. These have taken the form of meningitis, either pachy- or lepto-, encephalitis, localized softening, etc. Several instances of the absence, whole or in part, of the corpus callosum have been reported by Paget, Down, Reil, and others. To these Dr. Wilmarth, Assistant Physician and Pathologist to the Pennsylvania Institution for Feeble-minded, has added two cases. Porencephalus, absence of the parietal or frontal lobes, and of the entire cerebellum have been observed. To sum up, in the words of Griesinger, "there is scarcely any portion of the brain which has not been found either altogether absent or quite rudimentary in these creatures."

Mierzejewski, in commenting on the cerebral defects in idiocy (*Journal of Mental Science*, January, 1879), says that richness of gray matter and abundance of cells may be accompanied by idiocy, the system of communication between the convolutions being arrested; and this "failure in the connecting links," this inharmonious development, renders the whole organ defective. Wilmarth and others have endeavored to show a resemblance in idiot brains to the criminal type described by Benedickt, in the confluence of fissures. Whether their views can be sustained cannot at present be determined; there is no doubt, however, of the correctness of the observations which have ascribed to the idiot brain an extremely simple and rudimentary configuration.

EDUCATION OF IDIOTS.—The earliest mention of an attempt to educate idiots is an account of the labors of St. Vincent de Paul, who gathered a few idiots about him in the priory of St. Lazarus and attempted to instruct them. Though he succeeded in improving the condition of his pupils in many respects, his labors, which extended over several years, produced but meagre results in the way of mental improvement.

In 1801, Itard had placed in his charge a young idiot found in the forests of Aveyron, and proceeding upon the theory that he was a savage, undertook to educate him, endeavoring at the same time to solve the metaphysical problem as to the degree of intelligence and nature of the ideas in a lad who was deprived of education, and had lived separated from his kind (Itard: "De l'Education d'un Homme sauvage," quoted by Seguin). Pinel, who saw and examined the boy, declared him to be an idiot, and such proved to be the fact, though Itard never fully admitted it. Following Itard, Seguin investigated and experimented, and in France, and subsequently in America, demonstrated that idiots could be educated, and in many instances, by means of education, wholly or partially reclaimed. Schools were established in Hartford, Conn. (1818), at the Bicêtre (1828), at the Salpêtrière (1831), and by Voisin in Paris in 1833. None of the schools in Paris, either at the asylums or the independent establishment of Voisin, succeeded.

In 1840, Geggenbühl opened his school for cretins at the Abendberg, and at about the same time a school was established in Berlin for idiots in connection with an establishment for deaf-mutes.

Haslam, writing as long ago as 1819 ("Sound Mind; or, Contributions to the Natural History and Physiology of the Human Intellect," London, 1819), seems to have grasped the idea afterward put into execution by Dr. Howe. He says, in commenting upon a case described by Wardrop, the ophthalmic surgeon, of a boy born nearly blind and deaf: "Had this boy been confided to my management, I should have endeavored to educate him through the medium of his touch, so as to communicate his wants and afford an occupation to his mind. Thus, if milk had uniformly been served to him in a bowl, beer in a mug, water in a decanter with a glass stopper, and wine in a decanter with a cork; if these had been arranged in his apartment, he might have indicated his wish for any of these liquids, by producing the vessels that contained them; the two latter might have been subsequently abbreviated, by producing the glass stopper for water and the cork for wine."

This is of interest, as compared with the method of Dr. Howe in the case of Laura Bridgman. He commenced by placing in her hands a pin and a pen, and teaching her their difference through the sense of touch. From this he led up to the difference in the symbols of the deaf-mute's alphabet for pen and pin. Dr. Howe proved by this case the fallacy of Haslam's remarks upon the case above referred to, that, "being deaf, he could not have acquired the instrument of thought—language." His pupils acquired a free use of written and sign language.

The first systematic effort, after the earlier and irregular efforts in France, was made in the United States to educate idiots, and the schools of this country have deservedly been models, imitated by many instructors, but surpassed by none.

The United States census of 1880 returns fifteen institutions for the care and training of idiots. These institutions are in ten different States, and on June 1, 1880, had 2,429 inmates, 1,390 males and 1,039 females. Education must necessarily have with idiots small beginnings, and must be directed toward physical as well as mental training. The idiot, in many instances, must be taught to use his hands, his feet, his eyes, his tongue. He does not know how to co-ordinate his muscular movements. His motions are awkward and rude. All these defects must be corrected often, as the very ground-work to mental training.

The leading principle in the education of idiots is to study each case by itself, and to adapt the training to its peculiar deficiencies. The time at which training should commence depends somewhat upon the case. When there are physical malformations or diseases which may succumb to treatment, the subsequent training of the child will be much facilitated by early attention to these matters. Idiots are frequently so backward in general development that, at the age of fourteen and even older, they are not unusually no farther advanced than a child of six. There can, therefore, be no arbitrary rule made as to the age at which these children should be sent from home. The best results are doubtless to be obtained in institutions, and the opinion of those experienced in the care and training of these defective beings should be at once sought in individual cases. As the results of training, some remarkable cases are cited in works on idiocy and in reports of various institutions.

Occasionally there have been sent out young men and women from the training-schools, who have led useful lives and been able to mingle with the world without exciting any suspicion of their former state of mental weakness. Saegert, of Berlin, declared that he had accomplished this with idiots with small and malformed heads.

LEGAL STATUS.—Coke, under the head of those whom he declares are *non compos mentis*, and whom he divides into four groups, places: "I. Idiota, which from his nativitie by perpetuall infirmitie is *non compos mentis*." Coke, therefore, declares an idiot to be one who, *ex nativitate*, is deprived of his mental faculties. Practically this would be difficult to prove, and it is of no consequence in deciding an issue, whether the mental deficiency is congenital or acquired during childhood. Under the early English law this may have had some bearing, for the writ *de inquirendo idiota et examinando*, directed the commission to inquire whether the person concerning whom the writ was issued was an idiot from his birth, in which case his lands and tenements belonged to the king, who held them for the idiot's support; or fell by accident or sickness into the idiotic state, in which case his property did not pass into the hands of the king.

By common law an idiot cannot make a contract, sue, or be sued (except through a committee appointed after an *inquirendo de idiota*), nor can he appear as a witness in a case. As the result of a curious disinclination to interfere with the ballot, an idiot cannot be prevented from voting, if of age and holding a legal residence in the polling district.

Being *non compos mentis*, idiots cannot be held accountable for their acts; but in some States can, if those properly charged with their support neglect or refuse to care for them, in case of their becoming violent or doing harmful mischief, be apprehended as persons dangerous to be at large, and duly committed to a proper asylum, at the expense of their estate, if there be any. (Chap. 446, Laws of N. Y., 1874, Title I., Art. 1, Sect. 8.) In some States idiots are under special laws, but in others the laws governing lunatics are made applicable to them, as in New York, where the statutes as revised and codified in Chapter 446, Laws of 1874, and as since amended, apply to "idiots, lunatics, and all of unsound mind."

Edward N. Brush.

INSANITY: GENERAL PARESIS. General paresis of the insane was unknown at the beginning of the present century, but it is now one of the most typical, most common, and most deadly types of insanity. The probabilities are that some similar variety of insanity has always existed, but that, owing to the complexity of the symptoms, it was never separately recognized; and it is only by the zealous labors of many investigators that its varied features have been brought out in such bold relief that the clinical picture can never be mistaken.

The differentiation of general paresis as a distinct disease was begun by Perfect, who drew attention to forms of paralysis among the insane at the close of the seventeenth century. A few years later Haslam, another Englishman, gave a clear description of the paralytic symptoms, and he also mentioned that exalted ideas were common in paralytic patients; but he failed to give a name to the group of symptoms, or to make a clear distinction of a separate form of insanity. Esquirol, in his prognosis of cases, was fully aware of the gravity of paralytic symptoms associated with disturbances of speech, but the honor of the farther description of general paresis was shared by his pupils, Georget (1820), Delaye (1824), and Calmeil (1826), who each contributed a portion to the earliest literature of the malady. Calmeil deserved and received great credit for his monograph on general paresis among the insane, but he still regarded the paralytic symptoms as mere complications of the insanity. Bayle (1822), in his graduating thesis, first described the inflammatory lesions of general paresis as the basis of a distinct disease, of which the exalted delusions were accompaniments. After the publications of the two principal discoverers, Bayle and Calmeil, contributions of value were made by many writers—by Foville, Parchappe, Requin, Lasègue, Baillarger, in France; by Hoffmann, Duchek, Meyer, and Rokitansky, among Germans; by Austin, Sankey, Clarke, and many others, in England; and, in fact, the bibliography is as surprising in extent as the malady is remarkable in itself. A variety of names have been proposed for the disease, and by the French it is termed "paralysie générale," by the Germans "allgemeine progressive Paralyse," and in England and America it is most generally known as general paralysis of the insane. Some confusion has arisen from this latter term, and the title here employed has been proposed in England as less open to objection. It is known popularly as softening of the brain, or at least this vague expression is often used in connection with these cases; and physicians sometimes speak of it as paralytic dementia, which is a much more exact term; but still the latter is not desirable, from the fact that there are several kinds of dementia with paralysis.

General paresis is a disease of the cerebro-spinal nervous system, manifested by progressive motor inco-ordination and paralysis, and by a mental and moral deterioration that ends in extinction of psychical life. The disease involves progressively the trophic, vaso-motor, sensory, motor, and psychical functions of the nervous centres. The higher mental powers and ethical feelings first fail, at the same time that the more complex muscular adjustments of speech, gait, and other skilful habits are first impaired.

The average duration of the malady, from its invasion to a fatal termination, is about three years.

ETIOLOGY.—Some account of the causes of this peculiar disease will be first in order, before a description of its symptoms is given.

In arriving at conclusions as to its etiology, some general facts in its history are significant. In the first place it is a disease of highly civilized life, and its victims are often the most active business and professional men of large cities. It abounds where the bustle and stir of life is most active, the competition most keen, and the struggle for existence most severe, and in quiet and peaceful agricultural districts it is very rare. It is uncommon in many parts of Scotland, Ireland, and also of the United States, in which the habits of life are simple and hygienic, and it would only seem to become a scourge to those pursuing the highly artificial and selfish life of pleasure-seeking and money-making in large communities.

Another strange fact in the history of the malady is the great preponderance which has always existed of males over females attacked. It was doubted, for a time, whether females were ever affected by it, but it is now known that they furnish about one-sixth of the cases, which are not as decided in the general display of symptoms as the masculine types. Another exceptional fact is that among the higher classes women are extremely seldom afflicted by general paresis, whereas there is no exemption among men of any class, and of course this distinction is more evident in other countries having wider differences in the grades of society.

Again, it is found chiefly from thirty-five to forty years of age, at the period of greatest functional activity of mind and body, and it rarely occurs before thirty or after sixty years of life have passed.

Heredity is not to be traced very often among those attacked, and it has been estimated that not more than fifteen per cent. of the cases are due to transmitted taint.

Occupations in some instances seem to favor the development of the disease. In countries having large armies and navies, a high percentage of cases are attributed to the influences of military life. Those exposed by their occupation to a high degree of artificial heat furnish an undue share of cases. The learned professions, and all the more arduous callings, yield more than an average number of cases. Politicians, speculators, and all living precarious lives of sudden changes and great excitement, are especially liable to general paresis, and among women prostitution and its attendant miseries are causative influences.

Rapid childbearing, exhausting household duties, domestic grief, and sexual diseases are also causes among women, and they are doubly efficacious if there are superadded the effects of loss of sleep, insufficient food, bad air, and the use of artificial stimulants.

In the case of men the evil pre-eminence among causes is to be accorded to alcoholic and sexual excess. Not a few authors regard sexual excess alone as the most potent of all influences, and mention has been made in this regard, not only of promiscuous intercourse, but equally of over-indulgence in married life; and, contrary to what might have been supposed, masturbation has very rarely been regarded as a cause. Syphilis may produce general paresis, but the ordinary form of alienation arising from the action of the luetic virus is a pseudo-paresis, which is curable in many cases, and which, like the pseudo-pareses of alcohol, lead, and other toxic agents, cannot be viewed as a true form of general paresis.

Traumatic injuries of the head have been followed by general paresis in rare instances, and insolation is said to have been the origin of a few cases; but in both these instances it might be questioned whether the malady was not a pseudo-paresis.

In general, it may be stated that whatever causes are capable of creating prolonged states of cerebral hyper-

æmia may lead to general paresis in one predisposed to the disease.

There are certain diseases of the nervous system preceding general paresis that are to be mentioned in connection with its causation, and the chief one of these is locomotor ataxia. The general pathological process in this affection is similar to that which takes place in the cerebrum in cases of general paresis without spinal symptoms, and in cases known as "ascending" the ataxic spinal lesions extend to the brain-tissues. In other cases, termed "descending," there is an extension of cerebral paretic lesions to the cord, and the ataxic symptoms are then secondary. The coexistence of paresis and ataxia is so frequent that it cannot be attributed to mere coincidence, and there is undoubtedly an intimate relation between the two affections.

Some writers incline to the belief that not only spinal disease, but also lesions of the peripheral nerves, may lead to general paresis, and ascending neuritis beginning in the optic and sciatic nerves has been mentioned in this connection ; and others, still, are inclined to trace some causative relation between labio-glosso-laryngeal paralysis and general paresis.

Rheumatism, fevers, acute inflammations of thoracic or abdominal viscera, and all diseases that undermine the general constitution, have been brought into theoretical consideration by writers seeking causes for general paresis; but, so far as any single physical factor is concerned, it may safely be affirmed that the etiology of this type of insanity is an unsolved problem. No more definite success is attained in the search of a single adequate cause among psychical influences. It does not follow a sudden emotional shock, like primary dementia, and severe intellectual exertion alone will not occasion it. Neither the ordinary emotions nor the petty cares of life, which are the common heritage of all men, suffice for its production.

What, then, is the etiology of general paresis ? In the minority of cases—among sailors, soldiers, and prostitutes, and certain other exceptional classes—it is due to excesses, irregularities, and exposures ; while in the majority of cases it is to be attributed to the artificial mental, moral, and physical conditions of modern city life. It is the result of a combination of causes, such as greed for money and social position, the strife, bitterness, and disappointments of life, the intense pursuit of business to the exclusion of all rational diversions, the exciting and unhealthful nature of amusements, social extravagance and rivalry, lack of simplicity and sincerity in the home circle, with every form of domestic worry and married misery, the loss of sleep, insufficient or badly prepared food, overheated and impure air, absence of exercise in the open air, and a host of other unhygienic influences. When successive generations are born and bred in this highly artificial environment, there is developed an extreme excitability of cerebral nervous centres, revealed by intense functional hyperæmias of cortical regions, ending finally in the pathological changes of general paresis. The malady, then, is the result, not of one, but of a thousand deleterious influences of modern civilized life, and it has as its essential basis an instability of the nervous system which is but the cumulative expression for the operation of all of the above causes throughout successive generations. The special order and nature of the structural lesions will be described under the head of Pathology.

Symptomatology.—A general outline of the course and symptoms of the disease will first be traced, and then a separate analysis of the psychical and somatic phenomena will be given.

The general course of this malady may be divided into three stadia : The first is an incubatory stage of gradual change of thought, feeling, and action ; the second is an acute stage of active maniacal or melancholic manifestations with well-marked remissions ; and the third stage is one of mental and physical deterioration, and of terminal dementia.

The incubatory stage may last from a few weeks to a a year or two, and writers have even stated that its duration might be for five or ten years, or even for a longer time ; but this is an utterly unpractical view of the subject. Many forms of insanity are the result of the gradual modifications of mind and body brought about by life-long influences, and mutability is a constant attribute of all human character ; and to include all preliminary changes of mind and disposition among the actual symptoms of the disease is most unscientific. The actual manifestations of the affection are due to a pathological process in cerebral tissues that often ends fatally within a few weeks or months, and that seldom lasts more than three or four years ; and the prodromal stages of many years have probably occurred in primary monomania that has ended in general paresis, or some other like mistake in diagnosis has apparently been made in the reported cases with an incubation of such extraordinary length.

The symptoms of the incubatory stage are slight changes in character—an emotional frame of mind, and loss of self-control and of a nice sense of propriety of conduct ; partial amnesia, so that familiar names and recent events are forgotten ; exaggerated self-confidence, that leads to rash business ventures and undertakings far beyond the patient's abilities ; increased sexual desire, that may cause gross immoralities of conduct ; a longing for alcoholic stimulants, and unusual susceptibility to their effects ; slight inco-ordination of speech or gait, or of other complex movements ; defective innervation, or fibrillar twitchings of facial muscles ; a change in the pitch and quality of the speaking and singing voice ; increased organic need of motor activity, amounting to great restlessness, and a heightened sense of physical well-being.

During this stage the patient becomes relax in his business, which he may neglect for new speculations or larger enterprises, and his unbounded confidence in his financial ability sometimes leads to ruinous investments. He is also inclined to form many new acquaintances, usually of an inferior sort, and to indulge in convivial and prodigal habits ; and if the genesic tendencies are over-active, as is often the case, disgraceful and open debauchery becomes a part of the new order of things. At home the patient is irritable and unreasonable—he abuses the servants and scolds his wife and children, and on slight provocation he displays violent outbursts of temper. His forgetfulness and lack of firmness of purpose make him a somewhat easy subject for management, if he is skilfully diverted from one thing to another ; but direct remonstrance or attempts to thwart his undertakings throw him into a state of great emotional excitement. Some occasion of towering rage, thus provoked, not infrequently forms the introduction to the second stage of the disease.

A maniacal outbreak is apt to be the beginning of the second stage.

All the physical and mental phenomena of the typical maniacal state are present, and the only essential additions are the intense cœnæsthetic exaltation and the absurdly exaggerated ideas and delusions. These megalomaniacal conceptions are present in about two-thirds of the cases, and as they differ from the delusions of monomania in that they are not organized, they are highly diagnostic ; but they are not pathognomonic, as they are found in a few other types.

All the paretic symptoms during this second stage become more completely developed : the tongue is protruded with a jerking movement ; the separated fingers of the outstretched hand may have a tremor ; spasmodic twitchings of the lips, eyelids, and facial muscles are frequent ; the articulation of consonants, and more especially of labials and linguals, becomes imperfect in words having an unusual proportion of these sounds, and the timbre of the voice becomes very characteristic ; the gait at times is more evidently impaired than at others, as is also the co-ordination of the upper extremities ; the muscular habits requiring fine adjustment are lost ; the handwriting becomes tremulous and irregular, and the mistakes in spelling show the rapid amnesic failure.

The maniacal excitement is often extremely violent, and the patient may die from exhaustion, but if he survive this first storm of the malady he is left in a state of

mental and bodily weakness. He still has the exaggerated ideas and the contented frame of mind, though, from emotional weakness, he may cry like a child on slight provocation. He still declares that his health was never better; that he is the strongest man in the world; that he can eat more and drink more than any man living; that he does not need any medicine, and that he will cure all the sick people in the world with one dose of medicine, and then take them on a pleasure trip in one of his big yachts. There is no limit to the extravagance of the conceptions, except that which is set by the disease itself, for, as memory rapidly fails, the raw material supplied to the phantasy for delusion-building diminishes.

The vaso-motor disturbances of this second stage are often very great. The apoplectiform attacks may even precede the maniacal outbreak and cerebral congestions; hæmatoma auris and other occurrences point to vaso-motor paresis.

The third stage of general paresis has now been reached, and its symptoms are those of progressive dementia and paralysis. The patient has no longer any recollection of recent events, and he mixes up dates, places, and persons in a hopeless confusion. Near relatives may be recognized, but their visits are immediately forgotten. The number and names of his children are forgotten; there is not the slightest appreciation of the lapse of time, and weeks are like hours to the patient. The walk is unsteady, with feet wide apart and dragging or shuffling, and a fall is apt to follow sudden attempts to turn, or the meeting of any unevenness of surface or of any slight obstacle. The speech becomes more drawling, stuttering, and inarticulate, until finally it is unintelligible. The vaso-motor disturbances are more constant, and apoplectiform, epileptiform, and hemiplegic attacks, or the status epilepticus, may occur. The patient finally dies in profound dementia, from general exhaustion, marasmus, decubitus, pneumonia, or gangrene of the lungs; or the fatal result occurs in the status epilepticus, or from suffocation, by food lodged in the pharynx or larynx, if proper care is not exercised in the preparation and administration of nourishment.

The foregoing is a general outline of the ordinary course of general paresis, but in exceptional cases there are important variations in one or in all of the stadia.

The prodromal stage of gradual alterations of character may be wanting, or at least so latent as to escape all observation, and the malady is initiated at once by mania or an apoplectiform seizure. In other cases an ordinary attack of mania or melancholia is followed by an imperfect convalescence, and then general paresis is developed; or it forms the termination of primary monomania, or follows locomotor ataxia. The exception for the second stage is that it may be melancholic instead of maniacal. The emotional gloom is essentially cœnæsthetic, and it will be found to be due to disturbed organic sensations of visceral or peripheral origin. Not infrequently the physical examination will reveal organic disease of the thoracic or abdominal viscera, and in other instances there are severe neuralgic and paræsthetic pains. The melancholia occasionally has a distinct hypochondriacal form, but the progressive weakness of mind and the childish and unrestrained play of phantasy are present in the hypochondriacal delusions, which are still of the absurd or impossible kind. The convulsive seizures are not usually so frequent in this variety of the second stage, which is ordinarily of longer duration than the maniacal form.

Finally, the exception in the third stage is that, instead of an unbroken progress of all the symptoms to a fatal termination, there is an astonishing remission of the bodily and mental phenomena of weeks' or months' duration, and a convulsive seizure usually announces the renewal of the downward course.

A decided exception to the usual course of general paresis is the absence of the stadia as above described, as well as of all active psychical symptoms. There is a gradual enfeeblement of all the mental powers, and the physical symptoms progress more slowly than usual to a fatal end.

The general course of the disease has now been traced, and a brief analysis of symptoms will next be given, beginning with the mental phenomena.

Perception is variously impaired during the disease. The kinæsthesis, or muscular sense, which is so essential to co-ordination of movements, is involved at an early period, and it is finally completely lost. There are lesions of the sense of touch in most cases, taking the form of anæsthesia, paræsthesia, or analgesia. Thermo-anæsthesia is often marked, so that patients will stand against hot steam-coils, or stoves, and burn themselves without perceiving it, if they are not watched. Hearing is sometimes functionally disturbed, and a decided difference between the two sides will be found temporarily, and tinnitus aurium and auditory hallucinations are common. Visual perception is seldom perfect throughout general paresis, and amblyopia and amaurosis are often due to circulatory disturbance; and when they are not of vaso-motor origin they are the result of actual lesions, and ophthalmoscopic changes are often to be detected, such as choked disk and, later, gray atrophy. Other lesions of perception are gustatory anæsthesia and anosmia. The latter has been found, in a few cases, to be due to atrophy of the olfactory bulbs.

Consciousness suffers various degrees of eclipse during the progress of the malady. It is lost in attacks of sudden syncope, and in the apoplectiform seizures, as a rule; but it is partially retained in many of the epileptiform seizures. In the final stage it often becomes very obscure and dream-like.

The progressive amnesia is one of the most characteristic symptoms of general paresis, and it is one that is constant in all the varieties of the disease. All past events are gradually erased, and the tablets of memory are destroyed by progressive cortical lesions. Recent occurrences, dates, names, foreign tongues, and all late acquirements are first forgotten, and then whole portions of existence drop out of recollection, and the use of language fails, so that only the simplest sentences are constructed; and words and the conception of the movements of articulation are finally lost, and the resulting aphasia is both amnesic and ataxic. The patient forgets how to write, and also how to express his wants by gestures; but the agraphia and amimia are seldom present before the third stage. The remissions seldom bring a complete recovery of memory.

The rational powers of mind are impaired very early in the disease, and, next to the memory, they afford the most characteristic evidence of the nature of the disease; for whatever restoration of mind may take place in other directions, the higher processes of thought are never regained during the remissions. The patient may return to routine employment or to business transactions, but he cannot originate, invent, or compose, or do anything requiring the use of the highest powers of mind. Ordinarily the complete failure of the logical faculty is evident in the delusions, which are so devoid of all ideas of rational sequence and so contradictory of the universal relations of time and space.

The prevailing emotional state in typical general paresis is more constantly and intensely expansive than in any other form of insanity. The pleasurable frame of mind is due to some deeper cause than the presence of agreeable emotions. The expansion of feeling springs from deep organic sources, and the exalted cœnæsthesis is one of the most permanent and highly diagnostic features of general paresis (see cœnæsthesis in the general article).

The rapid moral deterioration in this disease is due in part to amnesic failure and loss of standards of comparison in conduct, as well as to morbid strength of the animal desires. Thus, through loss of discrimination as to what is proper, and increased sexual appetite in the early stage of the disease, the patient very often makes gallant overtures to ladies even in the presence of his wife, or, through abnormal desire for artificial stimulants, he gives himself over to alcoholic excesses. In most insanity, loss of altruistic sentiments and antisocial tendencies are early symptoms, but the general paretic may have social and generous feelings so long as he is capable of any distinct emotions.

Hallucinations and illusions are not infrequent in general paresis, more especially in the first stage or in the maniacal exacerbations. Auditory are more common than visual hallucinations, and tactile illusions occur in all the stages. Gustatory and olfactory hallucinations exist, and the latter are sometimes due to lesions of the olfactory bulbs. Peripheral disease is also the occasional cause of the hallucinations of sight and hearing.

The delusions correspond in the main to the prevailing emotional tone, which in turn is based on the expansive cœnæsthesis. When, from visceral disease or other causes, the resultant of all the sympathetic sensibilities is a painful state of organic consciousness—a depressed cœnæsthesis—a most interesting and remarkable change takes place in the delusions of the general paretic. His inflated ideas collapse, and he now minimizes things in the same way that he formerly exaggerated them. The depressed cœnæsthesis in exceptional cases continues throughout the disease, and the delusions are then of a melancholic or hypochondriacal character.

Volition, as the highest function of mind, is one of the first to suffer in general paresis. The loss of control both of actions and of ideas is one of the earliest symptoms, and in the fully developed stages there is no longer any volitional direction of the thoughts, and consciousness is filled with the creations of a morbid phantasy, and with such sensorial impressions as chance to arise. This failure of will-power and of all persistency of purpose makes the general paretic a comparatively easy subject for management.

Morbid impulses are common in the acute stages of general paresis, but they are seldom permanent. During the maniacal periods there may be active perversions of the instincts, but these, too, are ordinarily brief. Homicidal and suicidal tendencies are rare, but the fact of their occasional occurrence must be borne in mind in cases treated outside of an asylum. A morbid desire for stimulants is common, and the natural appetites are often exaggerated, and both polydipsia and polyphagia are common symptoms. The great increase in the sexual appetite in the early stage is followed by loss of sexual desire and by complete impotence. In a few cases libido persists and gives a tinge to the delusions long after the physical function has been lost.

The apparently kleptomaniacal propensities of the general paretic consist mostly in an automatic appropriation of whatever articles attract his attention rather than in any perverse desire to steal, and in the demented stage he still continues to accumulate things when he is no longer capable of the making of any distinctions as to ownership.

The somatic phenomena of general paresis are very constant and important, and they will next receive such notice as the limits of this article will permit.

The convulsive attacks may appear as an initial phenomenon, but they are more apt to occur as the disease advances, and they are most frequent in the final stage. They vary much in their character, duration, and effects, and they may be divided as follows:

1. Attacks of syncope, in which the patient suddenly loses consciousness, and falls to the floor if standing or sitting, and recovers in a few minutes, as if from an ordinary fainting fit, and without any serious sequels.

2. Apoplectiform seizures, which vary much in suddenness and extent. In one form there is very gradually developed a comatose state in the course of twenty-four hours, and during the second day the patient returns to his former condition, except that he is more stupid and a little more clumsy in his movements; but there are no additional signs of paralysis of arms or legs. In another form the patient, while retaining consciousness, suddenly loses voluntary control of one arm or leg, or suffers complete hemiplegia which may last for hours or days, and which on recovery may be followed by increased inco-ordination on the side affected. A final form is a fully developed apoplectiform seizure, with loss of consciousness and hemiplegia, which is apt to be of months' duration, and may be permanent and accompanied by aphasia. This form of seizure is sometimes fatal, and there is usually relaxation of the sphincters of the bladder and rectum and other signs of profound coma.

3. Epileptiform convulsions, which may take the shape of epileptic vertigo and of brief loss of consciousness, without clonic spasms, or of completely developed attacks having all the features of epileptic fits, but having a more prolonged comatose or stuporous stage and a most unfavorable effect on the general physical and mental condition of the patient.

In other remarkable instances consciousness is retained and the convulsions are unilateral, and they may continue for hours or days together. Finally, there is the status epilepticus, with great rise of temperature and the possibility of a fatal result if relief is not effected within a day or two.

All of these convulsive seizures are almost sure to recur and to hasten the course of the disease.

The vaso-motor disturbances are in the main of a congestive nature, and they are in some instances allied to those just described, and they are the result of a progressive vaso-motor paresis. These are vertigo, cephalalgia, congestions of the head and face, and circumscribed capillary hyperæmias of various parts of the body, which sometimes presents a mottled appearance. These local congestions may be attended by a rise in temperature. There is increased arterial tension in the early part of the disease, but in the later stages the pulse is monocrotic, and the sphygmographic tracing shows a characteristic tremor of the line of descent. Other appearances, that are vaso-motor and trophic, are the hæmatoma auris and rhinhæmatoma, for a description of which the general article on Insanity may be consulted. In the final stage the capillary paralysis is complete, and the extremities are cyanotic and cold, and œdema is frequent. Other trophic phenomena are excessive sweating, which may be colored or sanguineous, or confined to one side of the face or body; but chromidrosis, hæmidrosis, and hyperidrosis unilateralis are rare, and they are most apt to occur in the second stage of the disease.

An important trophic symptom is decubitus, which occurs at all points of pressure, and often proves rapidly fatal from extensive death of tissues and exhaustion, or septic poisoning of the patient. Gangrene of the lungs is sometimes a sequel of the decubitus. Other symptoms of trophic origin are herpes zoster, pemphigus, and pigmentation of the skin; also calvities that may be confined to certain portions of the hair.

The bones are subject to two kinds of changes; and they either become soft and pliant, from absorption of the phosphate of lime, or the animal constituents are greatly diminished in proportion to the earthy matter and extreme friability results, and accounts for the frequency of fractures among general paretics.

The joints, too, are subject to a variety of affections, and these arthropathies are especially frequent in cases complicated with locomotor ataxia.

The motor phenomena, however, are, of all others, the most obvious and characteristic. The most typical symptom of this class is the muscular inco-ordination, which progresses steadily throughout the whole course of the disease. The special muscular mechanisms of the most complex adjustments are first affected, and finally every voluntary group of muscles becomes involved. The impairment of speech is due to motor defect of the lips, tongue, soft palate, pharynx, and vocal cords, as well as of other laryngeal muscles, and loss of memory is accountable for a part of the hesitation in utterance. Unsteadiness of the diaphragm and of other respiratory muscles is in part responsible for the tremulous nature of the voice, and the nasal timbre is the result of palatal and pharyngeal relaxation.

The failure in the utterance of single consonants is due to labial and lingual inco-ordination, and the paretic stutter arises from spasmodic action of the lips, tongue, or vocal cords. The glottic spasmodic closure is rare, and the labial spasm is the most common, and the stutter in the early stage may be purely psychical in origin. The drawling manner of speech is due to the general lack of innervation of the vocal organs, as well as to mental lethargy.

It is an interesting proof of the fundamental nature of accent and rhythm in the English language that the general paretic who may have forgotten most of his mother-tongue still shows an appreciation of syllabic accent, and of the proper emphasis of phrases; and, likewise, paretic singers who have lost their musical voice and memory show that they retain the idea of the rhythmical accent of phrases.

The gait in general paresis is typically ataxic only in those cases that are preceded by locomotor ataxia, and not in those that are followed by it. The first sign of change of gait is usually simple clumsiness or stumbling on the part of the patient, who may fall at street crossings or in going up and down stairs, or he may become awkward in dancing or in athletic sports. The fully developed paretic gait is slow, stiff, and with short steps and widely separated feet that are only slightly lifted from the floor. The patient is finally unable to walk without support, but voluntary power of muscular contraction remains after inco-ordination is complete. Other symptoms of motor disturbance are twitchings of facial muscles, fibrillary contractions, and clonic spasm of single muscles or of groups of muscles, strabismus or nystagmus, subsultus tendinum, and rarely tonic spasm of muscles or tetanoid conditions.

The contractions and dilatations of the pupil are found in most cases at some time during the disease. Myosis is most common in the early stage and mydriasis in the final stage, and inequality of the pupils is more significant than either of them, if it be not due to iritic adhesions. If there is frequent change in the state of the iris, it is a still more important sign. The pupil sometimes fails to contract on exposure to light, and still contracts on efforts of accommodation. These pupillary alterations may be dependent on such a variety of causes that they are not of much practical use in diagnosis or prognosis, except as confirmatory evidence of central disease in connection with other signs.

The handwriting of the general paretic shows failure of memory ordinarily before the loss of co-ordination. Mistakes are made in spelling, wrong consonants are employed, or vowels may be omitted, or the correct idea of the form of the letters may be forgotten, and every imaginable chirographic error may thus occur. The ataxic features of handwriting are irregular letters—broken lines both in the upstrokes and downstrokes, the unequal size of the letters, and a paretic tremor most visible in the unshaded lines. Apart from these amnesic and ataxic signs, the chirography in general paresis does not furnish any specific aid in diagnosis. The dysphagia is often a troublesome motor complication, which is due partly to œsophageal and pharyngeal anæsthesia, and to paresis of the muscles of deglutition in the final stage. Through anæsthesia of the larynx, portions of food lodge there and may become the source of inflammation. The masticatory spasm of the final stage is often a constant motor symptom, and the teeth sometimes are loosened by this automatic grinding movement.

The superficial and deep reflexes are often lost in the fully developed disease, and this is markedly the case in paresis complicated with locomotor ataxia. The gastric and bronchial crises of the latter disease may appear during general paresis of the ascending type, as may also many of the ataxic sensory disturbances.

The temperature of the body undergoes wide variations in general paresis. First there are local differences of cutaneous temperature, especially of the head and face, due to vaso-motor disorder. Then there is the rapid rise of temperature during the maniacal exacerbations and in connection with the convulsive seizures, which may be preceded and are almost always attended by an increase of bodily warmth which may reach a very high degree (102° to 108° F.).

There is often a daily fluctuation of several degrees, with the highest temperature in the evening, and the difference between the morning and evening temperature is the best test; and the presence of a wide variation, if continued, is an unfavorable sign. In the final stage very low temperatures are occasionally present.

Finally, it may be said that in women all the symptoms are less pronounced, and that the general paralysis progresses more gradually to a fatal termination.

The closing scene of this terrible malady finds the patient bedridden, helpless, and requiring as much attention as an infant. The control of the sphincters is lost, the body becomes emaciated, and bedsores are almost inevitable, and the patient passes away by some of the modes of death already mentioned.

Pathology.—The pathology of general paresis has been the object of laborious research on the part of many able investigators, and there is a somewhat satisfactory agreement as to the main facts in the origin and nature of the disease. In the immense majority of cases very decided pathological lesions of the central nervous system are to be seen with the naked eye, as well as with the microscope. A few cases have been reported in which the characteristic lesions were not to be found.

The main fact is that general paresis is the result of a progressive degeneration of the encephalo-spinal nervous system, attended by subacute inflammatory changes in the membranes of the brain and cord. This degenerative process may begin in the cerebrum or in the spinal cord, and it may involve the central cerebral ganglia, the pons, the medulla, the cerebellum, and the ganglia of the sympathetic nervous system; but its most constant regions of predilection are the frontal lobes of the brain and the posterior parts of the cord. The pathological changes are not confined to any special order of tissues, but they occur in the vessels, ganglionic elements, fibres, neuroglia, and ependyma of the ventricles. The gross morbid result is wasting of the brain and cord, with local areas of increased or diminished consistency, with evidences of repeated congestions and effusions to replace the atrophy of the nervous elements. There are many modes of onset of general paresis, and it would not be in accord with clinical facts to suppose that the pathological processes always begin in the same way or pursue the same course. In some cases the membranes, and in others the essential tissues of the brain or spine, may be the point of departure of the morbid changes, and in others still, it is probable that the sympathetic nervous system is first involved; and in the rare instances of entire absence of pathological lesions, it is necessary to suppose that there are molecular and biochemical changes in the cortical cells that escape detection by our present means of research.

If some hypothesis is desired for the very earliest source of pathological change, it may be found in defect of vasomotor innervation, and in resulting angio-paresis and cerebral congestions, as suggested by some French and German authors. It is the writer's opinion that there is a still earlier source of the morbid processes, which is to be found in the essential nutritive and vital condition of the ganglionic cortical elements. In the most typical cases of general paresis, the earliest symptoms are those of functional disturbance of cortical cells. It is because the ganglion cells are in a morbid state of excitability, and respond with undue activity to outward impressions, that they demand and attract an excessive supply of blood, like all organic cells in a condition of great excitation. Between the psychical causes and the vascular disturbances there intervene the ganglion-cells that receive the outward impression and determine the manner and degree of its physical effect. In the most typical cases, no theory better tallies with the facts than that the ultimate genesis of the morbid process is in the cortical cells, and that the vascular disturbances are secondary to the earliest order of nutritive intracellular changes.

The gross autopsical brain-appearances will first be described, and then the microscopical changes of the various tissues will receive such brief description as limited space will permit.

The following post-mortem findings are common in cases that have reached the full height of the disease:

The calvarium is found thickened in some cases, and it is eburnated in rare instances. It is in other cases thinner than normal, and slightly diaphanous in places, but ordinarily the principal change is extreme vascularity of the diploë, which may be increased at the expense of both

the inner and outer table of the skull. There is sometimes proliferation of osseous tissue, and exostoses of the inner table are not very rare.

The dura mater is usually found thickened and adherent to the calvarium, and bony plates are sometimes present in the falx cerebri. There are not only blood-pigment stains of the dura mater, but all the appearances of pachymeningitis may exist, and even hæmatoma of the dura mater may result.

The arachnoid frequently appears thickened and opaque, and it may adhere both to the dura mater and to the pia mater.

The pia mater is usually not only thickened, but infiltrated, and considerable local hyperæmia is to be seen in certain areas, and opacity along the course of the larger vessels is common. It adheres to the cortical substance strongly at the summit of the convolutions of the vertical and parietal regions, and it occasions on its removal a ragged and perforated appearance of the brain-substance, which is not to be confounded with a somewhat similar condition due to a chronic atrophic process in other portions of the convolutions. All the pathological appearances are mostly confined to the frontal and parietal lobes, and the occipital lobes and the base of the brain are comparatively free from these morbid changes. The cerebrum has an irregular surface, the convolutions appear flattened in places, the sulci are gaping, and there is evident brain-wasting. Turbid or bloody serum may be found, but there is seldom any appearance of pus. The cortex cerebri is greatly atrophied in places, and it may be anæmic and pale, or deeply colored in circumscribed areas ; and it varies in consistency also, being softer than normal in some portions and harder in others. There is an unusual facility of separation between the cortical and white substance, and the latter is often indurated to a degree perceptible to touch. The white substance also presents occasional points of softening as well as of sclerosis, and in limited portions it may have a pinkish aspect pointing to capillary hyperæmia.

The ventricles are most frequently found dilated with serum, and the ependyma is thickened and granulated.

The olfactory bulbs and the optic nerves may be found atrophied, but there are usually no very decided appearances at the base of the brain.

Such are the macroscopic changes in many cases of general paresis, and the microscopical appearances will next receive some notice.

The Ganglion-cells.—The general fate of the ganglion-cells is best expressed by the word atrophy, but there are various modes and stages of the pathological process by which the cells are destroyed in limited cortical areas or over large portions of the convexity of the brain, and they may be summarized as follows :

1. Hypertrophied ganglion-cells with greatly enlarged nuclei, which may finally occupy the greater portion of the cell.

2. Complete granulation and pigmentation without change of contour.

3. Loss of cell-processes and various changes in outline, with fatty or pigmentary degeneration.

4. Disappearance of the nuclei and processes, and of portions of the granular mass representing the cell-body, or in rare instances calcareous degeneration.

Neuroglia.—The earliest and most important change is proliferation of the nuclei, and this increase of the nuclear elements of the neuroglia has been regarded by many authors as one of the most characteristic lesions, though it is by no means confined to general paresis.

The modified neuroglia-cells, known as spider-cells, and once supposed to be a pathognomonic lesion of general paresis, are now recognized as not confined to this disease, and as being not even necessarily abnormal, except in the numerical ratio in which they exist in this malady.

The final change is atrophy of the nuclei of the neuroglia, and all the pathological processes of the neuroglia are most common in those portions of the connective tissue which lie nearest to the cortex cerebri and in parts of the medulla oblongata.

The Vessels.—All the post-mortem appearances point to intense and repeated congestions. The dilatation and tortuosity of the vessels, great and small, witness to their prolonged over-extension, but there are also signs of chronic inflammation and effusions of formed elements of the blood. One of the most remarkable occurrences is the formation of new blood-vessels in pachymeningitis hæmorrhagica, and their repeated rupture. There are also a production of cerebral capillaries, an effusion likewise of blood-corpuscles into the perivascular spaces, and various changes in the coats of the small arteries. There is a proliferation of the nuclei of the walls of the vessels, and various deposits of pigment are found between the adventitia and the sheath of the vessel.

Hypertrophy of the muscular coat of the arteries, and occasionally of the adventitia, is to be observed, and miliary aneurisms have also been met with secondary to periarteritis. Pigmentary, fatty, and colloid degenerations of the capillaries have also been described.

The general changes in the spinal cord are similar in character to those above mentioned. The pia mater is opaque and adherent to the dura mater, and the spinal fluid is usually increased, and the whole cord appears flattened in the posterior region, which is the principal seat of lesions.

The posterior root-zones and the columns of Goll in ataxic cases show the degenerative process most distinctly. The microscopical examination shows the increase of the interstitial tissue, the disappearance of the nerve-fibres, proliferation of nuclei, and the presence of corpora amylacea and Deiter's cells. It is probable here, too, as in the cerebrum, in accordance with an opinion already expressed, that the degenerative process begins in the essential nerve-elements in most cases, though in exceptional instances the point of departure of the pathological changes may be the pia mater.

Other cases may be attended by disseminated sclerotic patches in the spinal cord, by degeneration of ganglion-cells in the anterior horns, by local ramollissement of the cord, and by hæmorrhages from the spinal membranes.

The cerebellum, also, presents various pathological changes in its membranes, cortical layers, and vessels.

The morbid processes found in the sympathetic nervous system, and reported more especially by Bonnet and Poincaré, doubtless exist ; but as they are also present in various other diseases, they have no distinctive value in general paresis.

Diagnosis.—The degree of importance of the diagnosis of general paresis is determined by the fatal nature of the malady. The diagnosis settles the question of life and death, as well as the mere form of the insanity, and the fatal word should not be pronounced until the utmost certainty has been acquired. The difficulty of conclusion does not occur in the presence of the fully developed disease, but in the incubatory stage, and at a time to derive benefit from treatment if curative measures are ever to be of any permanent use to the patient. It might naturally be supposed that in such a typical disease it would be easy to form an opinion, but it is found practically that the question of diagnosis is not only one of the most difficult which the physician encounters in the early stages of insanity, but it is one that is very urgent and that involves a heavy responsibility. The mere fact of the multiplicity of the phenomena that may occur primarily creates uncertainty, and amidst the wide possibilities of the disease the physician feels the need of a few main points of guidance in diagnosis. When consulted, therefore, the physician, like the priest of the Delphic oracle, may deliver his opinion largely from a tripod resting on the following three principal points of symptomatic guidance :

1. *The Exalted Cœnœsthesis.*—This expansive feeling of organic well-being is highly diagnostic. It reveals itself in the whole appearance and conduct of the patient—in his looks, gestures, and attitude ; in his self-satisfied frame of mind under all circumstances ; in his heightened sense of muscular strength, and in his absurdly exaggerated ideas. This cœnæsthetic exaltation is never so constant or decided in any other form of insanity.

2. *The Motor Disturbances.*—The timbre of the voice

as well as the defects of utterance are highly characteristic. The twitching of the lips and facial muscles, the fibrillary tremors, the vermicular motion of strands of fibres of the tongue, the loss of co-ordination in writing or in other acts of fine adjustment of movements, and impairments of gait and of all other motor functions, form another of the chief guiding signs in diagnosis.

3. *The Emotional and Intellectual Weakness.* — This diagnostic symptom is hardly less valuable than the two that have just been mentioned, for it is often present from the very beginning of the disease. There is a peculiar and striking weakness of feeling and thought in the general paretic, who, while still showing much mental activity in certain directions, will do and say the most silly things imaginable. There is no form of insanity in which the mental faculties offer such an appearance of activity, and in which the conduct is so contradictory of all good sense and so utterly absurd. The general paretic has no insane cunning, and not even the foresight of a child, and he constantly shows his mental weakness in inconsistent, or even criminal, acts committed openly and publicly.

Careful attention to the above three points, together with the history of the case, will in many cases render the diagnosis possible.

The various forms of insanity which present, at times, confusing resemblances with general paresis are the simple psychoses in their early stages, the toxic and luetic types, senile and epileptic insanity, and organic dementia.

For instance, in a case of simple mania of recent date there may be exaggerated ideas and exceptional delusions of grandeur, and if by chance there is inequality of the pupils, the idea of general paresis will be strongly suggested, and it may be necessary to review all the general probabilities in the case, or even to wait some time, before a positive opinion can be expressed.

If the patient is of the female sex, the chances of general paresis are greatly diminished, and they are minimized if the lady has always lived in ease and luxury. Again, if twenty years of age have not been reached, or if sixty years have been passed, by a patient of either sex, the probability of the existence of the malady is small. If some years previously there had been a perfect recovery from an attack of mental derangement, it is probably a simple psychosis, and not paresis, that is to be diagnosed. The etiology and personal history may throw some light on the nature of the disorder, but, if this be not the case, a certain lapse of time may become essential to the diagnosis; for if decided manifestations of general paresis do not soon appear, it may be concluded that the suspicious symptoms belong to a simple psychosis.

Chronic alcoholism may be attended by symptoms like those of general paresis in some respects; but the characteristic cœnæsthetic exaltation is wanting, and the delusions of persecution and of conjugal infidelity are unlike those of paresis, and the tremor is more general and coarser, and the lesions of speech and gait are different. The hallucinations of sight are different in the two affections, and they are much more constant in chronic alcoholism, in which continued delusions of grandeur are also rare.

Plumbism and other toxic states may give rise to pseudo-paresis, from which the patient may recover, and which differs also from true general paresis by the order and peculiar form of the paralytic symptoms, as well as by the mental manifestations. The distinction between syphilitic dementia and general paresis may be made on the ground of the infrequency of delusions of grandeur in the former, and on the existence of special paralyses of cranial nerves in syphilis, and by the fact that the latter will often yield rapidly to the influence of mercury and iodide of potassium, and that the remissions of general paresis are rarely seen, and that the general course of the symptoms is different in many cases.

In organic dementia of hæmorrhagic origin the cerebral effusion is followed by hemiplegia or other permanent loss of muscular power that differs from the loss of co-ordination of general paresis, and the exalted emotional tone is absent. Cerebral tumors may develop some of the motor disturbances of general paresis and somewhat similar speech defects, but there are none of the most characteristic mental symptoms present, and special paralysis of ocular or facial muscles and a numerous class of signs not often found in general paresis are to be observed.

Epileptic dementia may resemble general paresis in the third stage with epileptiform attacks, but the history of the course of the two affections is usually decisive, as well as the extreme inco-ordination that is almost invariably present at this late date in general paresis.

Finally, in those exceptional cases of the malady in which the mental symptoms do not appear, and in which a slowly progressive mental weakness is the only psychical sign, the diagnosis is often necessarily delayed until the physical phenomena are fully developed.

Prognosis.—The prognosis as to the recovery of the full powers of mind is absolutely hopeless. There may be remissions of many months, and very rarely of several years, during which the patient may return to business or to social life; but even in these exceptional cases there are always signs of slight mental impairment.

This opinion, however, is more unfavorable than that held by some writers, who believe that a few of the perfect recoveries recorded were genuine cases of the disease, and that there was no mistake made in the diagnosis though the disease was not fully developed.

The prognosis of life is not so absolutely bad as that of recovery of mind, for the patient, with good care and advice, may, in some cases, prolong life indefinitely, or at least for a long series of years. The average duration of life in general paresis is about three years, dating from the appearance of the early symptoms; but in exceptional cases, with long remissions, a period of ten years may elapse before the fatal termination.

The average term of the disease is longer in women and in old persons, in cases of a melancholy type, and in those that present simple progressive mental weakness as the only psychical symptom.

Unfavorable elements of prognosis are the convulsive seizures, and an early appearance of the motor disturbances of speech and gait.

Treatment.—The treatment of this fatal malady is necessarily symptomatic, inasmuch as no remedy has ever been known to effect a cure. In cases that are strong enough to bear prolonged medication it is sometimes found that the exhibition of iodide of potassium has a favorable influence, and it is always well to try the effects of the drug in cases reported to have had any form of specific disease, and to conjoin the use of mercury in those with a distinct syphilitic history.

The disturbances pointing to vaso-motor paresis are best met by the occasional use of ergot, and chloral hydrate has some useful application in connection with the epileptiform convulsions, for which the bromide of potassium is also indicated, but it should not be given during prolonged periods.

The maniacal exacerbations are best treated by seclusion of the patient and by tepid baths, and if there is a rise of temperature, by the wet pack; and if exhaustion threatens to result from the great excitement, subcutaneous injections of morphia, combined with the administration of digitalis, are the most effective remedies. Alcoholic stimulants are to be sparingly used, as they increase the general excitability of the patient, and they seem to favor the appearance of the convulsive seizures; but they are indicated in great exhaustion, and light wines in small quantities may, in some cases, be given with good results in general debility.

Tonics are to be employed, but seldom long continued, and iron is by far the most useful remedy in the advanced stage of the disease.

The diet should always be generous, and the careful preparation and administration of nourishment is the most potent means of prolonging the life of the patient.

Fresh air is most necessary, and the patient should drive or be carried into the open air every pleasant day. In the final stage retention of urine may call for the use

of the catheter, and an enema is often necessary; and the utmost cleanliness is essential to prevent bedsores, which are less apt to occur in the sitting than in the recumbent posture, so long as the patient is able to occupy an easy-chair. In this terminal period life may often be surprisingly prolonged by good food, good nursing, and attention to all other hygienic measures.

The general paretic cannot be treated at home in the early maniacal stage without a full corps of attendants, as he is often very destructive and violent; but in the helpless paralytic period, in which his personal care is a work of love, he may be better cared for at home than elsewhere, under the constant advice of a physician.

All ordinary objections to an asylum fail, however, in the case of the general paretic, who is usually perfectly contented and happy in confinement, and he is often as much delighted with his insane associates as he would be with his oldest friends.

In most cases of general paresis, therefore, asylum treatment is the best and most practical measure that the physician can advise. *Theo. H. Kellogg.*

INSANITY, HYPOCHONDRIACAL. The distinction between hypochondriasis and insanity is not always easy. They shade into each other, and there is a broad intermediate territory of associated mental and physical discomfort in which it is impossible to say this case is one of insanity, this of simple hypochondriasis. If a distinctive definition is required, and one often seems necessary, we think it may be said that when the opinions of the hypochondriac concerning his mental or physical health so control him in the transaction of his business, in his family relations, and in his relations with the world at large, as to change his ordinary way of meeting these, and to cause him to conduct himself at variance with the habits of people in his station in life, he may be said to be insane. For instance, a man may be of the opinion that he has such a condition of indigestion that no food is assimilated, but at the same time take food and move about without permitting this idea to control his actions. But should he refuse in consequence to take food, neglect his business, prepare for death, declare that his stomach had ceased to act, that it was full or had grown up, he would in the second instance be said to be insane. So in the case of the man who declared his head was made of glass—as long as he did not permit the idea to control his actions, he was regarded simply as wedded to a peculiar opinion; but when, following the joking remark of a friend, that he ran great risk of having it broken, he insisted upon remaining in the house with his head swathed in padding to protect it from injury, he was looked upon as insane.

It is evident that neither the above definition nor the illustrations are free from exception; they illustrate as well the difficulties attending an attempt at exact distinction between hypochondriasis and insanity as they do the phases of the maladies.

Romberg ("A Manual of the Nervous Diseases of Man," translated by Sieveking, London, 1853, p. 182) says: "Hypochondriasis cannot be developed unless there be a morbid tendency in the individual to dwell upon his own sensations. Childhood ought, *à priori*, to be exempt from it, and so it is. A certain intellectual maturity, a capability of independent thought, is necessary to its production; the predisposition to the affection, therefore, prevails from puberty to old age." Of the distinction between hypochondriasis and melancholia he says: "The difference is clearly expressed in all the patient's relations, not excepting his relation to his physician. The hypochondriac looks upon his physician, however often he changes his medical attendant, as his guardian and saviour; while the person laboring under melancholia treats him as if he were a hostile or ignorant individual, and constantly tries to avoid him."

Hypochondriacal insanity is usually of a melancholic type, and illustrates what is true of melancholia in general—the dependence of the mental depression upon bodily ill health. The varieties of the affection are manifold, and attempts have been made to classify them according to the various portions of the body to which the hypochondriacal delusions were for the time directed. Thus we have brain hypochondriasis, gastric hypochondriasis, cardiac hypochondriasis, pulmonary and sexual hypochondriasis; and the enumeration could be extended to involve every organ and member of the body.

In hypochondriacal melancholia the first changes observable are dejection, and an unusual attention to the bodily condition. Usually the state of the digestive organs becomes an object of great solicitude; sometimes the attention is directed toward the mind, and anxiety is expressed that it is failing in vigor. Soon morbid sensations are complained of—formication, flashes of heat and cold, as well as weight at the epigastrium, and a constant desire to talk over the symptoms with some sympathetic friend.

The hypochondriac is usually a great egotist. No case ever reached the severity of his; no one ever bore the pain that fell to his lot. He feels his pulse, examines his tongue and excretions, and as he interprets or misinterprets their significance, wavers between fear and hope. As the disease progresses his ideas assume a delusional form. The sensations of which he complains are given a basis. He finds it difficult to fix his attention and to change the direction of his thoughts. He imagines that his brain is dried up, or has softened. He shakes his head, that the physician may hear it rattle in his skull. He insists that the blood has coagulated in his veins; that his heart is gradually failing and will soon cease action. Perhaps the most common delusions are in connection with the stomach and bowels. One patient cannot eat, his throat is gradually closing; another has cancer of the stomach, is already full of a solidified mass of undigested and indigestible food. The following case is illustrative of what has been termed gastric hypochondriasis: W. S——, aged seventy, after a long journey and the excitement of new surroundings and associations, became sleepless; had impairment of appetite, nausea, and constipation. His appetite continued fair, but his stomach rejected nearly everything but milk. His constipation continued, and was somewhat aggravated by the milk diet; he became very dejected, talked over his symptoms and their probable indication, worried much about his constipation and nausea, and in a few weeks became controlled by the delusion that nothing could pass his bowels, that there was a stricture or other mechanical obstruction, and that a surgical operation would be necessary to relieve him. On admission, under the writer's care, at the Pennsylvania Hospital for the Insane, he was quite feeble, pulse over one hundred, tongue thickly coated and dry, breath offensive, with the "starvation odor." He had taken no food of any consequence for a week. He at once commenced talking of his deplorable state. His rectum had a stricture, he said; his stomach was full, his heart was failing, and gangrene of his limbs was about to supervene upon his other troubles. After much difficulty he was induced to take warm liquid diet; his bowels were moved by injection, large scybalæ being removed. The day following admission, and for some days thereafter, it became necessary for a physician to be present when he took food, and to give him to understand that if not taken voluntarily it would be administered. He declared that he could never get well, that the mass of material being forced into him would of necessity kill him. At this juncture he conceived the delusion that surgical operations of various kinds would be performed upon him, as for stricture of the rectum; or that amputations of his limbs, which were shortly to become gangrenous, would be necessary; and that after his death a most minute autopsy was to be made. When not talking of his physical discomforts, imaginary and real, he discussed the probability of these operations and the duration of life he might expect. Nothing could divert his thoughts from the supposed operations, and at each visit of the physician he was questioned and cross-questioned concerning them. As he improved physically his ideas took a range a little beyond himself; to his wife, who was to be beggared by the enormous fees to be charged by the surgeons, consultants, assistants, and others for the operations. He implored the hospital

managers to make some reduction in these charges, and queried if some cheap arrangement could not be made for his burial, that some small income be left his wife, who, he declared, would be left in penury by the expenses incident on the supposed operations, autopsy, and funeral. This patient eventually improved in strength and in flesh, but was and continues bedridden, under the delusion that he has some disease of the spine which prevents locomotion. He reads the daily papers and magazines, and discusses with intelligence and interest current topics. He still has a lingering fear of some surgical interference. Owing to lack of exercise, his bowels require an occasional laxative, and he looks forward with dread to the day when they will cease to respond to medicine, as he believes the stricture is slowly closing. He assumes the air of a martyr when discussing his condition—declares he cannot eat, will soon grow too feeble to help himself, etc. His attendant reports that he watches carefully the daily bill of fare, and is quick to notice and resent any omission in what is supplied to him.

Hypochondriacs, even when controlled by delusions, are sometimes relieved of their depression by the intervention of some incident or accident which for a continuous period absorbs their attention and diverts the egotistic train of thought to other channels. The writer saw, in Western New York, a few years since, a lady, at the climacteric, of good family history as far as concerned neuroses, but of a phthisical family, who was at the time in the incipient stages of hypochondriacal melancholia. She exhibited the veins on the back of her hands with a look of despair; her blood, she said, was all drying up; her heart was so far diseased that it would soon cease its beating; her memory was failing; she could take no pleasure in life, no one sympathized with her, and all wished her out of the way. Her husband had tried in every way to divert her mind, but she declared he had lost his affection for her, that he would be pleased to have her die; but, with the perversity characteristic of the disease, refused to permit him to leave her presence without protesting vehemently. Her countenance was dejected; she sat listlessly in her chair or moved restlessly about, without occupation or aim. Occupation was advised; she was directed to assume the left-off duties of the household, to walk and drive, and to seek amusement and recreation. Tonics and laxative medicines were suggested. At the advice she shook her head mournfully, claiming that she could not undertake tasks for which she had no strength. In regard to the medicines she exclaimed, "All that is too late." Within a few weeks her son was seriously injured. She immediately devoted herself to his care, though she had, in the interim, shown no disposition to follow advice, and continued to watch over him with great solicitude until he was convalescent, when it was found that she had forgotten her delusion and was happy and well. Here was a patient whose self-control to a degree was lost. The inhibitory centres were for the time paralyzed, but her brain-convolutions had not so far partaken of the diseased processes but that when the attention was fixed in new directions, calling into operation different activities, mental and physical, they were able to regain their normal functional powers.

It has been said that cases of hypochondriacal insanity seldom attempt suicide, though they frequently threaten it. Esquirol says: "It is a remarkable feature in hypochondriasis, and in no other disease, that there is such a fear of death and a desire to die combined. . . . Finally, it may be remarked that the hypochondriac talks most of death; often wishes his attendants to perform the friendly office; even makes attempts on his own life, but rarely accomplishes the act. The most trifling motive, the most frivolous pretext, is a sufficient excuse for prognosticating, from day to day, the threatened catastrophe."

The writer has at this time a patient under care who is afraid to take medicine, especially sleeping draughts, for fear sleep will result from which he will never waken; yet this same patient has made repeated attempts at suicide, and requires constant surveillance. With their real or imaginary physical ills they are kept constantly in doubt. The question "to be, or not to be?" is ever before them. The poet Cowper, a hypochondriacal melancholic, with suicidal impulses, wrote: "Could I be transported to paradise, unless I could leave my body behind me, my melancholy would cleave to me there."

The following case illustrates the strength of the suicidal impulse in some instances, and, in its early history, the difficulty experienced in making a diagnosis of insanity.

S. M——, aged twenty-six, of good family history, was admitted to the Pennsylvania Hospital for the Insane in a state of great depression over what he believed was his rapidly approaching death from phthisis. Two physicians of experience in examining lunatics saw him, with reference to making certification of his mental state. He told them that he had recently come from Colorado, where he had gone on account of his diseased lungs; that he had cough, hectic, hæmoptysis, pain on deep inspiration, etc. There was some dulness and absence of full respiratory murmur at the apices of both lungs, and this, together with the absence of an authentic history of the case, and the fact that in their presence the patient was able to exercise an excellent degree of self-control, and to argue that at his time of life the prospect of death, and especially death from phthisis, would naturally lead to depression, led the physicians to decline to make certificates. He was visited by his family physicians, in whose presence he gave expression to delusions, who were able to compare his condition at the time with his normal state, and had no difficulty in making certificates.

The patient was, when admitted, in a ragged state, and his face was bruised as from a fall. As he afterward admitted, he had jumped from a train with suicidal intent; had fallen into a river, and, after swimming about for some time, concluded he would not drown himself then. His first attack of hypochondriasis occurred at the age of sixteen, and was occasioned by anxiety concerning his lungs, a physician having told him he had phthisis.

Rest from business and change of scene, accompanied by a gain of several pounds in weight, dispelled the depression. The second attack, the one under consideration, was induced by irregular habits and loss of sleep, and began, as did the first, with a belief that he would soon die of phthisis, especially as he had some hæmoptysis. He became very nervous; could not sleep or attend to his business. Remembering his former experience, he did not submit as readily to his gloomy prognostications; but his depression, loss of appetite, and a habit of constant walking, so reduced him in flesh that he, especially after a sharp hæmorrhage, admitted to himself that he had phthisis.

He went to Colorado, but his nervous restlessness increased. As he expresses it, "I could not sit still five minutes." Becoming completely controlled by the delusion that he had phthisis, and growing daily more unhappy, he attempted suicide by taking over one hundred grains of chloral, but was resuscitated. In about a month he jumped into the water, but was rescued; in a short time hanged himself, but was cut down. After this he was sent home, and on reaching there was taken to a water-cure. The patient, in his own account, says: "I talked rationally enough about everything, with the exception of my supposed disease." Shortly after going to the water-cure he purchased three grains of morphia, which he took in two doses, with an interval of twenty minutes. The physician at the establishment, learning what had been done, applied the usual means of restoration with success. After this he left the sanitarium and started for home, but fearing another suicidal attempt his friends had him arrested. He was placed in a police station to await their arrival, and there attempted suicide by hanging. He was placed in charge of his friends, but on the way to the hospital jumped from the train, as has been stated.

For some time after admission this patient was in an exceedingly nervous state. He insisted that he had phthisis, was quite emotional, and sleepless. So certain was he of impending death that he desired his nurse to sleep in the same bed with him for fear of dying alone. He was given a tonic containing iron and strychnine

and full diet, and for a hypnotic from one one-hundred-and-twentieth to one-ninetieth of a grain of hyoscine hydrobromate at night. He gradually improved under this treatment, gaining in flesh, ceasing to talk so constantly about his lungs, and manifesting an increased interest in matters about him. At the end of a little less than two months, against the advice of the writer, he was removed by his friends in an improved condition. In a week he was returned in a state of frenzy. He had taken enough whiskey, while at home, on one occasion, to excite him, and had become violent. Within a few days after admission he attempted suicide by cutting his throat with a table-knife, but was at once disarmed. From this time he became controlled by the delusion that he was to be taken to an almshouse, and in about two weeks again attempted suicide by crowding a mutton-chop bone down his throat. This attempt was the beginning of a series of attempts on his part, numbering within twenty-four hours no less than six.

He expressed the delusion that he had killed a man, when drunk, at home, and that in consequence he was to be smothered, and he detailed quite minutely the methods that were to be used. His mental suffering at this time was acute. He paced the floor like a caged animal; he gave vent to interjectory exclamations, indicating the supposed manner of his death and his regret at having gone home. The delusion concerning phthisis left him, and he admitted that some of his statements concerning his symptoms were false. About three weeks after his readmission he obtained possession of a knife, by subterfuge, and inflicted a wound upon himself with suicidal intent, which extended from the posterior margin of the sterno-cleido-mastoid muscle, just below the ear, to the thyroid cartilage, severing everything down to the sheath of the carotid. He resisted having the wound dressed, and endeavored subsequently, by tossing about, throwing his head from side to side, etc., to tear it open. During the healing of the wound it became necessary to restrain him, and he was kept in bed. Fortunately he took food and medicine, as a rule, fairly well, and, to omit many details of a trying experience, it suffices to say that he gained in flesh, and when permitted to be up again, at the end of several weeks, did not talk as constantly of his delusions. During the last few weeks of his stay in bed he became very irritable, and on one or two occasions frenzied. His pupils were somewhat contracted, and he complained of a headache with a sense of pressure. He was given sodii brom., grs. xxx.; ext. ergot. fl., f ʒ j., morning and night, under which a marked improvement was observed. His headache disappeared and his mental condition visibly improved. While he remained in bed, as has been stated, he gained in flesh, and this gain continued after he was able to be about, until he now weighs—eight and a half months after admission—two hundred and thirteen pounds, fifty pounds more than when admitted, and is apparently convalescent.

Hypochondriasis in the male takes the place of hysteria in the female, and observations have shown that more males are affected with hypochondriacal insanity than females.

In many instances, in men, it appears at a period of life when the physical powers begin to wane, at what some writers have called the male climacteric. Occurring in these cases it usually takes the form of what has been termed brain-hypochondriasis, in which the delusions appertain to the mental or general nervous functions.

Cases of hypochondriasis, or hypochondriacal insanity, with false ideas regarding the sexual organs and functions, form the harvest-field for quacks and charlatans of all sorts. It is strange how powerful an effect a slight derangement, real or fancied, of the sexual apparatus has upon the mind of even well-balanced individuals—a disordered secretion, a slight mucous discharge, elsewhere would attract no attention, though, perhaps, indicative of serious mischief; but a little straining at stool followed by a discharge from the urethra, or the presence of a mucous deposit in the urine, raises at once a suspicion of spermatorrhœa and all the evils which they imagine, or have been told, follow upon it.

This is especially the case with those who have been guilty of masturbation. They have been frightened by reading some popular medical work, or the advertisements of quacks, and are alive to the appearance of the first symptom of the terrible retribution which they imagine is awaiting them. Paget ("Clinical Lectures and Essays," art. "Sexual Hypochondriasis") has graphically described these cases, and his remarks may be read with profit.

In reference to the bugbear of sexual hypochondriacs, the loss of semen in the urine, he says: "As to the passage of semen with the urine, I am nearly certain that it never does so unless when an emission of semen, in whatever way provoked, has lately taken place, or where there has been disease of a seminal vesicle."

These cases need good advice plainly put, freedom from excitement and irregular habits, tonics, good diet, and regular occupation. After a plain explanation of their condition, all conversation upon it is to be, as far as possible, discouraged.

There is a theory, which still has some support, that some lesion of the digestive tract will be found, post mortem, to account for the hypochondria, and for the painful sensations in these parts. This theory is not by any means borne out in practical experience, though cases are not infrequent of associated hypochondria and disease of the stomach or of some portion of the intestines. The absurd theory put forward a few years since, that melancholia of a hypochondriacal type was caused by abscess of the liver, is only deserving of notice as a medical curiosity.

The treatment of these cases not infrequently is dependent upon the surroundings, habits, and circumstances of the case. In some instances travel is of great value—change of scene, and variety of mental occupation, with varied diet, etc., proving all that is necessary to insure recovery. Travel is, however, to be prescribed with caution. Too frequently the excitement, irregular hours of sleep, and removal from home comforts prove positively detrimental.

In all cases a change in the direction of the mental action should be sought. Occupation and amusement afford means to accomplish this. Attention to the digestive organs, and especially to the bowels, is imperatively demanded, and the condition of the urine should be carefully watched; in many instances an excess of phosphates will be found, especially if there has been an antecedent mental and physical overstrain. Tonics, baths, electricity, and massage constitute the more positive therapeutic measures to be employed.

The prognosis in cases of long standing (several months) is not very favorable; nevertheless an effort, and a determined one, should be made in every case. In some instances removal to an asylum is the first step in provoking a change for the better. In all cases convalescence is apt to be tedious and attended by discouraging relapses. *Edward N. Brush.*

INSANITY, HYSTERICAL. The separation between hysteria and insanity cannot be distinctly made. In all cases of hysteria there is more or less of the maniacal element; the self-control, the moral element, or the feelings are always more or less affected. In the majority of cases of pure hysteria, however, the mental symptoms are so overshadowed by the convulsive crying and laughing, and the bodily infirmities, real or assumed, that they are overlooked, and, indeed, are usually so easily managed that insanity is not suggested. As hysteria has its mental element, so also many forms of insanity show, from time to time, hysterical symptoms. Occasionally cases of hysteria, with sufficient mental disturbance to warrant a diagnosis of insanity, are sent to asylums, and from the day of admission to the day of discharge exhibit no mental disturbance.

These are the cases, or at least form a portion of the cases, which figure in asylum statistics as "not insane." It is nevertheless true that a large, and by no means unimportant, class of cases is found, both in and out of asylums, which demands the most judicious and

persistent care and supervision, and which may be properly denominated hysterical insanity.

The insane manifestations of hysteria are mainly in the line of mania. Next comes melancholia, and in a few instances a condition of dementia, the terminal state of mania and melancholia.

In some cases dementia supervenes upon long-continued hysteria without previous active mental disturbance beyond the ordinary phases of the disease. In these cases the individual gradually loses interest in affairs, becomes indifferent and untidy in personal habits, passes into a dreamy, moody state, loses ambition and energy, and eventually leads a mere vegetative existence.

The diagnosis of hysterical insanity is largely dependent upon the previous history of the case. The occurrence of local anæsthesia, hyperæsthesia, paralysis, globus hystericus, etc., together with the physical condition of the patient, chlorosis, disturbed menstruation, uterine or ovarian disease, all have a bearing in the formation of a diagnosis.

Hysterical insanity is essentially a condition confined to women, though examples of its occurrence in men are not wanting. It occurs between the periods of puberty and the climacteric, and its victims are usually young women and old maids. Cases of so-called ovarian and uterine insanity are usually of the hysterical type, though not infrequently the hysterical element is masked or dormant. Insanity of pubescence, in both sexes, presents occasionally hysterical forms, and so also with certain vague and undefined forms of mental disturbance in young people which may be termed developmental. They appear at a period when the organs are assuming activities hitherto unknown, and occur in young people who have been taught, or have formed of themselves, perverted or exaggerated ideas of their duty in life. These cases are prematurely grave and reticent—bookworms, whose lives have been of the school-room and study rather than of the fields and play-ground; who, as life opens up, have vague longings and aspirations, born of sensational reading and hours spent in day-dreaming, which longings early take wrong directions, rendering their victims misanthropic, hypochondriacal, hysterical, insane. These cases not unusually have a neurotic heredity, and in many instances are given to masturbation.

The manifestations of hysterical insanity are as manifold as those of ordinary hysteria, aggravated and extended by perverted senses. These are the cases which carry the propensity of hysterical patients to eat incongruous materials, to the extent of taking substances into the alimentary canal which may be positively injurious. They swallow pins, coins, thimbles, stones, or pass them into the rectum or vagina. In women the insane state frequently takes the form of erotomania. They accuse their physicians of seeking improper relations with them, occasionally declaring that sexual congress has been accomplished under the influence of an anæsthetic.

A patient under the writer's observation charged that ether had been forced into her room and unconsciousness produced thereby. She insisted that the odor of the drug was present, and appealed to others to corroborate her statements in regard to it. Disorders of the special senses are not uncommon; disturbances of smell, taste, sight, and hearing are observed. Hysterical paralysis, hyperæsthesia, or anæsthesia complicate some cases. One patient, a single woman, had the delusion that she had been courted by a young man, that he won her, and that they were married. After retiring at night, the family, who were unaware of her delusion, were alarmed by shrieking, in her room, and a crash as of breaking glass. They found that she had leaped from the window, and was running across the fields. In explanation of her conduct she said that her husband came to her room, that they went to bed, when she smelled the odor of sulphur, and found to her horror that she had married the devil, at which she immediately escaped from his embraces and leaped through the window. This patient subsequently passed into a state of dementia.

The following history of a case of hysterical mania in a man shows the presence of hallucinations of sight and hearing. W. B——, male, aged thirty-six, married, father insane, was admitted under the writer's observation to the New York State Lunatic Asylum at Utica. He had recently married, had worked regularly at his trade of bricklaying, and had carried on a small farm. He had attended regularly for several days a mission of the Catholic Church, had abstained from food, and had lost sleep. He became, a week before admission, talkative and excited, said he had seen the Virgin Mary, and that the angels talked with him. On the morning of admission he became violent, and suddenly passed into a cataleptic state. He was brought to the asylum in restraint, and when first seen was lying on a sofa apparently unconscious. The restraint was removed and his friends questioned as to his history. During the interview he passed into a convulsive state. Observing that in his convulsive movements he managed to hit or kick those standing about him, and that it was impossible to separate the eyelids to observe the state of the pupils, the nature of the "convulsions" was suspected, and the patient sent at once to a ward, with directions to the attendants to abstain from any interference with him when in a convulsive state, beyond protecting him and those near him from injury, and to refrain from any mention of convulsions in his presence—in short, to apparently ignore their existence.

His bowels were moved by injection, he was put upon tonics and full diet, and after having six or eight seizures during the first few days of his stay in the asylum, he ceased having them.

He continued to talk about his vision of the Virgin for a longer period, and showed during his convalescence considerable mental enfeeblement. He gained rapidly in flesh, was within two weeks employed at his trade about the asylum, and in three months went home, recovered.

Cases of acute mania frequently have, before the maniacal symptoms manifest themselves, considerable depression and apprehension, sometimes amounting to positive melancholia. The early symptoms of the maniacal attack in these cases are often of an hysterical type, and the writer has no doubt that, had the case above narrated been longer detained from care, he would have passed into a prolonged attack of acute mania.

Patients with hysterical insanity form good subjects for experiments in hypnotism. A young girl at one time under the writer's care exhibited this characteristic to a marked degree. Before committal to the asylum she had been quite violent in her demonstrations toward her foster-mother (her family history was unascertained, but she was born in an almshouse)—she broke the dishes, upset the table, or, on the least or no provocation, assaulted those about her in the most violent manner, giving vent at the same time to piercing screams.

After admission she had, for a time, whenever crossed in any way, attacks of violent screaming, breaking the furniture, and tearing her clothing. She was proud of being noticed, especially by the male patients, and took pains at assemblies and entertainments to attract attention. She talked much of her sexual functions, and declared at times that she was married. Causing her to fix her attention for a few moments upon any bright object was sufficient to throw her into a hypnotic state, during which she obeyed suggestions made to her—held heavy weights in painful positions, etc. It was observed that she seemed pleased with the attention attracted to her by these experiments, and after two or three trials they were discontinued. When she passed from under observation she still had paroxysms of hysterical crying and screaming, attended at times with refusal of food. Her mind had deteriorated, she having become childish and simple.

While asylum care affords for many of these cases just the kind of treatment and repression they need, care must be exercised lest they become enamored of the ease and freedom from responsibility of asylum life, and drift into chronic mental enfeeblement from mere lack of anything to arouse ambition and energy.

A patient who passed through a very severe attack of hysterical mania, under the writer's observation, became

so attached to asylum life that, though possessed of ample means, she endeavored, under an assumed name, to obtain a position as nurse in the asylum wards.

Hysterical melancholia often presents a hypochondriacal type (see Hypochondriacal Insanity), and is but an exaggeration of the morbid desire of the hysteric for attention and sympathy. Such cases can be cared for properly at home, but are often much better sent away from home surroundings. They frequently threaten suicide, and not infrequently attempt it, usually, however, with some attention to publicity and the probability of observation. A hysteria melancholic who jumped into a pond, with supposed suicidal intent, was very anxious that the mud should be washed from her face and her clothing before the writer, who was hastily summoned to see her, should be admitted, and she made the attempt in the presence of a dozen bystanders.

These patients are morbidly sensitive—they imagine that some one is endeavoring to injure their character; they become seclusive, are moody, cry easily, begin to take unusual interest in their health, especially as concerns the sexual functions, and not infrequently develop morbid ideas concerning them.

They sometimes form habits of masturbation. They reject food from the stomach until the point of exhaustion is reached, and these cases, on this account alone, sometimes assume a serious aspect. While apparently very depressed, and acting without volition, they usually manage to present the symptoms which will attract the most attention and demand the greatest care. These are the cases which retain the urine, and occasionally volunteer the suggestion that the physician may find it necessary to use the catheter.

Sometimes, apparently for the purpose of making trouble, but usually under the influence of delusions that the food is poisoned, that the stomach is full, that the bowels will never be opened again, or through some religious idea that it is wrong to eat, hysterical melancholics refuse food. Such patients should be approached in every other way first, but recourse to the stomach- or nasal-tube may become necessary. A soft-rubber catheter (Nos. 10 to 12) attached to a Davidson syringe makes a convenient feeding apparatus. The catheter may be passed through the nose to the back of the pharynx, or carried beyond the epiglottis into the œsophagus. After the bulb of the syringe has been compressed once or twice, the dish holding the food may be raised above the level of the patient's head, when the apparatus will act as a siphon. The patient should never be permitted to get in a state of exhaustion from refusal of food. The process of forced feeding is simple and easy.

TREATMENT.—If nutrition is impaired, as is usually the case, attention should be directed toward the appetite and digestion. But for the unfortunate fact that these cases easily become wedded to the bed, the "rest treatment" would be a valuable adjunct in treatment. As soon as practicable these patients should be taken into the fresh air. Separation from the unwise sympathy of friends is necessary; if, therefore, they are treated at home, a good trained nurse should be placed in charge, and friends kept at a distance. Milk, eggs, and other forms of easily assimilated and nutritious food must be given in abundance. Occasionally stimulants are required. Valerian and assafœtida, in some forms, have been found to possess some value. Bromide of sodium in combination with valerianates exercises a calming influence upon the hysteric storms which disturb the progress of the case. If there be uterine or ovarian disease, treatment should be directed toward its removal; but those in charge of these cases cannot exercise too much caution in exploring the condition of the sexual apparatus. Rest, freedom from home cares, separation from the husband in the case of married women, will often be all that is necessary to correct disturbed sexual functions; and more than this may excite mental symptoms which will but aggravate the case. Timidity, however, in directing proper treatment is to be deprecated. A blister or leeches over the ovary, or cupping, may be of value in some instances, especially of ovarian irritation.

Pressure over the ovarian region, as suggested by Charcot, will not infrequently cut short the convulsive seizures observed in some of these cases. (See Hysteria.)

HYSTERO-EPILEPSY.—Under the head of Hysterical Insanity, this subject is deserving of mention. The title is somewhat ambiguous in that it implies a combination of hysteria and epilepsy. Charcot teaches (and correctly, we are inclined to believe) that the disease is not a combination of the two, but hysteria pure and simple pushed to its fullest development. The difference between it and the ordinary hysterical attack, with its convulsive movement, its storms of laughter and crying, and its

FIG. 1840.

mental disturbance, are quantitative, not qualitative. The following description of hystero-epilepsy is abridged from Jolly ("Cyclopædia of Practical Medicine," edited by Dr. H. von Ziemssen, vol. xiv.): Tetanic symptoms occur, the highest degree of opisthotonos developing itself. The patient rests upon the head and heels, or other distortions of the trunk and contortions of the limbs occur. The limbs are made to assume the most remarkable positions, the toes are flexed, the fingers flexed or extended in extreme tension. The countenance is distorted with grimaces, sometimes assuming a happy, ecstatic expression, sometimes the opposite. The patients throw themselves violently backward and forward. They pass into a state of delirium, and give expression, disjointedly and incoherently, to delusions. The attacks vary in duration from a few minutes to hours. Consciousness appears partially lost; through powerful or sudden impressions the attacks may be terminated.

Richer ("Etudes Cliniques sur la Grande Hystérie, ou Hystéro-épilepsie") divides the attack into four stages: First, the epileptoid period, divided into, first, the tonic phase; second, the clonic phase; third, the phase of resolution. Second, the period of contortions and of movement of the whole body. Third, the period of emotional attitudes. Fourth, the period of delirium.

The following description of an attack of hystero-epi-

lepsy is abridged from "Iconographie Photographique de la Salpêtrière," tome ii., from which the illustrations are also taken.

Beginning of the Attack.—The respiration is irregular, with evident oppression, and speech is interrupted. Feeling the attack coming on, the patient tries to restrain herself. "I have—dif—fi—cult—respiration. I will not be —sick—in order—not to have—nitrite of amyl." There are movements of elevation of the abdomen, the jaws move intermittently in mastication, the nostrils expand, the forehead wrinkles, the eyelids tremble, the gaze becomes fixed, the pupils dilate, the eyes are carried upward, the patient has lost consciousness.

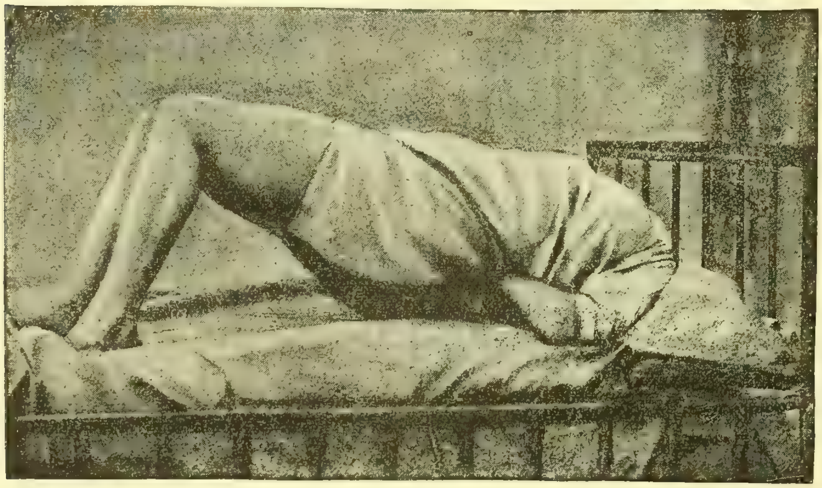

FIG. 1841.

First Period (*Epileptoid*).—(*a*) Tonic phase: The whole body becomes rigid, the arms stiffen, exercising more or less perfect movements of circumduction, often approaching one another in the median line till the wrists touch on their dorsal aspect. The lower limbs are thrown violently about, and then the feet assume the position of talipes equino-varus. Respiration is interfered with, the abdomen is motionless, the pulse hard. Occasionally during the first phase foam issues from the mouth. (*b*) Phase of tetaniform and clonic spasms: The head, which was drawn to one side, resumes its normal position; the face becomes more flushed; the patient cries out, "Oh! oh!" The facial muscles exhibit well-marked clonic convulsions; the eyelids are raised and lowered with considerable regularity and with marked slowness in contrast with the rapid tremor observed in the beginning of the attack. Clonic convulsions or tetanic spasms seize the limbs. (*c*) Phase of stertor: The face is bathed in perspiration, the foam from the mouth increases, the breathing becomes rapid and noisy. *Repose.* The respirations become regular; there are movements of deglutition and undulations of the abdomen.

Second Period (*Clonic Period, Period of Contortions*).—This period presents two varieties, which may succeed each other in the same attack. (*a*) Clonic movements of the limbs and reciprocal movements of the head, which is shaken from side to side or beats the pillow. The color of the face disappears, in spite of the rapidity of the movements. (*b*) The patient opens her mouth wide, puts out her tongue, moves rapidly from the edge to the middle of the bed, crying "Oh! oh!" The body becomes bent like a bow, resting only on the nape of the neck and the feet. The arms are alternately thrust out and contracted. After maintaining this position for some time the patient sits up and suddenly falls back on the bed, repeating the movement rapidly several times, the arms and legs being animated at the same time by movements of flexion and extension.

At times the position of opisthotonos is not fully assumed—the body is but slightly arched, the head thrown back, the eyes turned up, and the arms and limbs extended in a tetanic condition. To this position the term "crucifiement" is given by the French. (Fig. 1842.) Another period of repose is followed by—

The Period of Delirium.—The patient sits up, and her countenance assumes an expression of joy. She follows an imaginary being with her gaze, to whom she addresses her remarks. (Fig. 1843.)

Attacks of hystero-epilepsy are preceded by a prodromal stage, lasting, in some cases, several days, which Richer subdivides into five periods, viz.: First, the psychical, with hallucinations and delusions; second, the period of affections of organic functions; third, period of affections of mobility; fourth, period of affections of sensibility; fifth, period of syncopal attacks.

In the first of these prodromal stages the patient neglects her usual occupations and falls into a condition of introspection. Insignificant circumstances are exaggerated. She neglects her dress, and not infrequently abandons propriety. She may be profoundly depressed. At times painful hallucinations disturb her; occasionally the depressions alternate with periods of elation and excitement. The organic functions—digestion, respiration, circulation—are disturbed in the second prodromal stage. Nausea, and want of, or perverted, appetite are manifested. The bowels are constipated or the reverse. The urine is abundant, pale, limpid. Spasms of the throat and larynx are not uncommon. The loss of muscular power is an extension of the paralytic symptoms so often observed in hysterical patients, and is blended with the affections of sensibility of the fourth stage. There are usually anæsthesiæ. In some stages, but not in all, the syncopal stage is masked, the patient

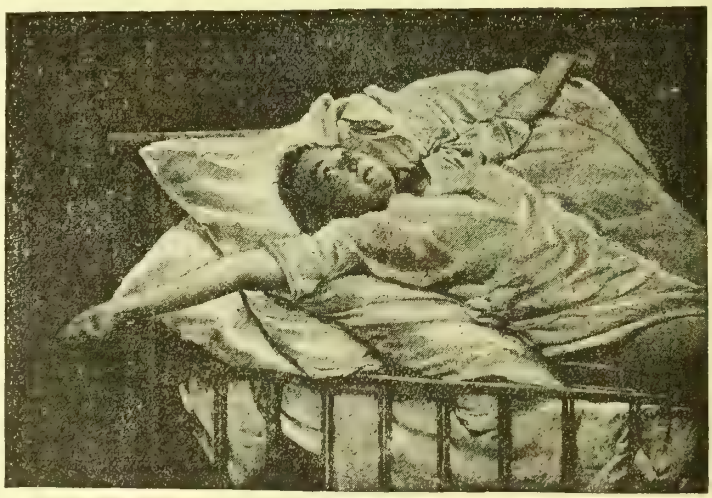

FIG. 1842.

passing into this just prior to the epileptoid stage of the seizure.

In some instances the physical disturbance is the most marked of all the prodromata, and it has been termed in consequence the "physical aura." Charcot and Bourneville consider the absence of a rise in temperature the best diagnostic test between the epileptic state and the condition known as hystero-epilepsy. Only in exceptional cases does the temperature rise above 38° C., while in epilepsy a temperature of 40° C. is observed.

As to treatment, the course pursued in cases of ordinary hysteria is indicated. Electricity, especially with the static apparatus, may be used with good results. Occasionally the seizures may be cut short by applying the poles of a galvanic battery—one to the forehead, the other to the ovarian region—and suddenly reversing the current.

FIG. 1843.

Pressure over the ovaries has been referred to. A. McLane Hamilton (*Brain*, January, 1886) reports a case of hystero-catalepsy in a male patient cut short by firm pressure applied to one testicle. An analogy exists, which is of interest in a medico-historic sense, between hystero-epilepsy and some of the epidemic delusional states of the middle ages and of the present day indeed. The flagellantes, the victims of the dancing mania of some parts of Europe, and the jumpers of Maine and Canada belong to this class. *Edward N. Brush.*

INSANITY IN ACUTE AND CHRONIC ALCOHOLISM. The word alcoholism might be used to include all the effects upon the functions and structures of the human body of alcohol when taken in a dilute form, as found in the different varieties of fermented and distilled liquids. And the various degrees of intoxication, or perversions of mental action, caused by the direct effects of alcohol, while present and circulating in the blood, might, with technical accuracy, be included under the general head of insanity. Both psychologists and jurists have properly, however, maintained a distinction between those mental disturbances produced by the direct imbibition of alcoholic liquids, and which cease in a few hours after the imbibition ceases, and those mental derangements and hallucinations that may continue for days, weeks, or months after all use of alcohol has ceased. The first are universally styled paroxysms of intoxication, or simple drunkenness, and the latter some form of insanity.

With the same propriety, the word alcoholism should be applied only to such changes in the functions or structures of the living animal body as continue for a longer or shorter period after the imbibed alcohol has entirely disappeared from the circulating fluids of the body. Such more persistent changes are probably never induced by the drinking of a single day, or by a single paroxysm of intoxication. But whenever excessive drinking of alcoholic liquors is continued for one or more weeks, it induces such modifications of the mental and physical processes as may require the lapse of an equal length of time for their recovery after the drinking ceases; and hence these cases are classed under the head of acute alcoholism. When individuals frequently repeat such protracted periods of excessive drinking for years, or if, instead of more or less frequent periods of debauchery, they take alcoholic liquors more moderately, but daily, for many years, changes of a permanent character are established in the various structures and functions, and the condition is known as chronic alcoholism.

The cases of insanity, or marked mental derangement, occurring in acute alcoholism may be classed in two groups, usually called delirium tremens and mania à potu; while those existing in connection with chronic alcoholism are included under the heads of dipsomania and alcoholic dementia. As it is not my purpose to discuss here the general pathology of either acute or chonic alcoholism, I shall proceed directly to the consideration of the first of these groups, viz.,

DELIRIUM TREMENS.—The symptoms that characterize and accompany the mental disease called delirium tremens vary much in severity and duration in different cases. They may supervene while the individual is still using a full supply of the alcoholic beverage or other narcotic, or they may not commence until eight or ten days have elapsed after the supply has ceased. In at least three-fourths of all the cases that have come under my observation the disease has manifested itself while the patient was still taking a full supply of the alcoholic drinks.

In the initial stage the face becomes more pale; the skin cool and generally moist; the pulse quick, soft, and variable; the muscular system tremulous and unsteady; and the mind excited and apprehensive, with little or no disposition to sleep.

In the milder cases these symptoms continue to increase until, at the expiration of two or three days, the expression of countenance becomes anxious and excited, the muscles are constantly tremulous, and there is complete insomnia, with frequent hallucinations of sight and hearing, generally of an unpleasant or frightful character. These are usually increased at night, the patient being startled every few minutes at imaginary noises and visions of enemies, demons, snakes, etc., rising up in every corner of the room, or chiefly on his bed, with sometimes sensations of reptiles crawling over him under the bedclothes. Thus tortured by fear, the patient sometimes endeavors to protect himself by drawing the bedclothes closely around him and refusing to move; but more frequently he makes the most frantic efforts to escape from the room, either by the door or directly through the windows, and requires two or three vigilant attendants to prevent him from injuring or destroying himself. The sleeplessness, the constant terror, the physical exertion occasioned in combats with his hallucinations, and generally the refusal to take food through fear of being poisoned, rapidly reduce the strength of the patient, and before the end of a week his pulse becomes small, soft, and frequent; his respiration hurried and unsteady; his extremities cool, and skin wet with perspiration; urine scanty, with occasionally traces of albumen; bowels inactive; tongue generally clean and tremulous, though, in some cases, covered with

a dirty-white coat; there is much thirst, especially for alcoholic drinks; and, not infrequently, prompt rejection of both food and drinks takes place by vomiting. In much the larger number of cases after thus reaching a state of decided general prostration, and after the lapse of from five to ten days, the tormenting hallucinations begin to abate; the patient gets longer intervals of rest and partial sleep, especially during the day; he takes and retains more nourishment; pulse becomes slower and more steady, and his skin more natural. These changes indicate the beginning of convalescence, which is generally well established by the end of the second week. But in the more severe class of cases all the mental and nervous phenomena are more intense, and after from four to six days and nights of extreme agitation and insomnia great exhaustion supervenes, with constant muscular tremors and picking of the bedclothes, unsteady and weak cardiac action, thready and variable pulse, cold and leaden-colored extremities, copious and sometimes involuntary intestinal discharges, or persistent vomiting, and very scanty or suppressed urine; and death, sometimes preceded by a general convulsion, speedily follows.

In a few even of the milder cases the early stage is accompanied by fever, indicated by more flush of the face, a white coat on the tongue, a fuller pulse, more epigastric tenderness and vomiting, and an elevation of temperature of two or three degrees.

Such symptoms indicate the presence of more than usual irritation or inflammatory action in the gastric mucous membrane, and more or less hepatic congestion. Bronchitis and broncho-pneumonia also occasionally exist as complications of delirium tremens, especially in the cold and variable seasons of the year, and add to the danger of fatal results.

Causes.—While it is true that ninety per cent. of all the cases of delirium tremens that have occurred in civilized countries have been caused by the use of alcoholic liquors, still cases have occasionally occurred from the injudicious use of the preparations of opium and other narcotics and anæsthetics.

Cases have been produced by the use of the weaker alcoholic preparations, such as the varieties of beer and wine, but far the larger number arise from the abuse of the stronger distilled spirits, as whiskey, brandy, rum, and gin. To act as an efficient cause, it is generally necessary that the amount should be sufficient to destroy the appetite for food, and maintain at least a state of partial intoxication daily for from one to six weeks. The disease appears to be more readily induced in persons of a nervous, excitable temperament and feeble vitality; and one attack leaves the system more susceptible than before to subsequent attacks from the same causes.

Much the larger number of cases are met with in the male sex, and between the ages of twenty and fifty years; not because men are more susceptible to the disease than women, but simply because a much larger proportion of men than of women drink excessively during the active period of adult life.

Pathology.—In all cases of death from delirium tremens, in which the post-mortem examination has been conducted with thoroughness and skill, some appreciable pathological changes have been found in portions of the brain or its membranes, the gastro-duodenal mucous membranes, the muscular structure of the heart, and, indeed, in all the more important excretory glandular structures of the body. In most cases the membranes of the brain present a certain degree of passive congestion or hyperæmia, with some parts of the arachnoid and pia mater thickened and opaque. Similar fulness of the vessels of the brain is generally seen on section, though in some cases the convolutions have appeared rather shrunken and increased in density, and microscopic examinations also detect fat-granules, atrophy of nerve-cells, and hypertrophy of connective tissue. Some degree of serous effusion may be found both on the cerebral surface and in the ventricles, and more rarely there are slight hæmorrhagic extravasations in the cerebral substance.

No marked changes are found in the lungs, except slight passive congestion and occasionally hypostatic engorgement and œdema in the posterior and inferior parts. The muscular structure of the heart is much more frequently found pale, soft, or flabby, and revealing under the microscope fatty granular degeneration. Post-mortems in this class of subjects reveal no more constant morbid condition than the congested state of the mucous membrane of the stomach and duodenum, with some parts thickened and showing abrasions or slight ulcerations. The liver and kidneys are rarely found free from unnatural fulness of the vessels, with increase of fat-granules and hyperplasia or commencing sclerosis of the connective tissue.

But no one of all the important pathological changes I have mentioned, as found in different structures, can be claimed as peculiar to subjects having died of delirium tremens. On the contrary, they all belong to the general morbid conditions known as acute and chronic alcoholism, and are generally found developed in direct ratio to the length of time the subject had indulged in the use of alcoholic liquors during life and the quantity used. The special morbid conditions of the brain causing the phenomena of delirium tremens are not readily appreciable to the senses in a post-mortem examination. They evidently consist in an impoverishment or lack of nutrition from protracted omission of food, coincident with the diminished cell-activity or molecular change caused by an excessive impregnation of alcohol. It is only when a patient has maintained a more or less protracted state of acute alcoholism, coupled with sufficient deprivation of food to cause defective nutrition of nerve-cells, that the peculiar phenomena of mental derangement are manifested. In former times it was generally supposed that the immediate manifestation of delirium and hallucinations was caused by a too sudden withdrawal of the alcoholic drink. But it is now conceded by all clinical observers of experience that much the larger number of cases commence while the alcoholic beverage is still being freely used by the patient. So far as my experience goes, only such patients are attacked with the phenomena of delirium tremens several days after having discontinued the use of the alcoholic drink as either from gastric disease or traumatic injuries fail to take and retain sufficient nourishment to commence reparative nutrition as soon as the alcohol is discontinued. The rational inference, therefore, is that the essential pathology of the disease consists in cerebral impoverishment, with more or less of retained products of disintegration coincident with acute alcoholism, or a similar general condition induced by some other anæsthetic or narcotic.

Diagnosis.—Little need be said in regard to the diagnosis of delirium tremens, as it seldom happens that the history of the case is not easily obtained; and the peculiar character of the mental hallucinations, coupled with muscular tremors, supervening upon a course of alcoholic dissipation or the excessive use of other intoxicants, leaves very little chance for doubt or error. From acute or subacute inflammation of the brain or its membranes it is distinguished, not only by the character of the hallucinations and muscular tremor, but by the absence of pyrexia and acute pain, and the presence of a soft, quick pulse, cool and moist skin, and nearly natural condition of the pupils.

Prognosis.—When not complicated by some important inflammation, as gastro-duodenitis, meningitis, or pneumonia, delirium tremens is a self-limited disease, with a pretty uniform tendency to recovery of the patient. Clinical observations have shown that a large majority of such cases begin to convalesce in from five to nine days, if simply deprived entirely of the further use of alcoholic drinks, kept as much as possible at rest, with milk, or other bland nourishment, and quiet, careful nursing, without medicine. And yet, such is the distressing nature of the delirium, the fear and anxiety that it impresses upon the patient and his friends, that it is desirable, and indeed necessary, for these patients to be placed in the hands of a judicious physician, who will pursue some definite course of treatment, aided by a faithful and intelligent nurse. The latter is perhaps of more importance than the former; for nothing exerts a

more unfavorable effect upon a patient under the excitement of delirium tremens than to be left in the hands of half a dozen frightened friends, who will constantly endeavor to convince him of the imaginary character of his hallucinations and hold him in bed by direct physical force, thereby hastening on a dangerous degree of exhaustion.

Perhaps the most frequent complication is acute or subacute gastritis or gastro-duodenitis, and when it exists there is great danger that the persistent vomiting and entire deprivation of nourishment will end in early fatal exhaustion. The coexistence of either active meningitis or pneumonia is still more dangerous, but fortunately of much less frequent occurrence.

Treatment.—When I commenced the practice of medicine, about fifty years since, the disease under consideration was very generally thought to require an active, if not decidedly heroic, treatment. The leading objects then appeared to be a lessening of the supposed danger from cerebral inflammation and the control of the delirium by inducing sleep. One pretty free bleeding, by venesection, and a dose of physic at the commencement, to be followed by full doses of opium or some one of its preparations until sleep was induced, constituted the general outline of the treatment. Both clinical experience and increased knowledge of the pathology of the disease soon caused the practice of venesection to be abandoned as unnecessary and often injurious. But the liberal and often excessive use of opiates was continued much longer, and is not wholly abandoned even at the present time. One of the first fatal cases of delirium tremens that came under my observation was treated by his physician with large and frequently repeated doses of opium until sleep was induced, quickly passing into profound coma or narcotism, and death a few hours later. Such results in those days were not very rare, and were generally attributed by the physician and friends to cerebral congestion or effusion. But in the case under my observation the closely contracted pupils, the rapid transition from wild hallucinations, first to sleep, then to profound insensibility, coldness and blueness of the surface, and, last, involuntary discharges and death, led me to think that the result was directly attributable to the rapidly accumulative effects of the opiates. While at the present time the active opiate treatment is much less followed than formerly, and has been largely superseded by the use of bromides and chloral as quieting agents, there is still danger from the administration of frequently repeated large doses of the latter. Soon after the introduction of chloral as a remedy in these cases, a patient was admitted to the medical wards of the Mercy Hospital, Chicago, in the early stage of active delirium tremens. The house physician administered chloral hydrate, in doses of fifteen decigrams (grs. xxij.), every hour. Soon after taking the third dose the patient became quiet, and in another hour was unconscious and the respiration so nearly suspended that artificial respiration had to be practised for three hours, when the effects of the chloral began to abate, and the patient subsequently recovered. Another less fortunate case came to my knowledge in the same city, which illustrates the great danger of giving full doses in quick succession of different narcotics. A naturally strong working-man had been in a state of constant delirium, with terrible hallucinations, for three or four days, when his physician, anxious to gain control over the intense excitement, gave several fair doses of bromide and chloral at short intervals, and not seeing much immediate effect, he added a hypodermatic injection of two centigrams (gr. $\frac{1}{3}$) of sulphate of morphine, which was soon followed by entire quiet and apparent sleep. He left directions to have the patient kept quiet so long as he should sleep. In about two hours he was sent for in great haste, and on arriving at the bedside found his patient already dead. The apparent sleep had passed rapidly into profound insensibility, with slower and slower respiratory movements until they ceased entirely. It is not probable that either the hypodermatic injection of morphine or any one dose of the chloral hydrate alone would have put the life of the patient in jeopardy. But administering them at too short intervals produced a fatal accumulation. I have thought it proper to allude to these cases as a warning, because the same error has been many times committed, not only in the treatment of delirium tremens, but in combating many other forms of extreme distress.

For the successful management of nearly all cases of delirium tremens three things are very desirable, if not indispensable.

First, a faithful, courageous, and kind nurse, who will keep the room quiet, properly ventilated, and instead of arguing with the patient about his imaginary objects, will court his confidence by assuming to protect him from his supposed enemies, and as often as possible induce him to take small quantities of milk or other bland nourishment, but resolutely keep from him all kinds of alcoholic drinks.

Second, the administration of moderate doses of such medicines as are capable of exerting a quieting or sedative effect upon the excited condition of the nervous system, and to increase the steadiness and force of the systolic action of the heart. For these purposes we have no remedies more reliable or better adapted to these cases than the bromides and digitalis. The first, in suitable doses, act as efficient sedatives to the nervous excitability, and the latter increases the systolic force of the heart, while it diminishes its frequency, and also aids the quieting effect of the bromides. A convenient formula for administration consists of bromide of potassium, twenty-five grammes (ʒ vj.); tincture of digitalis, twenty cubic centimetres (fl. ʒ v.); simple elixir, thirty cubic centimetres (fl. ℥ j.), and water, ninety cubic centimetres (fl. ℥ iij.)—of which four cubic centimetres (fl. ʒ j.) may be given in a little additional water every two, three, or four hours, according to the degree of mental excitement exhibited by the patient. If these doses do not prove quite sufficiently quieting as night approaches, in the early stage, a dose of from ten to thirteen decigrams (grs. xv. to xx.) of chloral hydrate may be given at eight o'clock in the evening, and, if necessary, repeated two hours later. I have seldom found it necessary to give the one or two doses of chloral in addition to the bromide and digitalis longer than during the first three nights, after which a continuance of the latter, at intervals varying from three to six hours, has been sufficient to complete the convalescence in a few days. In some cases where the patients are first brought under observation, the tongue is found coated, stomach sensitive, urine scanty, with indications of general derangement of secretions, and slight fever. These symptoms are generally readily removed, without interfering with the administration of the remedies already directed, by giving thirteen centigrams (grs. ij.) of calomel, and repeating every four hours until three doses have been taken, and following them with a saline laxative sufficient to move the bowels.

Third, it is quite as important for the successful management of cases of delirium tremens that proper nourishment should be intelligently administered in suitable quantities as it is that medicine should be given. It should be plain, easily digestible, and readily absorbed and convertible into the elements of blood with but little action of the gastric secretions; for the larger proportion of these patients have but little normal secretion of gastric juice. Milk, beef-tea, and other animal broths, oatmeal gruel and milk, rice, and arrow-root are nutriments well adapted to these cases. But when patients manifest a desire for other food, they may be supplied with any variety of the plainer articles that they desire. When a case is complicated with sufficient irritation of the gastric or duodenal mucous membrane to cause even the blandest food to be rejected, or to speedily become sour, much benefit may be derived from giving four cubic centimetres (fl. ʒ j.) of the following formula immediately before the patient takes food, or at least four times a day:

℞. Resorcin	4 Gm.	(ʒ j.)
Glycerin	16 c.c.	(ʒ iv.)
Tinct. Gelsemin	16 c.c.	(ʒ iv.)
Tinct. Opii Camph.	60 c.c.	(℥ ij.)
Aquæ Menth	60 c.c.	(℥ ij.)

M. Dose, four cubic centimetres (fl. ʒ j.).

Some practitioners still think it necessary to allow patients laboring under delirium tremens to continue the use of some wine or other alcoholic drink, under the impression that it will lessen the violence of the delirium, or that its sudden entire withdrawal might increase the danger of fatal prostration. Direct clinical observation, during the first ten years of my practice, satisfied me that this impression was erroneous; and for more than thirty years I have allowed no patient under my care with this disease any alcoholic liquor, either fermented or distilled, and the results have been most satisfactory. The patients not only recover more speedily without it, but they abstain longer after their recovery before commencing anew their former debaucheries. After convalescence is established, the only treatment required is plain food, good air, and light occupation for both body and mind until the strength is well restored.

Mania à Potu.—This name has been used by the great majority of writers as synonymous with delirium tremens. A smaller number have restricted its use to the designation of a variety of mental derangement resulting from acute alcoholism, not of frequent occurrence, but presenting some peculiarities which are sufficient to distinguish it from the ordinary form of delirium tremens. It is most frequently met with in persons of nervous temperament or hereditarily disposed to insanity; and it commences in the midst of a period of excessive drinking, and sometimes before such periods have been in progress more than one or two days.

Symptoms.—The most characteristic symptoms are the sudden occurrence of violent maniacal delirium, while in a state of semi-intoxication, with such mental delusions as to create a strong homicidal tendency. There is little or no muscular tremor, less fear or anxiety depicted in the countenance, and the mind is filled, not so much with fearful hallucinations, as with illusions which transform the persons and things around the patient into bitter enemies or disgusting objects, which he may be irresistibly impelled to destroy. The face is generally flushed, the pulse increased in frequency; there is little or no appetite, no sleep, and the mind varies from a state of suspiciousness, moroseness, and violence of temper to one of most furious or destructive mania. The greater number of these maniacal paroxysms are of brief duration; but in some cases they pass into a more passive form of melancholia, which may continue several weeks. There can be little doubt but that much the larger number of those shocking homicides which disgrace the criminal annals of civilized countries, in which mothers, or children, or both, have been suddenly slaughtered in the midst of the father's debauchery, have been the direct result of true paroxysms of mania à potu, such as we have just briefly described. The medico-legal bearing of this class of cases deserves more thorough investigation than it has hitherto received. And as one attack of this form of mania leaves the patients more disposed to another, whenever indulging in the use of alcoholic drink, they constitute the most dangerous class of inebriates.

Prognosis.—The more violent character of the paroxysms of mania in those cases, coupled with more indications of cerebral irritation or hyperæmia than in ordinary delirium tremens, renders them more dangerous to the life of the patient; yet far the larger number tend to recovery, while a few have been known to terminate fatally in a few hours, and a large number, after a few relapses, have terminated in permanent insanity. When death has resulted early, from a first or second attack, the post-mortem appearances have been the same as belong to acute alcoholism, with more traces of inflammatory congestion in the meninges and substance of the brain, and more rarely slight hæmorrhagic exudations.

Treatment.—All the rules already given in regard to the management of delirium tremens apply equally to the treatment of such cases as we have classed under the head of mania à potu, except in one particular, namely, the abstraction of blood. I have seen a few cases of this class presenting so much firmness of pulse, redness of the face and eyes, and heat of the head, that I commenced the treatment by one venesection to the extent of from twelve to sixteen ounces, and with very marked benefit. Dr. Henry Hartshorne mentions a similar case in his notes in the first volume of "Reynolds' System of Medicine," p. 680. The practice of venesection in such cases is generally accompanied by some difficulty, on account of the struggles of the patient, and it should be resorted to only in those exceptional cases when it is clearly indicated by the symptoms I have mentioned. All subsequent treatment may be the same as in corresponding stages of delirium tremens.

Dipsomania, Methomania, Oinomania.—These are names that have been applied to a large class of cases of chronic alcoholism, characterized, not so much by ordinary symptoms of mental derangement, as by persistently returning periods of uncontrollable drunkenness, varying in length from one to four or six weeks, with intervals of sobriety lasting from one to six months.

During their periods of drinking most of this class of patients give themselves up to unrestrained debauchery and vice, until either their money is exhausted or their stomachs refuse longer to tolerate the alcoholic drinks, when they stop as suddenly as the paroxysms commenced, and in two or three days return to their customary work with as much correctness and diligence through the usual interval as any other citizens.

As the years pass by, in nearly all of these cases the intervals of sobriety become shorter, the periods of debauch recur more frequently and are more liable to end in delirium tremens or permanent gastric, hepatic, or renal disease; or, escaping these, in the final development of alcoholic dementia. The most singular features presented in the early history of these periodical drinkers are the recklessness of their periods of drinking while they last, and, for the most part, the practice of total abstinence during the intervals. During the former their mental emotions and illusions are such as prompt strongly to acts of licentiousness and the indulgence of unprovoked jealousies, while in the interval the larger proportion of them, at least, are chaste, upright, affectionate, and deeply humiliated by their previous conduct. And yet, despite their earnest resolutions and pledges, when the time comes round, the most trifling circumstance, often without the slightest apparent reason, will cause them to plunge into another debauch. Members of this class are to be found in all ranks of society; and it has long been a mystery, not only to their friends, but to physicians and moralists as well, why men of this class—intelligent, refined, and eminently respectable as many of them are, at least in their early years—can continue to repeat such apparently causeless periods of revelry and disgrace, of the consequences of which they are so fully conscious during the interval.

The strictly periodical return of active phenomena, the tendency to gradually shorten the intervals as the years pass, and the observance in many cases of the fact that each returning debauch was immediately preceded by certain mental conditions, have led to the suggestion that these patients were laboring under some obscure disease in the cerebral nervous centres analogous to that of epilepsy and other recurring neuroses. It is alleged by many writers that a large majority of this class derive their persistent tendency to periodical drinking from hereditary influences. While the facts adduced in regard to such influences are sufficient to render it probable that they had been potent in some cases, they are wholly inadequate to explain the origin of many others. It was the increasing conviction in the minds of psychologists and philanthropists that the phenomena of this class of inebriates were founded on actual morbid conditions of the nervous structures, aided by hereditary predispositions, that caused it to be separated from ordinary cases of habitual intoxication, and ranked as a form of mental alienation under the name of dipsomania or methomania.

Prognosis.—Abundant clinical observation has shown that a very large proportion of these so-called dipsomaniacs have resisted every means devised for their permanent cure, but a smaller ratio have recovered, and doubtless the same result could be obtained in a much

larger number if they could be placed under the most favorable influences in the early part of their career.

Treatment.—From a careful study of the many cases that have come under my observation, I have been led to regard it necessary to give the most careful and persevering attention to three things if we would achieve the greatest degree of success in the management of this class of cases:

1. The patient must be so fully instructed in regard to the deceptive and injurious influences of alcoholic drinks in the human system that he is actually convinced their use is entirely unnecessary in any of the relations of life, either ordinary or extraordinary. Unless this is done, hardly the length of an ordinary interval will pass without the occurrence of some one of the thousand mishaps or emergencies, such as getting wet, or cold, or exhausted, etc., for which the popular mind says just a glass of wine, or punch, or toddy is the sovereign remedy, and he will take it. And in nineteen times out of twenty that glass will initiate a full period of characteristic debauchery. In conversing with many of this class of men, I have found few who did not mention some circumstance of supposed necessity or, at least, benefit which had been the occasion of commencing each paroxysm. Consequently it is an important step gained if the patient and his family can be so thoroughly instructed that they will not only regard the use of alcoholics as unnecessary, but will not keep them anywhere within convenient reach.

2. The second object in the management is to acquire as complete knowledge as possible of the mental characteristics, business habits, and tone of physical health of the patient, that we may the more accurately adjust all those influences capable of acting favorably upon him during his intervals of sobriety.

So far as possible all sources of petty annoyance in either the family or social circle should be avoided, and also all speculative enterprises involving large risks and consequently alternate emotions of elation and despondency; and if the digestive functions are impaired, the nervous system irritable or sleep disturbed, a proper use of remedies should be continued until such infirmities are removed. I have seen excellent effects result in these latter cases from the use of one milligram (gr. $\frac{1}{60}$) of digitaline and two milligrams (gr. $\frac{1}{30}$) of strychnia at each meal-time, and from twenty to thirty minims of dilute hydrobromic acid at bedtime. In cases accompanied by costiveness I have added from ten to thirty minims of the fluid extract of cascara sagrada to each dose of the hydrobromic acid. Instead of the digitaline and strychnia I have given, with good effects upon the digestive and nervous functions, a pill or gelatin capsule containing extract of hyoscyamus, six centigrams (gr. j.), and oxalate of cerium, two decigrams (grs. iij.), at each meal-time. If it has been ascertained in any given case that the periods of dissipation recur at nearly regular intervals, the patient should be induced, if possible, to commence a week before the usual time of recurrence to take at each meal-time a pill containing sulphate of quinia, thirteen centigrams (grs. ij.); extract of eucalyptus globulus, thirteen centigrams (grs. ij.); and extract of cannabis indica, two centigrams (gr. $\frac{1}{3}$); and to continue the same for two weeks or more.

3. The third item that requires attention in the management of this important class of patients relates to their occupations and personal associations. All experience has shown that little or no progress can be made toward the permanent recovery of a dipsomaniac so long as his business places him in more or less contact with alcoholic drinks, or in frequent association with drinking comrades. Consequently, both physician and friends should combine all their influence to separate, as far as possible, the patient from such associations. And if it cannot be done in any other way let him be induced to take a residence for six or twelve months in a well-regulated asylum for inebriates, until the usual paroxysmal tendencies have been broken.

By a patient, judicious, and persevering application of the system of management I have briefly sketched, I have had the pleasure of seeing a considerable number of this class of sufferers permanently restored to mental, moral, and physical health. But when a fair trial of such measures finally fails, as it will with many, and the periods of uncontrollable debauchery become more and more frequent, nothing short of enforced seclusion in a proper asylum, with no possibility of obtaining any kind of alcoholic drink, but where good air, good food, kind treatment, and some suitable employment can be furnished, on the same principle that applies to the treatment of other insane persons, will save them from early destruction.

Alcoholic Dementia.—The long-continued use of alcoholic drinks is capable of inducing all grades of mental impairment, from simple weakness to complete dementia. Those who drink to such excess as to become either habitual or periodical drunkards, and are not cut off by delirium tremens, mania à potu, or visceral diseases, before the near approach of old age, pretty uniformly develop symptoms of progressive mental impairment, caused by pathological changes in the membranes and substance of the brain resulting from the long-continued contact with alcohol. These results, however, are not limited entirely to those who drink enough to be recognized as inebriates, but there are many of both sexes who make liberal daily use of alcoholic liquors for many years without ever becoming grossly intoxicated, and yet later in life develop all the phenomena of alcoholic dementia.

Symptoms.—The early symptoms of alcoholic dementia vary much in different cases. In a large majority of the cases the first noticeable symptoms are weakness and unsteadiness of the voluntary muscles, giving a slight tottering motion in rising from a chair or walking, and some trembling of the hands, especially when weary. At the same time the memory is less reliable; it is more difficult to fix the attention; the emotions and passions are more easily disturbed; the facial expression more dull; sleep is often disturbed, and there are various annoying sensations, such as creeping, pricking, or numbness in the scalp or other parts of the surface, and not infrequently noises in the head and momentary pulsating sensations. Sexual illusions and jealousies are peculiarly prominent in this class of subjects. These various symptoms once begun, usually steadily, though slowly, increase until the patient can neither walk nor even stand without being supported; the muscles of the face become relaxed, often letting the saliva dribble, and imparting a decidedly idiotic expression to the countenance; while the mental faculties continue to fail until the patient has neither memory, power of attention, nor ability to converse, and hardly gives heed either to his food or to his evacuations.

In other words, the dementia becomes complete; and still the patient may live for months in utter helplessness, but fortunately without sufficient intelligence to realize the degree of his degradation. Many cases, instead of progressing through all the stages to the complete loss of nearly all functions, both mental and physical, become early subject to well-marked symptoms of pacyhmeningitis interna, such as sudden attacks of vertigo, partial paralysis, temporary suspension of consciousness, and finally fatal cerebral hæmorrhage. In other instances the earlier stages of mental failure are characterized by intercurrent periods of exciting hallucinations or illusions, constituting active outbursts of insanity, during which the patients are very liable to commit criminal acts directly prompted by the nature of their illusions. In these periods of more active derangement many of this class find their way into asylums for the insane, where they add to the great class of incurables and ultimately to the number affected with general paralysis of the insane.

Nearly all the patients affected with alcoholic dementia present, even from an early period, an anæmic look, and are affected with more or less gastric and duodenal irritation, rendering digestion imperfect. The excretory functions of the skin, kidneys, and liver, are also frequently disordered.

Pathology and Pathological Anatomy.—All the essential phenomena of alcoholic dementia are traceable, not to the immediate presence of alcohol in the cerebral vessels

or structure, but directly to those structural changes in the membranes and cerebral substance that I described as present in fatal cases of delirium tremens, and the still further progress of those changes in the same direction, which may continue, in some cases, long after the use of alcoholic liquids has ceased. In addition to the changes just alluded to, in nearly all the post mortems in cases of fatal alcoholic dementia there are found more thickening and opacity of the pia mater and arachnoid, with thrombi or varicosities in the vessels of the dura mater, and sometimes hæmorrhagic spots and more or less serum on the surface and in the lateral ventricles. The convolutions, especially over portions of the cerebral hemispheres, appear most frequently pale, shrunken, and harder than natural, though in some cases there are limited regions of increased redness and less density. These appearances are caused mostly by more or less atrophy of the nerve-cells of the gray matter, and either sclerotic or fatty changes in the connective tissue. Fatty or atheromatous changes in the coats of the cerebral vessels are also present in most instances.

Numerous small cystic degenerations have also been described by some observers. It is to these various and extensive degenerative changes in the cerebral structures that the patient owes the loss of his mental faculties.

Prognosis and Treatment.—When well-marked symptoms of dementia have supervened upon chronic alcoholism the prognosis is decidedly unfavorable.

In the earlier stages something may be done to palliate symptoms and retard the progress of the morbid processes by rigidly abstaining from all alcoholic liquids, whether fermented or distilled, a proper regulation of the diet, the avoidance of excessive exercise, either mental or physical, and the use of such remedies as may be indicated for maintaining a healthy condition of the digestive and excretory functions. The only additional items of treatment relate to such measures of a legal and sanitary character as will best protect the patient from injuring himself or others, and secure for him the most faithful and humane attention until the end of his life.

N. S. Davis.

INSANITY (MEDICO-LEGAL). Early legal discussions now seem strangely crude. Courts and lawyers of two centuries ago knew but little of insanity. They considered that a person of competent age who could not count twenty, did not know his parents, could not be taught to read, showed by these tests that he had never acquired reason. They also supposed that a person who had possessed reason might be deprived of it, particularly by the rays of the moon striking upon him. They called persons of the one class idiots, those of the other lunatics, and denied the responsibilities and refused the rights of ordinary human beings to both. This rude division has survived in jurisprudence to the present day. But the legal idea of distinguishing the insane seems to go no further in earliest accounts than this, and the early knowledge of the physiological causes of mental aberration is illustrated by the following extract from an antique law book entitled: "Non compos mentis; or the law relating to natural fools, mad folks and lunatick persons," Eng. 1770. The author's "true account of the cause of distraction" is this: "When the Animal Spirits, by some Accident or other, are so over-heated, that they become unserviceable to cold and sedate Reasoning; and then Reason being thus laid aside, Fancy gets the Ascendent, and, Phaeton-like, drives on furiously and inconsistently. This Combustion of the Spirits happens, sometimes by over-great Intention of the Mind, in long and constant Study; sometimes by a Fever, which inflaming the Blood, that communicates the *Incendium* to the Spirits, which take the Original from it: But most usually by the Rage and Violence of some of the Passions (whether Irascible, or Concupiscible, as they are wont to be distinguished), a Man setting his Heart vehemently upon some Object or other, the Spirits are set on fire, by the Violence of their own Motion; and in that Rage are not to be governed by Reason."

Physicians would not be benefited by an attempt to trace minutely the general growth, among jurists, of a knowledge of insanity, for the reason that jurisprudence has not possessed any peculiar means of studying the subject, but has been accustomed to follow the course of medical science and to accept, sometimes, indeed, after long hesitation and inquiry, the results which skilful and experienced alienists have united in declaring established, so far as such results have been pertinent to the purposes of the law. And there is an important difference between the uses of any definition of insanity or classification of the insane in medicine, which regards the insane as subjects of treatment in hope of cure, and their uses in law, which deals with these unfortunates with reference to their custody for their own safety and that of the community, to their capacity for exercising civil rights, and to their amenability to punishment. It is because the law accords to both idiots and lunatics special protection and immunity that occasion arises so often for the inquiry, Was he insane? This question, however, is, in the courts as elsewhere, a question upon which the advice of scientific experts is the primary guide. The physician summoned to testify in answer need not anticipate that he will be confronted with fixed legal definitions, or be required to answer according to tests having legal authority. On the contrary, he will be asked for the most accurate and trustworthy of medical definitions; and all information he can give of the progress of knowledge among medical experts, and particularly the results of his own observation and research, will be welcomed by the law of the land, though perhaps not by opposing counsel.

To give an accurate and exhaustive definition of insanity, one which shall exclude all who are sane and include all who are not, has been deemed by many writers to be impracticable. Others have proffered definitions, the most instructive of which are collected and reviewed by Dr. Hammond ("Diseases of the Nervous System," 332), who also gives one. The classification which has been most commonly cited by courts and lawyers during the present generation, though possibly others may have more merit, originated with Esquirol. It is familiar to physicians, and has been instructively restated by Dr. Hammond, who presents it in comparison with three others, one of them his own, well worthy the attention of jurists ("Diseases of the Nervous System," 335, 336).

Passing now to the issues involving insanity which particularly concern the sufferer, they are: The inquiry whether a committee of his person and estate should be appointed, and the inquest which precedes his going to the asylum. In the first, generally known as the writ *de lunatico inquirendo*, or inquest of lunacy, the influence of modern views, embracing lesser grades of aberration and a larger number of persons within the protection of the law, is distinctly seen. Here the general fitness of the subject to act and deal freely with his fellow-men is what is in question, and the appropriate standard, or test, is: Unsoundness of mind which disables the person from attending to his own affairs. Early English decisions, in cases of this class, required a more positive finding. But the necessity of according legal protection to persons who, though neither idiots nor lunatics in the strong sense in which these terms were used in the common law, nevertheless showed serious derangement, led to the introduction of the term, "unsound mind;" and the modern practice has been to let witnesses narrate to the jury all the eccentric behavior, delusions, and incoherent language of the person under inquiry, and then to throw the responsibility upon the jury as advised by the physicians. If the jurors, after hearing the opinions of the experts, say: "We think he is of unsound mind and incapable of managing his affairs," the court will appoint guardians, or a "committee," as the custodian is called in several States, for the person and the estate. If they hesitate to speak so positively the appointment will be refused; the courts seem to decline to accept any lighter imputations of disability than this. But the progress is toward making the test easier, and giving the protection of guardianship to persons whose insanity is not so marked as was once thought necessary (Ray, "Medical Jurisprudence of Insanity," § 5).

Dr. Ray criticises this rule, derived from English cases,

as too strict for the necessities of the insane at the present day, without noticing statute 11 Geo. IV. and 1 Wm. IV. ch. 60, which appears to give power to issue a commission of lunacy in all cases where an individual is incapable of managing his affairs, although he may not be an "idiot," a "lunatic," or a "person of unsound mind," in the strict sense of those words. But this statute, passed in 1830, does not modify for the United States the stricter rule derivable from the earlier decisions.

In this country, the decisions have been to the effect that a finding which merely declares the party "to be incapable of managing his affairs" is insufficient (1 Hawks, 11). So is a finding that the party is incapable of managing his affairs, or of governing himself, in consequence of mental imbecility and weakness (7 Paige, 236). So is a return that the party, by reason of old age and sickness, is so deprived of reason as to be unable to manage his estate (1 Whart., 52). But a finding that he is *non compos mentis* is not affected by the addition of the words "lunatic and idiotic;" those may be rejected as surplusage (1 Ired. L., 523). All the characteristics of *dementia* mentioned by medical writers need not be manifested by an individual to warrant a finding of *non compos*. If the jury are satisfied that the party is affected by such unsoundness of mind, caused by *dementia* or other mental alienation, as renders him incapable of managing his affairs, they may find him a lunatic and of unsound mind. But failure of memory, or feebleness of intellect from old age, is not of itself an evidence of that unsoundness of mind which warrants a finding; to warrant it, they must be such as to import total deprivation or suspension of the ordinary mental powers (10 N. J. Eq., 186). Where, however, a person, from old age or any other cause, becomes mentally incapacitated from managing his affairs, a commission of lunacy may, upon clear evidence of his ailment, and a full and prudent inquiry, be sustained (2 Johns. Ch., 232). That a person makes improvident bargains and is generally unthrifty in his business or unsuccessful in his enterprises, does not necessarily prove him to be *non compos mentis*, though it might tend to prove it (36 Ala., 514). The test question is whether the mind is deranged to such an extent as to disqualify the person from conducting himself with safety to himself and others, and from managing and disposing his affairs and discharging his relative duties (6 Watts & S., 451); whether the prosecution have shown (they have the burden of proof) that the defendant has become deprived of reason, so far as practically to have lost the power to govern his mind, body, and estate; but it is not necessary to show a derangement or loss of all the faculties, and, on the other hand, perfect mental action is not necessary to entitle the defendant to prevail (2 Brews., 491; 59 Pa. St., 328).

Suppose the question to be whether a person ought to be placed in an asylum; what degree of insanity is needed? The grounds are either his liability to outbreaks of violence endangering his neighbors, or his need of medical care and remedies. This is not a subject governed by quiet, steady adhesion to a long course of English and American decisions; nor is it regulated by any convenient statute of the National Government, one and the same for the whole country. Any State may have its law, and most of the States have comparatively recent laws. There has been in times past some reason to complain, and there has been earnest complaint, that the law did not protect sane persons from being immured in asylums on false charges of insanity. But recently the subject has had careful attention.

Let the New York law be taken as an example of a carefully prepared, well-framed State law dealing with this subject. It was passed in 1874 (Laws 1874, p. 564, c. 446; Ordronaux, "Judicial Aspects of Insanity"). This should be premised. The rule is an old and necessary one that a person who falls suddenly under an attack of violent lunacy may be taken care of temporarily, without any legal authority or papers, so far as needed to prevent his doing mischief. A crazy man attempting to kill himself may be stopped; or one rushing through the streets with a drawn knife or pistol may be caught, and the weapon taken away. The imminent mischief may be prevented. If a passenger by cars should break out into crazy violence, putting himself or fellow-passengers in danger of injury, they or the conductor would be justified in confining him enough to prevent the injury. Beyond this, by the New York law, nothing can be done without a certificate. Husbands or brothers cannot carry their wives or sisters, who object, to an asylum without a certificate. A person cannot go of his own accord to an asylum and enter himself as a patient unless it be in such a manner that he can leave the next day, if he chooses.

The certificate must be signed by two physicians; one is not enough. It must be sworn to be true. It must be founded on a personal examination of the patient, and must state particularly the facts which have convinced the signers that the person is insane. Moreover, it must show that the physicians who sign it have this special authority; for all practitioners are not allowed to give these papers; only physicians who have been approved by the judicial authorities as "Medical Examiners in Lunacy" can give them. Without such a certificate, no person can make any pretence to escort another, who objects to going, to an insane asylum, no matter whether there is insanity or not A quiet, peaceable, insane person has right of liberty until this certificate, on an examination by two authorized physicians, has been made.

This document can be used for ten days from its date only; and it authorizes keeping the insane person shut up for five days, and no longer. If the friends of a lunatic obtain a regular certificate and carry him to an established asylum, and he is evidently insane (not violent), the superintendent cannot keep him on the certificate alone. The friends must submit the case in some court of record where the person resides, and obtain approval of the court; and the courts have full power to examine witnesses and make every inquiry. Justices of the peace used to have this authority, but it is now confined to the higher courts. The State Commissioner in Lunacy has also large powers in investigation and control of asylums.

The law, during the twelve years which have elapsed since its passage, has received a few slight amendments, but no changes materially affecting its substantial provisions have been made. Somewhat similar laws in other States may be found by consulting the compilations of Folsom or Harrison, mentioned below.

It remains to add that the power of an insane person to exercise civil rights, and his amenability to punishment, have been treated under the headings Civil Incapacity—Criminal Irresponsibility.

Works treating of the legal aspects of insanity are numerous; those of modern date, and most likely to be useful to physicians, are: Ray, "Medical Jurisprudence of Insanity," fifth edition, 1871; by an author of abundant medical experience. Browne, "Medical Jurisprudence of Insanity," second edition, 1875; by an English lawyer whose father was Commissioner in Lunacy for Scotland. Archbold, on "Lunacy," England, second edition, 1877. Ordronaux, on "The Lunacy Laws of New York," and "The Judicial Aspects of Insanity," 1878; by an author of wide learning, both in jurisprudence and medical science, and for some years New York State Commissioner in Lunacy. Bucknill, on "Insanity," England, 1880. Wharton, on "Mental Unsoundness," embracing a general view of psychological law, 1882; this forms vol. i. of a new edition of Wharton & Stillé on "Medical Jurisprudence;" the author, Francis Wharton, enjoys high repute as an author on many topics of jurisprudence. Buckham, on "Insanity in its Medico-legal Relations," 1883. Mann, "Manual of Psychological Medicine," 1883. Folsom, "Compilation of the American Statutes Relating to Custody of the Insane," 1884; abstracts of these statutes are appended to Clouston's "Clinical Lectures on Mental Diseases." Harrison, "Legislation on Insanity;" embracing foreign as well as American statutes, 1884; a very elaborate and extensive compilation, privately printed. Buswell, "Insanity in its Application to Civil Rights and Capacities, and Criminal Responsibility," 1885.

Benjamin Vaughan Abbott.

INSANITY OF PUBERTY AND ADOLESCENCE. The term "Insanity of Pubescence" is capable of a wide range of application. It may be so employed as to include all cases of insanity between the ages of twelve or fourteen and twenty-five. Statistical inquiries in this line are likely to be vitiated by including cases of epilepsy, idiocy, imbecility, or organic disease in patients who have been mentally defective from birth or childhood, but whose ages, on coming under observation, fall within the limits of puberty and adolescence. On the other hand, certain writers, like Schüle, limit the insanity of pubescence to a rare and peculiar variety comprising only certain well-marked and typical cases. Applied in one of these ways, therefore, the term represents all the morbid mental manifestations possible at this epoch, in the other, a handful of cases of the purest type of a single form. Avoiding both of these extremes, we shall find not a small proportion of cases which present distinctive features due to a variety of causes, operating only in youth, and based upon an arrest of the transformation of the childish into the adult character. The term "pubescence" is likely to mislead. The time of puberty is, strictly speaking, limited to a varying period between the ages of twelve and sixteen, or the initial years of the functional development of the reproductive organs in man. It is plain, then, that "insanity of pubescence" should include only such distinctive cases as occur within that interval.

Use of the term "insanity of pubescence."

Now, it is the experience of most alienists that it is not at the time of the *first* appearance of the reproductive function chiefly that there is peril to the healthy mental balance, but it is those after-years of gradual coming to maturity that are often full of danger to the mental health of both sexes.[1] Moreover, no useful purpose, either physiological or pathological, is subserved by establishing a dividing line between puberty and adolescence, which together represent one continuous period of development. But, for want of a single comprehensive title, we shall employ the term *Insanity of Puberty and Adolescence,* as the most convenient and accurate one available.

Hebephrenia[2] was intended by Hecker, who originated the term and was the first to describe this variety, to denote a species of insanity peculiar to adolescence. This will be described later. The term has lost its original significance, and is now frequently employed to designate almost any form of insanity of this period which is noticeable for manifesting peculiar symptoms, or is complicated with pathological nervous states incident to the age, *e.g.*, epilepsy, hysteria, catalepsy.

Hebephrenia.

To influence the form as well as the cause of the insanity of this period, comes the advent of the reproductive era and its changes—the evolution of the sexual apparatus and its functions. Any process in the growth of the individual involving the establishment of a new function is likely to be attended with mental and nervous change of some sort; witness the convulsions and choreic states accompanying the dentitions. Impregnation, parturition, and lactation, it is almost needless to state, are attended with perverted dispositions, morbid tastes and likings of varying intensity, and attacks of convulsions. Mania and melancholia are among the complications to be feared. This pathological law applies with especial force to the independent natural growth of the reproductive organs, as shown in the rise, development, and establishment of the sexual functions.

Influence of the period of evolution of sexual functions and new powers generally.

To intensify this influence and to increase the liability of young women to nervous and mental disturbance, is added the function of menstruation; while, on the one hand, there exists this reflex action upon the mind of these bodily changes which are incident to this period of growth, we must also take into account the peculiarly impressionable nature of the youthful mind itself, an inherent quality of immaturity. In order to realize the profound transformation the organism undergoes at this time, we need only recall the new desires, sentiments, and passions that are awakened by the development of these new sexual functions. The emotions and passions of youth are also in great force, at a time when the judgment is only beginning to take shape and to bring its controlling influence to bear upon them. In short, considering only the normal physiological state of the organism at this period and the amount of strain from within and from without that is put upon it, the term of puberty and adolescence, the first climacteric, completely overshadows the menopause or the second climacteric as a critical period of life.

Influence of menstruation.

Natural instability of the mind itself.

When this process of development is accomplished with difficulty, disordered or suppressed menstruation, anæmia, and chlorosis, may play a prominent part in causing mental breakdown. The prevalence in young women of migraine, hysteria, and the rarer functional neuroses serves also to increase this tendency.

Physical causes.

Among the external causes, faulty education has much to answer for. Too close application to studies and to religious exercises in youth not infrequently begets in the hereditarily predisposed a mental overstrain which is the forerunner of disease. The limits of a boy's or a girl's mental capacity may, for example, fail to be considered by the fond and ambitious parents. The dull youth is, perhaps, harassed by perpetual reproaches, and dismayed by tasks to which he is unequal. The bright and willing one, on the other hand, whose ambition to study should be checked or diverted, is not allowed to flag in his zeal and exertion until possibly an exalted mental state, eventuating in an attack of mania or stupor, is reached. The youthful mind, when too deeply imbued with religious sentiment, its natural inclination repressed by parental restraint or by a morbid consciousness, may succumb to melancholia or exaltation of a religious type, or to a profound dementia or ecstasy, which might possibly have been averted or deferred by more judicious training. It is at this period also that the young feel called to take the veil, or they may have extreme religious experiences, that may be afterward regretted as mistaken ones, and in which they feel themselves to have been misguided.

External influences. Faulty education.

Masturbation is most frequent and most harmful in this period of nervous instability. When habitually practised by the healthy youth of neurotic temperament, it tends, without doubt, to weaken the nervous centres. It also, just as certainly, may engender insanity, but only in those who are highly nervous from hereditary predisposition. When this is the case, the habit modifies considerably the form of the insanity of this period. Masturbation, however, no longer holds the place it once had as a cause of insanity, the bulk of evidence furnished by recent inquiry favoring the view that it is far oftener the result than the cause of mental demoralization. It is, however, a difficult matter, in the present state of popular belief regarding the potency of the practice as a cause of madness, to persuade non-medical persons that when masturbation appears in the usual rôle as a symptom of insanity, the patient has not been addicted to the habit from boyhood. It also not infrequently happens that young men attacked with melancholia are branded with the stigma of a disgraceful habit, owing to this almost universal notion, which is eagerly seconded by the ready self-disparagement and exaggerated fears of the patient, in whose eyes one such act, it may be, has accomplished his imagined mental and bodily destruction.

Influence of masturbation.

Sound ancestral stock and well-directed education are the chief means provided by nature and man for the avoidance of the numerous physiological and pathological pitfalls in the path of mental integrity in youth.

Powerful influence of heredity.

There is little difference of opinion regarding the immense influence which bad heredity exerts in the production of insanity in the period of puberty and adolescence. The large majority of the youthful insane bear this taint. In fact, the insanity of this epoch is essentially hereditary, and no less an authority than Skæ regards hereditary predisposition as an indispensable factor.

Sir Crichton Browne, however, holds a different opinion regarding one variety of this class, viz., "acute dementia," or, more properly, stupor with dementia. These cases, he maintains, generally come of a perfectly healthy stock. He considers it a peculiarity of "acute dementia" that it is less frequently connected with hereditary taint than perhaps any other form of disease. As his monograph[3] deals chiefly with asylum cases, a class whose antecedent histories are notoriously defective, this conclusion, so at variance with those of other observers, is open to question.

Opinions differ not a little as to the sex most likely to suffer from attacks of insanity in youth. The advent of the function of menstruation, with its periodical disturbance of the mental tone, not to speak of its liability to morbid states; the greater preponderance of the affective over the intellectual life in young women; the more powerful influence of the organs of reproduction upon the female mind and the limited range of mental activity possible for women, as well as the fewer vicarious outlets for feeling allowed them, are the chief reasons advanced by Maudsley, Ball, and Blandford for considering the female sex more liable than the male to mental disease in youth. On the other hand, Clouston finds the total numbers and relative proportions of females to be smaller in this period than at later periods of life, and infers that adolescence is not so powerful an upsetter of mental equilibrium in women as in men.

Sex.

The result of our own inquiries, as will be seen farther on, shows little difference in this respect between the two sexes; but in numerous other collections of asylum statistics the number of the males attacked with insanity, between fifteen and twenty-five, considerably exceeds that of the females.

The transitional state of youth being necessarily the union of childish and manly traits in modified form, it follows naturally that mental derangement occurring between the ages of twelve or fourteen and twenty-five should combine in varying degrees the salient features of the neuroses both of childhood and mature life. Insanity in the very young is infrequent enough to be phenomenal. The patients are apt to show an intelligence beyond their years, and perversions of instinct, feelings, and the moral nature are the rule, while genuine mania and melancholia are scarcely ever found. Nervous disturbances in children are well known to be almost exclusively of the motor variety, convulsions, chorea, and epilepsy being almost the sole functional manifestations.

General peculiarities of this form as distinguished from insanity at other times of life.

From the commencement of puberty to the close of adolescence insanity becomes rapidly more frequent, and is characterized by a union of motor and mental manifestations. To the epileptic convulsions originating in childhood is added mental complication, as shown in delusions, excitement, and increased unmanageableness, often the precursors of the epileptic furor of the grown man. The severest forms of chorea occur about this time, and are attended with delirium or mania, which often is so severe as to mask the real disease. Hysteria, most frequent in young women, now appears for the first time, and in its severest form—chiefly sensory and motor—but always attended with a varying amount of defective inhibitory power. Moral or affective insanity, manifested chiefly by outrageous conduct and emotional displays, likewise dependent on morbid loss of control, is always very prevalent at this time.

The variety of mania and melancholia, also, which now appears is noticeable for noisy and violent movements, a choreic tendency, cataleptic rigidity, etc. At the same time the disturbance of the intellect is of a superficial, changeable nature, mingled with emotional outbursts. The absence of the systematized and fixed delusions and disorder of the general intellect found in the insane of mature years is conspicuous. Another feature of youthful insanity is that the patient is usually left in a demented, weak-minded state, the result of an arrest of mental development

In mature and advanced life the different types are the same, but are all well characterized. Mania and melancholia are more profound. The conduct of the patients is more often influenced by persistent, systematized delusions; their violence and demonstrativeness are apt to be more methodical. Outbreaks of mania, with incoherence and aimless violence not due to structural cerebral disease or to toxic influences, are far less common than in youth, and are chiefly confined to the recurrent type of chronic insanity. Periodical insanity, paranoia, monomania, are much more prevalent. General paralysis and other organic cerebral changes now appear on the scene and modify the form of insanity. Hysteria at this time of life has discarded the motor symptoms manifested in youth, and its congeners, neurasthenia and hypochondria, are now added to the list. The proportion of dangerous epileptics is now far greater than in youth, and epileptic mental states taking the place of convulsions are more frequent.

This outline sketch is enough to indicate the general characteristics of mental disease in puberty and adolescence as contradistinguished from its manifestations at other times of life, and to make it plain that the pathological as well as the physiological mental state simply bears the stamp of the immaturity of the age.

Symptoms and Course.—It is impossible to give an exact clinical picture of the insanity of pubescence and adolescence, as its manifestations are not confined to any one form of mental disease, but assume several guises, from an apparently distinct group of symptoms following a legitimate clinical course down to a heterogeneous collection of phenomena the essence of which is weakmindedness.

Hebephrenia takes the first rank among the prominent clinical groups of this period. Its course is described by Hecker as characterized by a stage of melancholy, more or less pronounced, followed by one of maniacal excitement of greater or less intensity, after which a weak-minded state characteristic of the disease develops; of this, however, there have also been evidences in the first stage of the disease. The peculiar character of the melancholy and the excited states, and particularly the transition in the same attack from depression to excitement, call immediate attention to these cases. The writer, several years ago, when unaware of Hecker's monograph, reported four cases of this kind as probably being peculiar to the insanity of young people.[4] Among them is the following:

Hebephrenia.

E. C——, a girl aged nineteen, was admitted to the Danvers Lunatic Hospital, December 2, 1880, with the following certificate of insanity: "Has delusions. Refuses to take nourishment or medicines. Is melancholic."

Her previous history, as given by her father, was as follows: Had a common-school education. Possessed ordinary mental capacity before the attack. Was naturally cheerful and well behaved, but of quiet and reserved disposition. Never insane before. Has a sister who is insane. Was quite well until three weeks before admission, when she went to her first party, where there was considerable excitement. After it she seemed ill, and "lost her speech" for three days. She then manifested great distress, declaring that she had never stolen, never lied, never had a child, etc., and constantly besought her parents to forgive her sins. She lost her appetite, and suffered from wakefulness at first. Menses regular until the week in which she was taken ill.

Is a fairly well nourished, pretty-looking Irish girl. Face pale, expression indicative of profound dejection. Lungs and heart apparently normal. Appetite gone. Bowels inactive. Will not protrude tongue or make any voluntary exertion whatever. She stands in one place most of the time, only moving mechanically. Requires to be dressed and undressed by the attendant, to be led to and from the table, and will not eat without constant urging and even putting the food into her mouth. When addressed she usually makes no response, and, at most, her replies consist of a few disconnected words. She prefers to stand silent and motionless. Is evidently under the influence of some overpowering delusion.

At the end of a month's stay in the hospital the patient had begun to take her food better and appeared somewhat brighter, but was still extremely despondent, and at times terrified. During the third month of her stay she showed increasing animation and activity, and was interesting herself in work in the ward. Her appetite had greatly improved, and she slept fairly well. She was still despondent, and took a gloomy view of her condition. From this time she began to emerge rapidly from her mental and bodily torpor, and a month later she had become busy, cheerful, and sociable. She referred freely to her past condition as an illness from which she had recovered, and recognized her delusions as such.

On March 21st (about four months after her admission) she was considered recovered, and was taken home by her mother. The change was deemed especially proper, as she began to display an undue freedom of manner and vivacity which her new surroundings were tending to increase, and which it was thought might cease in the quiet of home life.

On June 2d, or about two months later, the patient was again committed to the hospital, this time under widely different circumstances. Her parents had found it utterly impossible to control her, on account of her determined recklessness and improper conduct. Her alteration in behavior and disposition was a source of constant astonishment and mortification to the family, as she had been a quiet and unobtrusive girl before her attack of insanity. She was now continually on the move. Would suddenly leave her work and visit some neighbor. Could not be induced to stay at home in the evening, but would walk about the neighborhood in an indiscreet manner, seeking men's society. On one occasion she ran off in her night-dress and wrapper to some resort where there were a number of men, who recognized her condition and sent her home.

It was noticed that during her menstrual periods she grew "heavy," and would sleep a good deal of the time. The physician's certificate reads: "No moral sense; is unruly and unreasonable, tending to dementia, nymphomania, and ungovernable passion for men's society." It was found on admission that a corresponding change had also taken place in her physical condition. She had gained greatly in flesh and strength, appeared to be in excellent bodily health, but rather heavy and coarse-looking. Her manner was forward and pert. She would talk in a loud, excitable way, denying accusations of misbehavior, and making a number of requests at once. She explained her conduct in a glib, plausible manner. She manifested no delusions or hallucinations of any sort.

During most of her second stay at the hospital, which lasted five months, her condition was one of excitement and restlessness, attended with a perfect appreciation of her condition and surroundings, with complete self-abandonment to her impulses and whims. Owing to this lack of self-control she proved very intractable, but was always ready to promise good behavior. She was deceitful and unreliable, and fond of telling about the most private matters of her life, whether compromising or not. She was particularly anxious to attract attention, and would call out familiarly to strangers. In order to make all possible display she would frequently steal from other patients various articles of dress, persuading the more demented ones to give whatever pleased her fancy; would secrete these things about her person, and when accused and cornered she would become noisy and defiant. Her attempts to set the patients against attendants, and to get the latter into trouble, were frequent and ingenious. She twice escaped from the hospital, and resisted violently when brought back. In order to make trouble for an attendant by whom she had been locked into her room, she tore to pieces her clothes and bedding and befouled the room.

During the last month or two she began to grow more quiet, steady, and undemonstrative, and her outbreaks ceased. She now went regularly to work in the laundry. Soon afterward she expressed chagrin at her former conduct, and plainly showed a desire to do better. Finally, having become quiet, unobtrusive, and tractable, she was taken home much improved.

In this case nearly all the peculiarities of hebephrenia appear as originally described. The patient's excitement in particular was marked by the absence of incoherence of acute mania, and by her freedom from any actual delusion. On the other hand, she showed utter want of feeling and principle, and yet a certain ingenuity and plausibility. In these ways, in the absence of shame and remorse, and in a constant unreliability and incorrigible conduct totally foreign to her nature, the case resembles moral insanity, which Dr. Blandford calls the insanity of the young. Indeed Hecker, alluding to this resemblance, says that the moral unsoundness is such a conspicuous feature that, under the old system of classification, this form would be classed as moral insanity. The peculiarity of the melancholic phase does not appear in the report of this case, owing, perhaps, to want of due observation before the unusual course of the case was noticed. It is said to be noticeable for its lack of depth, a silly, childish mood mingling with the sadness—the feature of weakmindedness spoken of above. In the depth of his woe the patient betrays an inclination to make fun. Our patient, as was learned a year and a half after her discharge, apparently recovered. In most of these cases, however, the intellect grows more and more weak and the patient becomes demented, having occasional intercurrent maniacal or melancholic attacks, or else remaining in a stationary condition of weakmindedness, doing quite well at home and being considered as simply stupid.

Hebephrenia and circular insanity.

Although hebephrenia represents an advancing morbid process, and usually ends in dementia, a certain proportion of recoveries are reported. May it not be that among these are some cases of circular insanity, a form characterized chiefly by successive attacks of melancholy and excitement, followed by intervals of sanity, frequently beginning at puberty and lasting through life? This variety is difficult of diagnosis in young people, owing to the fact that the length of the interval of sanity at this time of life is so much greater than in older persons that no opportunity is afforded for witnessing a succession of attacks recurring in the regular order characteristic of the disease.

Ball[6] mentions a "circular form of hebephrenia."

Stupor.

Stuporous insanity, or stupor with dementia, also called, formerly, acute dementia, has, in our experience, occurred exclusively in young people. Spitzka finds this the rule, and Blandford gives fifteen to twenty-five as the limiting ages. This is distinct from melancholic stupor, stupor with delusions, which is usually met with in mature and later life. Genuine stuporous insanity has marked features, which are so well known as hardly to need description. Its manifestations are also very characteristic ones, and represent a clinical group quite as exclusive as any of those originating during puberty and adolescence, not excepting hebephrenia proper. There is, besides, in these cases, a direct connection between the stupor and the developing sexual and reproductive functions. Intense sexual excitement, or continued sexual drain from intercourse or masturbation, must necessarily produce a powerful effect upon hereditarily weak minds, particularly in young people. In this way is brought about, in many cases, the impairment or suspension of mental activity peculiar to the disease. Profuse hæmorrhages and shock may occasionally, also, produce this result in young people. Typical cases of this form manifest decided physical, as well as mental, symptoms. The circulation is deficient, as shown by a subnormal temperature, cold hands and feet, blueness of the skin, slow and small pulse, and weak heart-action. There is always more or less swelling of the feet, and pallor is marked. These patients refuse food, and may require to be fed by the stomach-tube. From inattention to their bodily wants they may become very unclean, voiding urine and fæces regardless of time or place. From the same cause constipation and long retention of urine are not infrequent. The mind of these patients is apparently a complete blank, and, as a rule, they have no recollec-

tion on recovery of the period of their illness. They make no reply to questions, and give no indication that they notice anything about them. Flies may crawl over the face unheeded by the patient, who sits or stands motionless, utterly oblivious of his surroundings, the saliva, it may be, dribbling from his mouth. Various automatic motions are sometimes observed, however, while in this state, such as snapping the jaws, wagging the head, or repeating words or short phrases. These acts are often continued for a long time, in spite of all efforts to stop them.

This form is to be distinguished from the more common and important one of true melancholic stupor. The prime points of difference are the presence of delusions in the latter, and its occurrence, with but few exceptions, in older people. Stuporous insanity, or stupor with dementia, is almost always preceded by maniacal symptoms of a transient nature, while patients of the other class are melancholy from the outset, and the depressed state consequent on delusions—the chief feature—crops up in all stages of the illness. The latter, also, are more prone to suicide ; they also emaciate faster, and sleep far less than the class under consideration. The states of stupor incident to general paralysis, epilepsy, and excessive alcoholic drinking are, as a rule, readily diagnosticated by the history of the cases.

Hysterical insanity.

The hysterical element greatly predominates in insanity of puberty and adolescence, and is often associated with epileptiform states. One or all of the principal features of hysteria in its mental aspects—*e.g.*, apparent feigning of real disease and an enervation of will, emotional activity, groundless complaints of illness, craving for attention and sympathy—may be expected at some stage in the course of almost any form of the insanity of youth. We have mentioned the sense of unreality which the superficiality of the symptoms of mania and melancholia in young people give the observer. This is in the same line of morbid mental action as the plainly hysterical tendencies manifested in the states of weakmindedness following these attacks. Hysterical insanity, which is not a distinct and exclusive type in itself, commonly affects girls, and is frequently associated with disturbances of menstruation—amenorrhœa chiefly. It has certain unmistakable features which are, in fact, peculiar to the age and sexual development, and directly attributable to that process. We refer to the erotic and impulsive patients who, when maniacal, are amorous and obscene in action and language, and at other times are restless, prone to dwell on such subjects as love, marriage, etc., or else show a decided and morbid repugnance to any, even the remotest, suggestion of such matters, a shrinking which reveals the unnatural sexual bias of their thoughts. Their constant demands upon the notice, attention, and sympathy of those about them, especially those of the opposite sex, and their petulance and outbursts of passion when neglected, are characteristic. The tendency to lie, and to make groundless and outrageous accusations, brings these patients in close relationship to the so-called morally insane.

Sensory and motor complications, which are not uncommon in youthful cases of this form, are seldom associated with hysterical symptoms later in life. Moreover, as has been before indicated, neurasthenia and hypochondria, the forms under which hysteria is chiefly manifested in older people, are comparatively infrequent before the age of twenty-five years. These forms stand, therefore, for the hysteria of mature life.

"Masturbatory insanity."

"Insanity of masturbation" is used by some writers to designate cases of mental disease in which masturbation is a prominent feature. There is no special form of insanity attributable to masturbation. It simply modifies other forms whose character is more or less recognizable in proportion to the predominance of the phenomena peculiar to the habit. In all insanity it creates or hastens a diminution of intellectual power, which finally passes into dementia. Shyness, avoidance of meeting the glance of others, indolence, irresolution, cowardice, suspiciousness, and weakness of memory are the more prominent of the classic signs of the masturbator. These traits are prominent in the youthful insane. As the patient passes into manhood, delusions appear and become fixed, which are invariably those of suspicion, and chiefly through some unseen agency. Such patients are tormented by imaginary persecution, by means of electric batteries, resulting telephonic communications, etc. An element of impulsiveness comes in these cases to be added to the weakened control, and they are accordingly, whether with or without delusions, liable to outbursts of great violence. Spitzka [6] has observed a variety of primary deterioration, marked by moral perversion, in young victims of the habit, which yields to treatment if the habit is abolished. If unchecked, it culminates in complete fatuity. This he has observed in subjects between the eleventh and twenty-third year. It is one of the numerous conditions which passes under the designation of "primary dementia." It is the only one to which the term insanity of masturbation can be properly applied.

Minor peculiarities of the insanity of puberty and adolescence.

In keeping with the instability of youth is the shifting nature of its morbid mental manifestations. The insanity of this class is peculiar in the variety and changeableness, even in the same attack, of stages and symptoms. It is chiefly at this age that the anomalous cases occur that seem to resist classification. Hysterical, epileptic, and maniacal symptoms may be inextricably mingled in one case, while in another a stage of genuine non-melancholic stuporous insanity may alternate with a set of symptoms resembling moral insanity. Equally striking are the abrupt intermissions and remissions in cases of this class. Not infrequently the intermission is a flash of clear intelligence, lasting for a few hours or a day, to be abruptly clouded over again by the mental state from which it emerged. In another case a longer lucid interval gives hope of a speedy recovery, with a similar result. Repeated and frequent relapses in the same case may take place before either recovery or dementia are reached.

Frequency of insanity of puberty and adolescence.

An estimate of the frequency of the insanity of pubescence and adolescence can be approximately made from the following statistics. They include only cases of insanity originating in youth. For the five years ending October, 1884, 180 males and 213 females, or a total of 393 persons, were admitted for the first time to the Danvers Lunatic Hospital, who were between the ages of fifteen and twenty-five years at the time of their first attack. The total number of different persons admitted in that period was 2,305, of whom 1,127 were males and 1,178 females. It thus appears that over sixteen per cent. of these admissions were those of persons between the ages mentioned.

This proportion of youthful cases has greater significance when we consider that its figures pertain only to cases of ordinary insanity. So that if a comparison of this with later decades be made, we must eliminate cases of organic brain disease. The psychoses incident to childbirth and its immediate concomitants, being far more prevalent in older people, must also be taken in consideration.

In this connection it is of interest to recall the fact that at the York Retreat the greater number, one-third of those admitted during forty-four years, were *attacked* between twenty and thirty years of age. Each subsequent decennial period is marked by a gradual decreasing proportion. This excessive proportion cannot be explained by the greater proportion of the number living at that period.[7] This statement, viewed in connection with the fact that most cases of insanity of adolescence occur between twenty and twenty-five, has especial significance.

Frequency of the separate varieties.

The frequency of the different forms of insanity in the pubescent and adolescent cannot be estimated, as no two observers take the same views regarding them, and, consequently, do not make the same classification. The frequent intermingling of symptoms and sets of symptoms especially peculiar to the insanity of this age accounts for this discrepancy in a great measure. Hebephrenia, for example, is considered by Hecker to be quite common, 14 in

100 cases being his estimate. Schüle, however, thinks it a rare form, and places the proportion at 2 in 600. Spitzka's figures are 3 in 187. Ball finds it a very common form, but considers it very difficult to limit its domain—a difficulty which is increased when we consider its tendency to occur by preference in the weakminded. After eliminating all doubtful cases there remains a sufficient number of facts to prove that outbreaks of insanity are plainly connected with the epoch of puberty, and that the influence of genital evolution in producing mental trouble is as evident as that of the most universally accepted causes of mental disorder.

Prognosis.—The prognosis of these cases, hereditary as most of them are, is extremely grave. Many, sooner or later, undergo irrevocable mental loss, and rapidly become demented. Others have intervals of comparative sanity between outbursts of mania, which recur throughout a long period before developing decided mental failure, while some cases really get well. The most curable cases are those of stupor with dementia. In our experience, however, cases of complete and permanent recovery from any form occurring at this time are very rare compared with those originating later in life. Masturbation affects the prognosis most unfavorably.

Treatment.—The treatment of this class of mental disease is, *par excellence*, preventive. To give an adequate idea of the course and methods best adapted for the preservation and improvement of young minds with the strong neurotic predisposition usually requisite for the production of insanity would involve a more extended account of educational methods—mental, moral, and physical—than is admissible here. A few of the more prominent precautions, however, should be stated. It is best, when the morbid inheritance is through the mother, or is in doubt, that the child should not be left to its mother, but to a healthy wet-nurse. Children inheriting this taint should be separated, so far as possible, and their association with others of a healthy and vigorous nervous organization encouraged. For instruction, something more than a knowledge of the pupil's mental and moral exterior is necessary. The course of their lives needs to be directed. Physiology, hygiene, and some knowledge of the influence of heredity are indispensable requisites for the proper education of these unfortunates. To some extent, ignorance of these individual needs is unavoidable in large schools; but where separate tuition is possible, and is well-chosen, idleness, insubordination, or stupidity will not be found to require a multiplication of punishments, and the boy's or girl's mental capacity will be the measure of the kind and amount of instruction needed. Masturbation is to be guarded against by inculcating a healthy moral tone, by the careful selection of associates, and by precept rather than by a policy of distrust and espionage. The diet of such children should be plain and unstimulating, and out-of-door life should be insisted upon.

When disease is once established the treatment, of course, varies with the character and intensity of the manifestations, and follows the general lines elsewhere laid down.

The following case is presented as an illustrative epitome of the insanity of puberty and adolescence in most of its protean aspects.

W. R——, a young man, twenty-one years of age, was admitted to the hospital, January 13, 1881. He was of ordinary mental capacity, and had a common-school education. No known insanity among his relatives. His habits were temperate, and his moral character good. His domestic surroundings were comfortable and congenial. For a few months before admission he seemed somewhat melancholy, and was so anxious to keep busy that he would have worked in the shoe factory and on the farm late into the night if allowed. Three months before entering the hospital he began to pass restless nights, and to lose his appetite. Shortly afterward he seemed suddenly to become additionally depressed and melancholy, being at first afraid that someone was going to shoot him, and that he must take leave of his family. His father had suspected him of masturbating for some time past.

The physicians' certificate reads: "Persistent melancholy. Refusal to take food or drink. Negligence in attending to natural calls, and at times great violence of action." When admitted he was in fair bodily condition, but seemed entirely demented. He would seldom answer a question, but sat in one place all the day, completely inert, and regardless of everything. When dressed or fed he would resist violently in a dogged, aimless way. He was exceedingly dirty, passing his evacuations in his bed or clothing, and otherwise neglecting his person. He continued in this state for several months, the only break being an intermission of apparently complete lucidity, in which he talked freely and rationally and appeared in every way like himself for several hours. His stupor then returned with its former intensity.

During the months of May and June (six months later) he manifested more activity and appreciation of surroundings. Would talk quite sensibly at times. He had also become tidy and industrious, working most of the day on the hospital farm, although inclined to wander away. He still talked in a vague, unintelligent manner, but no delusions were detected. On August 2d he was discharged at his father's request. He had grown somewhat brighter, but still showed considerable mental inactivity.

On October 31, 1881, about three months later, he was recommitted on the following certificate: "Refuses to obey reasonable requests of parents, disposed to make foolish trades. Wild expression in conversation, and extravagant notions."

There was, as stated, a remarkable change in his manner. He was loud, vulgar, and familiar. Not one of his former symptoms was present, but in their place others quite the reverse of them and of his natural conduct. He was mentally active, "knowing," and free from delusions. He was very fat and well nourished, and enjoyed remarkably good bodily health. He had not been two days in the hospital before he loosened the iron grate of his window at night, made a rope of his bed-clothes, and, lowering himself to the ground, escaped.

During this second stay, which lasted nearly nine months, the patient was always restless and excitable, with exalted ideas about himself. He spent much of his time writing letters to his parents filled with promises of reformation and good behavior. His conduct, notwithstanding these promises, continued to be very mischievous, and he was a source of uneasiness and discomfort to the ward by constantly plotting to escape, making others discontented, etc. He was quick to discover in others what was most likely to ruffle them, and delighted in taking advantage of it. He thought himself the handsomest man, best dancer, and most thorough good fellow in the house. He would write his father that he had left off using tobacco, and by the same mail send an order for cigars and similar things. Was fond of using low phrases, and thought their use implied a certain smartness.

During the spring months his behavior became somewhat better, and he was put to work with the gardener. Here his loud boasts rendered him ridiculous and disagreeable, but after a time he became less troublesome. At no time did he seem to realize how foolishly he made himself appear. At the last he worked quite steadily under the promise of returning home if he behaved himself, and to some extent he left off swearing and boasting, though he still indulged in much "loud talk." Was very well nourished, and in apparently vigorous bodily health when discharged in the following June.

After this attack he remained at home about a year, giving, his father said, no trouble, and seeming to be in better condition than ever before. His mother wrote: "Since his return from the hospital he has worked on the farm steadily, and has seemed interested in his work. He is contented to remain at home all the time. He seems active and bright in most respects, but in conversation will ask questions about events long past, the same questions that he has heard answered a great many times. When he has done a day's work he is willing to stop, while before the attack he would have liked to work far into the night."

The patient was twice committed to the hospital after this record, with the symptoms of excitement already described. His weakminded, childish behavior had increased, his mental deterioration between the attacks being evident. His last attack began recently (September, 1884), and lasted until July, 1885. When the symptoms were first noticed he began to ride about a great deal, and to talk about great farming schemes he had in view. He attempted to make trades and contracts which he could not fulfil; slept little and lost flesh; became excited and talkative. On admission he is reported to have been animated and extremely loquacious. After a few weeks' stay in the hospital he developed an attack of acute mania. This had been preceded by restlessness and unmanageableness. He would demand all sorts of privileges, threatening to "expose" people unless they acceded to his demands. He purloined from others, and unblushingly lied when detected. His maniacal seizure was ushered in by great excitement—he shouted, sang, and made a general disturbance; required to be placed in the padded room. He had many exalted delusions, *e.g.*, that his father was Charles Sumner and worth $500,000, that he owned the hospital, etc.; ate well, but was badly nourished. A few days later he again became greatly excited and highly maniacal, disrobing and soiling himself in his room; had many delusions, chiefly of identity; took only liquid food and slept badly. This excitement lasted two months in its extreme form. For a long time he would not wear anything and was kept in a padded room. At the end of this time he began to grow quiet enough to leave his room and to take walks out of doors, although he talked constantly to himself, repeating meaningless phrases or oaths. About four months after his commitment, while still incoherent but comparatively quiet, he had a slight dysenteric attack followed by an exacerbation of excitement, this time attended with great fear from delusions of persecution; refused medicine and food. In short, has continued more or less actively excited for more than six months of his stay at the hospital. When discharged he was apparently as well as in his previous interval of comparative sanity, having had a convalescence of about a month. *Henry R. Stedman.*

[1] See Clouston on Mental Diseases, p. 369, Am. edition.
[2] Die Hebephrenie oder das Pubertätirrsinn, Der Irrenfreund, 1877, xix., 4. [3] West Riding Asylum Medical Reports, vol. iv.
[4] Boston Medical and Surgical Journal, vol. cxiii., pp. 505–509.
[5] De la Folie de la Puberté, L'Encéphale for 1884.
[6] Spitzka: Insanity—its Classification, Diagnosis, and Treatment, p. 379. [7] Bucknill and Tuke: Physiological Medicine, p. 75.

INSANITY: ORGANIC DEMENTIA. The insanity which arises from gross brain disease, such as apoplexy, abscess, tumors, and softenings, has been called apoplectic insanity and paralytic insanity, and it has been otherwise designated more or less appropriately. Organic dementia is a better term for these forms, and for all other cases which spring from a variety of cerebral affections that cause gross alterations of brain-tissues. The term dementia expresses the prevailing tendency of all these cases, and it is qualified by a word that denotes the organic lesions that are always the source of the mental disorder.

Organic dementia is the insanity which results from intracerebral hæmorrhage, embolism, thrombosis, ramollissement, tumors, multiple cerebral sclerosis, hydatids, pachymeningitis, and a few other affections.

These cerebral diseases are not necessarily accompanied by mental alienation, of course, and it is only exceptionally that they occasion it. Still, they cause delirium, or coma, and certain psychical disturbances, very frequently, and it is but natural that the mental disorder should have the nature and the permanency of positive insanity in some cases.

In considering the etiology of organic dementia, it must be admitted that heredity may play a certain part, and that organic lesions of brain-tissues that would be insufficient for the production of mental aberration in a soundly constituted person may arouse a latent tendency to insanity in one less fortunately endowed. It is also to be considered that most of those attacked by organic dementia are well advanced in life, and have no longer the powers of resistance of younger persons, and some of them have atheromatous arteries and other signs of tissue degenerations. In some instances, however, the cortical lesions are so gross and extensive that insanity inevitably results.

It is evident, from the above list of causative affections, that the mode of their action must vary widely in different cases of organic dementia.

Most of the causes enumerated are focal diseases, and the modes of their pathological action in the production of insanity may be classified under the following simple divisions: 1, by direct pressure on brain-convolutions (tumors); 2, as irritative lesions in a reflex way (hydatids, tumors); 3, by obstruction of blood-supply (embolism and thrombosis); 4, by inflammation and destruction of brain-tissues (encephalitis, ramollissement). Some focal diseases may act, not only in one, but in all of the above ways. Thus a tumor may, as an irritative lesion, cause psychical disorder in a reflex way; and at a later stage of its growth it may effect the same result by direct pressure on the convolutions; and still later it may obstruct the blood-supply and nutrition of a large area of the cortex cerebri; or, again, it may cause inflammation and extensive destruction of cerebral substance. Likewise, an apoplectic focus in the basal ganglia may excite sympathetic mental disturbance, or lead to insanity through secondary encephalitis and ramollissement, which in rare instances may involve a large part of the projection system of fibres between the cortex and central ganglia on one side. The main fact about all these coarse brain diseases is that they produce insanity with greater certainty in proportion as they effect bilateral or diffused lesions of the cortex cerebri, in which some form of atrophy is the most common autopsical appearance.

In view of these etiological facts, it is evident that the course of organic dementia in different cases will depend on that of the brain disease, and that its exacerbations and remissions will correspond in the main to those of the physical malady.

The most common psychical character of organic dementia is a progressive impairment of all the mental faculties, ending in complete loss of mind. The ever-advancing course of this mental weakness is often interrupted by sudden accessions of mental excitement or depression, which in some cases may be fully developed into brief attacks of mania or melancholia, which subside only to leave the patient in a still more enfeebled state of mind and body. Organic dementia in general has a prolonged course, and an average duration of many years. It ends ordinarily in the complete extinction of mental powers, but exceptionally in recovery, and not infrequently it terminates in sudden death.

The clinical course and symptoms of organic dementia may be illustrated by the consideration of a few of the ordinary possibilities in the brain diseases already mentioned.

Thus, following an apoplectic effusion, the patient, after recovery from the first shock, is hemiplegic and shows a little mental and emotional weakness, but no more decided symptoms of psychical disorder. In a few days, as secondary œdema and encephalitis arise about the blood-clot, the patient may pass into a maniacal state, from which there may be a gradual convalescence at the end of six or eight weeks, at which time the blood-clot may have become encapsuled and have ceased to be an irritative cause of active reflex disturbance of cortical functions. The apoplectic cyst is replaced by a cicatrix, and the most complete physical and mental recovery possible under the circumstances has resulted. The patient is never capable again of the same mental endurance, however, and he has a weak point in both his physical and mental organization.

The mental disorder in this case only represents one of the phases in the ordinary course of organic dementia, which usually appears in chronic apoplectic cases, in which new effusions of blood take place, with a renewal of the maniacal state or of active melancholic symptoms on the extension of the physical disease. The mental

weakness progresses constantly in these cases, and each return of the active physical or mental symptoms hastens the course of the dementia, which in rare instances passes through its entire course without any exacerbations of exaltation or depression.

If the organic dementia be caused by a tumor of the brain, the symptoms may be exceedingly changeful and chronic.

There are present, first, headache, insomnia, giddiness, along with irritability, restlessness, loss of self-control, and hallucinations of the special senses.

As the tumor increases and causes pressure and inflammation of the surrounding parts, the symptoms are double optic neuritis, agonizing headache, vomiting, convulsions, and various forms of paralysis, and the mental disorder is the maniacal state with vivid hallucinations. All these symptoms may disappear for a time, and then recur with increased intensity ; and a progressive failure of all the mental faculties becomes evident, and finally reaches the degree of complete dementia, if the life of the patient is not terminated by the brain disease prior to this loss of mind. There are no records of recoveries from insanity as the result of brain-tumors, so far as the writer is aware, unless it be in the case of syphilitic gummata.

Parasitic tumors may cause insanity having the most varied symptoms. Cysticerci of the brain are located ordinarily in the cortex, and they give rise to cephalalgia, vertigo, clonic spasms of muscles, epileptiform convulsions, and attacks of acute delirious mania, which may be followed by stuporous or melancholic states. The paralyses that follow, and all of the above symptoms, may suddenly disappear and return. In other cases there are no acute mental symptoms but dementia, which is gradually developed.

Echinococcus hominis is another brain-parasite which may excite mental disorders like those just mentioned. The echinococcus cysts may attain the size of a walnut, and they may be discharged through the cranial bones, and they act as irritative lesions in a reflex way in exciting insanity.

Although the usual nature of the insanity of these coarse brain diseases is a progressive dementia, with intercurrences of maniacal, melancholic, or stuporous states, it is well to know that this is not invariably the case. Maudsley relates the case of a young lady of sixteen years, who complained of loss of sight and hearing, and of inability to walk ; but as she could both see and hear at times, and was wilful and mischievous, and had long conducted herself unreasonably, it was supposed by her family and the physicians who saw her that she was hysterical. Attacks of excitement occurred from time to time, during which she was noisy and violent. The patient finally complained of violent headache, and died delirious ; and the post-mortem examination revealed a tumor of the size of a hen's egg in the right hemisphere as the cause of the symptoms.

The tumor may be an aneurism of one of the cerebral arteries at the base of the brain. In this case the cephalalgia, neuralgia, disturbance of the special senses, and psychical disease are all apt to be of a very acute character ; but if life be sufficiently prolonged, dementia will be the result of the mental disorder.

Space will not permit a separate consideration of the clinical symptoms of organic dementia in connection with embolism, thrombosis, pachymeningitis, chronic abscess of the brain, and some other organic cerebral affections. The general nature and course of the mental symptoms cannot vary essentially in these different cases.

In the acute exacerbations of mania or melancholia there are illusions and hallucinations of the special senses, and delusions that are not organized and that often originate in the sensory disturbances. Then there are the constantly advancing loss of memory, and of all the higher processes of thought, great emotional weakness, and finally complete dementia.

There is a general similarity, too, in the physical symptoms in most of the cases. There are neuralgias, cephalalgia, vertigo, anæsthesia, paræsthesia, clonic spasms, paralyses, aphasia, convulsions, trophic and vaso-motor disorder, loss of the special senses, and finally fatal coma.

The most remarkable clinical feature is the remission that may suddenly take place in both the mental and physical symptoms, and the number of times that this is observed to occur in the course of certain cases of this form of insanity.

The pathology of organic dementia is as extensive as that of the cerebral diseases from which it arises, and no attempt will be made to give the details of its morbid anatomy. The main pathological fact is that atrophy of the cerebral convolutions, and of the essential ganglionic elements, is found post mortem in more than sixty per cent. of all cases.

The diagnosis of organic dementia is to be based on the presence of an irregular type of insanity in connection with coarse brain disease. The irregularity of the mental disorder is constituted by the capricious appearance of mania, melancholia, and dementia, which may disappear and recur in contradiction of all ordinary sequences. The terms mania and melancholia, ordinarily used to describe the condition of exaltation or depression, in these cases are misnomers. It is not mania or melancholia as distinct diseases and having a distinct course which are present in these instances, but it is the maniacal and the melancholic states prolonged which are clinically observed in these cases (see maniacal state in the general article). The physical symptoms intermingled with these disorderly mental manifestations, and the characteristic exacerbations and remissions attending the gradually progressing dementia, render the diagnosis easy in most cases.

Occasionally, the defect of speech and gait and the dementia suggest general paresis, but the expansive emotional tone of the latter disease is wanting, and at such an advanced stage the diagnosis of the special brain disease that underlies the organic dementia is almost always possible.

The prognosis of organic dementia is, in general, very unfavorable as regards psychical recovery, and it is frequently hopeless in respect to life. The chief element of prognosis is the organic brain disease itself, for mental improvement is only to be expected through disappearance or arrest of the physical affection.

In apoplectic effusions the clot may become encysted and recovery may be almost perfect, and there may be no recurrence of mental trouble. If the cerebral hæmorrhage has taken place from a miliary aneurism, and if there is general arterial degeneration, there will almost always be subsequent attacks, and the prognosis is unfavorable.

The prognosis in the case of cerebral tumors is invariably bad, and it is scarcely less unfavorable in chronic abscess of the brain, in thrombosis of cerebral arteries and ramollissement, and in pachymeningitis.

The chances of recovery may be expressed numerically in the general statement that organic dementia constitutes two or three per cent. of cases admitted to asylums for the insane, and that about ten per cent. of the cases recover.

The treatment of the mental symptoms in organic dementia is purely symptomatic. The maniacal excitement and insomnia call for the use of sedatives, and other similar self-evident needs for therapeutic interference are to be attended to as they arise ; but all the fundamental indications for treatment are furnished by the organic brain disease which causes the insanity.

For the special treatment of the various cerebral affections that have been mentioned above as efficient in the causation of organic dementia, many articles in this HANDBOOK may be consulted. *Theo. H. Kellogg.*

INSANITY, PUERPERAL. SYNONYMS.—L., Mania puerperarum acuta, seu Mania Puerperalis, seu Mania lactea, Insania puerperarum, Encephalopathia puerperalis ; Fr., la Folie Puerpérale ; Ger., Puerperalwahnsinn.

DEFINITION.—Puerperal insanity is a generic term used to include all cases of mental derangement incident to

pregnancy and its sequelæ. The derangement may assume the form of mania, melancholia, or dementia. It may occur at three distinct periods: First, during utero-gestation. Second, during, or immediately or shortly after, delivery. Third, during lactation. Mania occurs most frequently in the second period. Melancholia occurs in the first and third periods. Dementia commonly occurs in the second and third periods. Mania occurs more frequently than melancholia. Of a large number of cases of this malady which have been collated, about twenty per cent. are to be classed as insanity of gestation, fifty per cent. as puerperal insanity proper, and thirty per cent. as the insanity of lactation.

FREQUENCY.—Writers on this subject present statistics varying greatly. Scanzoni states that one case out of every 1,357 confinements had puerperal insanity. His observations were based on 30,785 cases of delivery. At the other statistical extreme it is found that at the Queen Charlotte's Lying-in Hospital, the proportion of cases of puerperal insanity to deliveries reaches the astonishing figures of 1 to 182.

Dr. J. B. Juke, after collecting statistics extensively from institutions devoted to the treatment of insanity, states that about 7.1 per cent. of all cases of insanity are of puerperal origin.

ETIOLOGY.—Anæmia of gradual development during gestation, or suddenly produced by hæmorrhage after delivery, is a potent factor in inducing puerperal insanity. The gradual draining of the physical resources by prolonged lactation also leads to anæmia. This condition, accompanied with broken rest incident to the care of the baby, is often enough to induce the malady under consideration. However, other conditions often accompany anæmia and intensify its malign influence on the mind, among which may be mentioned the often observed disturbance of the abdominal or pelvic organs. Simpson attached much importance to albuminuria, to mental impressions, and to a certain undefined toxæmia which would, some day, receive a name and description from pathological chemists, as belonging to the etiology of this disorder.

By far the most prolific cause of puerperal mania is an hereditary predisposition to insanity.

SYMPTOMATOLOGY.—The form of insanity most commonly observed is mania. Melancholia occurs next in frequency. The symptoms observed differ in no way from those of common mania and common melancholia, or of some mixed type of insanity.

The most commonly observed prodromal symptom is sleeplessness. A puerperal patient, who has not slept at all in two consecutive nights, becomes at once an object of the utmost obstetric solicitude, lest she lapse suddenly into insanity. This solicitude is intensified if there be an insane hereditary tendency in her family. Albuminuria in such a patient increases the gravity of prognosis as to the supervention of insanity.

Another often observed premonitory symptom is pertinacious taciturnity. With this symptom is often observed a suspicious, furtive vigilance wholly unwarranted by the patient's surroundings.

Often, in other cases, the patient is dejected and listless, refusing food, or is indifferent to her child, or even evinces an aversion to it.

Occasionally no preliminary symptoms are observed, the patient awakening from an apparently healthy slumber, delirious and uncontrollable.

After the attack has commenced, insomnia, partial or complete, is a persistent symptom. The facial expression is indicative of alarm or of suspicion. The eyes are bright, and the face pallid with an occasional flush. The pulse is quick, the head throbbing. The tongue is dry and furred, tympanites is often present, and the bowels are occasionally loose, although constipation is the rule. Usually the appetite is uncertain; often it is absent, but more commonly it is voracious. Food is often doggedly refused, because of fear of poisoning. Frequently the taste is perverted. It is rare that the breath is not offensive.

One of the first mental symptoms commonly noticeable, is some thought, expression, or act, markedly at variance with the patient's customary manner. Many patients utter nonsense or adhere to some one topic so persistently as to arouse suspicion. Others talk very volubly or with an unusual vehemence, which soon merges into incoherent raving. Often the patient seems to be dissatisfied with her attendants, or imagines them to be other persons than they are. Patients markedly anæmic from privations, disease, or intemperance, often present symptoms analogous to those of delirium tremens. Weeping or laughing without the usual incentives is not infrequent. A morbid sensibility to light, odors, and sounds, is often observed before the full development of the attack.

After the full onset of the disorder the patient becomes very violent and noisy. She repeats some word or words with monotonous or ever-varying repetition, which once heard can never be forgotten. She tears her clothes, exposes her person persistently, often becoming profane or obscene to an astounding degree. Erotomaniac symptoms are very common. The tendency to suicide often occurs.

The symptoms of insanity existing in the three divisions of puerperal mania present no differential diagnostic indications. An exhaustive description of symptoms can be found in any standard work on insanity. As stated before, during utero-gestation melancholia is most commonly observed. In severe cases the suicidal tendency is developed. The accompanying delusions are generally exaggerations of the anxieties and whims of pregnancy.

Mania is the form of disorder usually observed in the puerperal period proper.

Melancholia is most commonly developed in the period of lactation. It is often preceded by cephalalgia, tinnitus aurium, and flashes of light before the eyes, and other indications of debility.

PROGNOSIS.—According to published statistics, about five per cent. of the cases terminate fatally, and about seventy per cent. recover. The remainder become permanently insane. The longer the period of insanity continues, the less promising is recovery. The greatest proportion of recoveries occurs within the first six months of the malady. The more easily the general health can be repaired, the more promising is recovery. Puerperal insanity alone is the most curable form of mental disorder. The more complicated it is with physical disorders the graver becomes the prognosis.

The duration of the attack varies from a few days to a year or longer. Following convulsions, when the patient does not die in them, recovery is generally very rapid. The duration of the attack can never be predetermined.

When the mania disappears in twenty or thirty days, the ensuing period of partial dementia generally precedes complete recovery.

The development of an acute phlegmasia as peritonitis, cellulitis, or pneumonitis, renders the prognosis exceedingly grave. Phrenitis is almost always followed by death.

Much vascular excitement portends gloomily. In proportion as the pulse rises above 120 does the prognosis become grave. *Occasionally*, with this one symptom, patients do recover, and then recovery is often more rapid than when no vascular excitement exists. So long as the pulse remains below 100, no immediate danger to life is to be feared.

Patients manifesting erotic tendencies present a more favorable prognosis than those who are melancholic with suicidal impulse.

Patients who suddenly become quiet and evince natural wants, as thirst, hunger, or a desire to defecate or urinate, and recognize those about them, present a favorable prognosis, although relapses in them may occur.

It was an aphorism of Gooch that "mania is more dangerous to life and melancholia to reason."

TREATMENT.—The transitory mania accompanying severe suffering in labor requires no special treatment. When any reason exists to expect this occurrence, it may be averted by an anæsthetic. Simpson described a pa-

tient who had puerperal mania after five consecutive labors, in whom it was averted in her sixth confinement by the use of chloroform. After such attacks the patient should be kept absolutely quiet till her strength is fully established, be the time brief or protracted.

In the graver form of puerperal mania, rest, restoration of health, and removal of all irritation comprise the items of treatment.

Insomnia, first of all, should be removed. Of all remedies, chloral hydrate stands first; given in thirty-grain doses it often succeeds. The chief danger in its use is its depressant action on the heart. Opium should be avoided, because of its adverse action on the secretions, excepting where pain is clearly present, as in cellulitis. Occasionally the protracted use of chloroform anæsthetization will be followed by a prolonged period of sleep, which is the commencement of recovery. More often it fails. Its occasional success commends its use.

Every effort should be made to promote tranquillity, by darkening the room, by preserving quiet, removing the baby from the mother's presence, and by excluding every person from the sick-room not needed in taking care of the patient. Strangers to the patient answer best as nurses, because familiar faces often act as causes of renewed attacks of excitement. Often poor patients will be best cared for by removal to asylums when the physical condition warrants it. Whenever possible, however, they should be treated at home.

It should be steadily borne in mind that anæmia and exhaustion are the most constant factors of puerperal insanity, and the treatment is thereby indicated. Promoting nutrition is of the utmost importance. Attention to the alimentary functions is imperatively demanded. Strong and repeated purgations are to be avoided. Laxatives to remove dark and offensive discharges are always beneficial. They should be administered with great care. Often their use is astonishingly beneficial in the early stage of the malady. Liquid food is most easily administered, and should be given frequently and in small quantities. As soon as solid food can be administered, it should be given in preference to liquids, as it is far better. It should be the aim of the treatment to secure the largest amount of food digestion possible. Alcoholic stimulants should be given to the fullest extent where well borne. Their effect on the pulse, skin, and tongue will indicate how much can be administered. Sometimes they are contra-indicated. In melancholia they are more beneficial than in mania.

Forced alimentation is sometimes necessary. A large wooden or metal spoon deftly introduced between the patient's teeth by the right hand of a strong assistant, lying on the bed by the side of the patient, while the left arm is folded firmly over the top of the patient's head, will serve as a means of pouring a small amount of liquid nourishment into the mouth. A third person can hold the hands of the struggling patient. I fed a woman in this manner for a period of several weeks, thrice daily.

Diuretics are sometimes of service in promoting excretion. The usual indications for their use should guide us in resorting to them. Digitalis and potassium acetate are an excellent combination. The bladder ought to be watched daily, and the catheter used promptly when necessary.

A harsh, dry skin is often a source of eccentric nervous irritation not to be overlooked. Daily sponging with alcohol and water is often beneficial. Anointing with oil or with vaseline is often productive of restoring a degree of quietude.

The strength of the heart should be maintained. In exhaustion it should not be forgotten that the feeble cardiac action leads to an imperfectly nourished brain, which is often the cause of the perpetuation of this malady. Digitalis in small, repeated doses is frequently of the greatest advantage.

As a rule, asthenia prevails in this disorder. Hence the use of depressants, as tartar emetic, bleeding, and cardiac sedatives, is to be sedulously avoided. When digitalis is used, its cardiac stimulant action only is to be sought for.

The treatment of the insanity of lactation differs in no way from the course of treatment herein detailed.

The treatment of all conditions of irritation, as cellulitis, must not be neglected. Convalescence must be treated as that of common mania, or melancholia, or dementia, is treated. *James H. Etheridge.*

INSANITY, SENILE. Mental disorder in the aged may take several forms—in fact, any kind of ordinary insanity may appear then—although it will in every case bear the stamp of senility. The only characteristic form of mental impairment, however, due solely to old age is uncomplicated senile dementia. This is sufficiently distinctive to be considered a clinical entity. It is characterized, as the name implies, by a group of symptoms indicating a progressive loss of mental power, or a failure of mind. The symptoms represent an exaggeration of the mental state of normal senility, a condition characterized by loss of intellectual vigor, and comprising failure of perception and also of memory (particularly of recent events), dulness of apprehension, inability to assimilate new experiences, impaired self-control shown in slight emotional changes, indiscreetness in speech and action, elation and enthusiasm over small matters, etc.; all facts of common notice. It is only in old age that such a sequence of natural mental phenomena is to be met with. Consequently, a disease which is simply an intensification to a morbid degree of that condition must also be a distinct and characteristic one. Another peculiarity of senile dementia is its gradual growth from the natural mental state. Unlike the dementia manifested in other forms of ordinary insanity, excepting, perhaps, occasional adolescent mental states, it is not consecutive to any other group of symptoms, such as mania or melancholia. Moreover, senile dementia is invariably and uniformly progressive—a general diminution of all the mental faculties; while in ordinary secondary dementia the memory, for example, is for a long time, in many cases, but little impaired, and the patient may for years be able to perform a certain round of simple duties, although the ideas are confused and very limited, and the signs of mental deterioration marked.

The onset of the disease is insidious, but it may be said to begin, as a rule, when the memory has become notably enfeebled. The patients, for example, fail to recognize familiar persons and places, constantly lose and misplace various articles, ask the same question repeatedly, etc. Forgetful of the claims of their relatives, whose advice they once valued, childishly ignorant of the ways of the world through the loss of their old experience and acumen by reason of mental failure, they often turn a ready ear to the counsels of the first-comer, to servants it may be, or to utter strangers. Unless thwarted, they confide to one after another their interests. Through their credulity they are turned against their best friends. Strong prejudices are sometimes formed, leading to undesirable attachments or to an utterly unreasonable animosity. This is in keeping with their tendency to suspect those about them without cause, another marked feature of the disease. A large part of the peculiar conduct of some of these patients is their excessive perversity and tendency to oppose measures for their care, no matter how much they may stand in need of them. This utter intolerance of necessary advice and help has of itself often been the decisive reason for a certificate of insanity and commitment to an asylum. A tendency to extreme penuriousness, even to miserliness, may be manifested not infrequently. Senile dements are also given to frequent outbursts of great anger and scolding without adequate cause. On these and other occasions persons formerly circumspect may not hesitate to use coarse and foul expressions. In fact, not infrequently, before their physical vigor has given out, such patients pass through a stage of moral deterioration which manifests itself in changed habits and tastes, in a "moral insanity." They become perhaps intemperate, extravagant, and dissolute; they expose their persons or commit indecent assaults on young girls; others, not infrequently, in the early stages of senile dementia, make absurd marriages. Delusions are not

uncommon, particularly those of suspicion. The patient commonly believes he is being cheated or robbed.

The mental loss is occasionally so slight that it is doubtful whether it can be properly considered pathological, and the amount of responsibility may become a perplexing question for the expert.

The mental vigor varies with the physical condition of the patient. The memory which is poor one day may be quite accurate the next. The disease, however, steadily progresses, the preponderance of symptoms of loss of mental power over those of its perversion (*i.e.*, delusions, etc.) becoming more and more marked. The loss of memory and helplessness become extreme. The patient, through failure of the mind and senses, appreciates little or nothing. Many cases do not reach this pass, but at whatever stage the patient dies the troubles to which he succumbs are of a kind which is especially common among the aged, whether sane or insane, viz., apoplectiform seizures, diarrhœa, cystitis, pneumonia, or bedsores. Death not infrequently results from falls and other injuries, due to the patient's helplessness and the increased fragility of the bones in the aged.

Other Forms.—Besides the true senile dementia just described, mental impairment in old age (as at other times of life) may manifest itself in ordinary melancholia or mania. This fact has led to the use of the terms "senile melancholia" and "senile mania," which, although expressive clinical designations, are not distinct forms of insanity, as neither of these mental states are peculiar to old age, and when occurring they are merely modified by the mental enfeeblement incident to that time of life. Senile insanity is the proper collective term for all such conditions. In a large proportion of senile cases melancholia is the prominent characteristic. This is to be expected from the lowered vitality, the diminished energy of waning life. All shades of melancholia are met with, the severest form, melancholia agitans, as it has been called, being not infrequent.

Mania likewise may complicate senile cases. Here also the aspects are various, active mania, with incoherence and great motor excitement, being at one extreme of the manifestations possible, and mild delusional insanity at the other. The maniacal cases, as a rule, are more or less noisy, and are especially restless and unruly at night. They are feeble and emaciated, and appear bewildered and confused, failing to understand and misinterpreting and resisting efforts to help them.

The symptoms of mental and bodily degeneration described as being associated with the melancholic variety are here also to be met with in varying degrees. A stage of mental excitement may occur in this class of patients, and is apt to be the starting-point of a general mental and bodily break-down. It appears as exaltation and boundless self-confidence, even excitement. Ambitious delusions may be present. It is a peculiar form of mania in the aged, and has been sometimes mistaken for general paralysis.

Age.—There is no fixed age for the appearance of senile insanity, Some men are old at forty, others have good mental and bodily vigor in the seventies; for the signs of old age appear at different times in different persons, and are regulated by a number of different influences, such as the amount of inherited mental vigor and the physical condition of the individual—particularly the state of the vascular system. It can only be said that, as a rule, the signs of senile decay first appear between the ages of sixty and seventy.

Diagnosis.—The course of mental disturbance associated with old age bears a strong resemblance to that which accompanies and results from coarse brain-lesions, such as apoplexy, softenings, tumors, and other destructive processes—a kind of mental enfeeblement known by some as post-paralytic dementia, by others as paralytic insanity.

There is in this form the same progressive failure of mind, inducing loss of memory, helplessness, etc., which marks senile insanity. The same depressed and maniacal states also appear. The fact that old age is the period *par excellence* for destructive cerebral disease, of which paralysis and mental loss are usual results, accounts for the fact that most paralytic cases are also senile. Typical cases of senile insanity, however, lack the peculiar motor features of paralytic insanity, viz., the hemiplegia, characteristic articulation, aphasia, and other relics of an apoplectic seizure. There may be other signs of special lesions, such as ptosis and other local paralyses, the purulent discharge from the ear occurring sometimes with cerebral abscess, the persistent cephalalgia not uncommonly found in cases of cerebral tumors, etc. The course of paralytic insanity is far more irregular, rapid, and uncertain, as a rule, than is that of senile dementia or senile insanity in any of its forms, not to speak of the far greater preponderance of bodily disorder in the first-named form.

Cases of senile mental degeneration have sometimes also served to swell the number of general paralytics, and such mistakes are not surprising when we consider that not a few of the latter class are demented from the start, manifesting no excitement and, occasionally, not a delusion during their entire course. In the progressive failure of the mental and bodily powers these patients are singularly like certain senile cases in whom the degeneration is advanced. The impaired articulation and peculiar gait of the general paralytic is not always easily distinguished from the thick and hesitating utterance and insecure step of certain senile cases. These considerations, coupled with the facts that we occasionally meet with a general paralytic between fifty and sixty years of age, and that all the signs of senile mental degeneration may appear prematurely between fifty and sixty, or earlier, make it exceedingly difficult to recognize the identity of occasional cases within this period. In the vast majority, however, the age is conclusive, as general paralysis rarely occurs after fifty. Then, too, an intimate knowledge of the cause of the disease, and the peculiar mental and motor characteristics of general paralysis, will prevent any error in most cases.

Pathology.—The histological investigations of Major and others [1] seem to leave it no longer doubtful that degenerative change (simple senile atrophy) occurs in the brains of all aged people, although in normal senility only its simplest forms are encountered. Not only is this the case, but we also are often surprised to find a degree of cerebral change out of all proportion to the slight amount of mental impairment manifested. The intellectual vigor may even seem to have been wholly unimpaired. Nevertheless some deficiency of mind is, we believe, always to be found in such cases, if inquiry be closely directed to the mental condition.

Uncomplicated senile dementia, the exaggeration of the normal mental state in senility, appears to be the direct manifestation of, and to go hand in hand with, this atrophy or slowly progressing marasmus (Spitzka) of the nervous tissues. We have alluded before to the similarity between its mental phenomena and the after-symptoms of hæmorrhagic and necrotic brain-lesions. The chronic brain-wasting following, and obviously dependent upon, the latter is often remarkably similar to senile dementia in its course, and the underlying brain-changes are often identical. According to Major, the great change in senile cerebral atrophy, and one which is invariably present to a greater or less extent, is a granular condition of the large nerve-cells of the cortex. The nature of this granular change is thought to be fatty. Dilatation of both arterioles and capillaries, and enlargement of the vascular canals, is also to be found in senile atrophy as in other forms of brain-wasting. Pigmentary deposits on the vascular walls are commonly met with. The fibres throughout the course of the gray matter are broken up and twisted and irregular in their course. The neuroglia also becomes wasted and atrophied. It is by the atrophy of the nerve-cells, keeping pace with the breaking down and shrinking of the neuroglia-element, that the wasting and diminution in thickness of the cortex, which are invariable accompaniments of senile atrophy, are brought about. The frontal and parietal lobes are the chief seats of the atrophic change, and whether external wasting is visible or not, the microscope will invariably reveal changes incompatible with health.

It is by minute changes that the course of senile dementia is influenced. Its usually gradual progress may be transformed into rapid breaking down of brain and mind by some of the coarse destructive lesions so common at this age. Occasionally, when a maniacal attack unexpectedly occurs, some sudden congestion seems at work.

The gross appearances are usually, in the advanced stages, marked pallor, softness, and tenuity of the cortex, cloudy and thickened but non-adherent arachnoid, wasted convolutions, broad sulci, and a varying amount of compensatory serum. Atheroma of the vessels of varying extent is so frequent an accompaniment of senility as hardly to need mention here. It is often present before any mental change has occurred, and can hardly be considered in any degree pathognomonic.

Duration and Prognosis.—Senile dementia is often of long duration and may last for many years, but its course is progressively downward. The length and outcome of attacks of senile insanity depend chiefly on the vigor of the patient, the number of previous attacks, and especially on the amount of cerebral decay present, as manifested by the accompanying symptoms of dementia from gross destructive lesions or from the advanced senile state.

Treatment.—Probably a larger number of cases of mental disorder in old people are cared for in their homes than is the case in any other class of the insane. This is due to the prevalence of the milder forms. Here the question is one of general nursing. In all senile cases the chief indications for treatment are special feeding, rest, warmth, cleanliness, and protection from exposure and injury. The natural state of general enfeeblement, which tends to deplete the mental and bodily forces, is often difficult enough to combat apart from any mental complications. It is the tendency to exhaustion which is the chief point of attack. In the way of support, the patient should be encouraged to take a sufficient amount of simple but nutritious diet. The supply, especially in cases where it cannot be regulated by the patient, should be always commensurate with the amount usually taken by old people, as large quantities of food cannot be digested by old and feeble stomachs. On the other hand, with the blunting of the sensations which is incident to old age, hunger may be little felt, and the patient, if left to himself, may tend to starve if depressed and weak. Proper and systematic feeding is therefore, on all accounts, essential in senile cases, and the amount and kind of food should be known to the physician. The regulation of the amount of exercise is also essential. Owing to their natural tendency to wander about, these patients are especially apt to fatigue themselves. Plenty of fresh air, a limited amount of exercise, and regular daily naps will do much toward conserving the waning energies. Confinement to bed is indicated when the patient begins to grow fatigued easily, to lose appetite, and to become emaciated. When this stage is reached, bed-sores should be guarded against by the usual methods for protecting and hardening the skin at exposed points. A regular allowance of alcoholic stimulant is of value in these cases. Medicinal treatment of the tonic and fattening kind is often useful. Cases of excitement give the greatest anxiety, owing to the difficulty in feeding and properly restraining them. To simply seclude the patient and thus allow him to give vent to his morbid energy, a practice often even desirable in younger and stronger patients, is disastrous in these cases. Warm clothing should be kept upon the patient at all hazard, and the temperature of the room should be even and comfortable. Two or three nurses may be required. Confinement to bed should be insisted upon, unless it provokes protracted struggling. Food, preferably milk and eggs, should be given frequently in small quantities. Such cases seem to yield to the opium treatment oftener than is the case with younger patients. Cannabis indica, combined with bromide of potassium, often answers well in allaying excitement and producing sleep. Chloral is to be especially avoided, owing to its depressing effect on the already weakened action of the heart. Except in extreme cases, and where the family resources are insufficient to command proper nursing, caution should be used in advising the commitment of senile patients to an asylum, owing to the disastrous effects of change on old people, because of their inability to adapt themselves to new surroundings.

Henry R. Stedman.

[1] Vide West Riding Asylum Report, No. iv.; also, Kostjurin On Senile Changes in the Brain, Wiener Med. Jahrbuch, 1886, Heft 2.

INSANITY, SYPHILITIC. The syphilitic virus may destroy the functions or the tissues of any organ of the body. The brain, as the highest organ of the economy, does not escape the influence of this virus, which may cause the derangement of cerebral functions or the death of cerebral substance. The psychical disturbances which result from syphilis, when they have attained a certain degree, are termed syphilitic insanity, just as delirium, in keeping with its cause, is named alcoholic, febrile, or traumatic, and for the same reason that the etiological principle of nomenclature is used so generally in medicine. If further reason need be assigned for the nosological propriety of syphilitic insanity, it is to be found in the practical fact that the term at once fully indicates the etiology, pathology, and treatment of a certain class of cases of mental disease. The etiological influence of syphilis may be exerted in a direct or in an indirect way, as regards the insanity. Thus, in one predisposed to mental disease the general anæmia and ill-health caused by the luetic poison may become the immediate cause of the insanity, and a slight tendency to hypochondria, for instance, that would have remained stationary for life, becomes confirmed hypochondriacal melancholia under the influence of the syphilitic cachexia.

In other individuals of a sensitive nature the specific disease, even though it produce no profound disorder of health, may interfere with business promotion or social aspirations, and, exciting remorse and despondency, it may act as a psychical cause of mental alienation.

The vast majority of cases, however, that are embraced under the title of this article, are such as display the direct effects of cerebral syphilis and of gross material lesions of the organ of mind. The specific disease either attacks the osseous or membranous coverings of the brain, or causes the death of cerebral substance by pressure or by obstruction of arteries.

A gummatous growth on the convexity first proves an irritative lesion of the brain, but as it extends it causes destruction of cortical elements and psychical disorder. Again, if syphilitic arteritis leads to occlusion of the vessel, and to softening in the area of the anterior cerebral artery, mental disturbances are almost sure to follow.

The general course which the insanity pursues and the form which it assumes vary greatly in different cases; but in the main it may be said that it has the characteristics of syphilis considered as a distinct disease, viz., a chronic and relapsing nature, and great suddenness and variability in the special symptoms.

Just previous to, or at the time of, the secondary eruption there may be an onset of acute mania, which may subside with the disappearance of active syphilitic symptoms, only to recur upon another outbreak of the specific disease. Or there is gradually developed, along with the syphilitic dyscrasia, some form of mental depression having syphilophobia and hypochondria as prominent symptoms.

These early and simple psychoses may recover if there is a complete remission of the specific disease, but otherwise they tend to pass into some progressive form of mental weakness.

It is during the most active stage of the pathological cerebral lesions that mental disturbances are the most common, and here, too, there are acute and subacute types. There is occasionally acute delirious mania in connection with syphilitic meningitis or diffused gummatous growths, and in some cases there is a sudden termination in fatal exhaustion of the patient. In other cases syphilitic exostoses act as a cause of irritation of the cortex, giving rise to discharging lesions and epileptic convulsions, which may eventuate in insanity of the epileptic type. The most characteristic form of mental derangement, however, is of gradual development, and it

is a slowly progressive dementia which, on account of its accompanying motor disturbances, has some resemblances to general paresis. It often arises in connection with the gradual obliteration of vessels, and the consequent starvation of brain-tissues. The relative predominance of psychical or of motor symptoms is determined by the cerebral vessels affected. If the syphilitic thrombosis be in the middle cerebral artery, and if lesions occur in parts supplied by it, motor troubles prevail, and hemiplegia may result from complete interference with the blood-supply of the lenticular nucleus ; but if there be an occlusion alone of the anterior cerebral artery, mental disorder will be the chief manifestation.

This chronic form of psychical deterioration is commonly termed syphilitic dementia, and those cases that most nearly resemble general paresis have been called pseudoparesis.

It is not surprising that some confusion exists in opinions expressed by different writers as to the relations of syphilitic insanity to general paresis. Whatever difficulty there may be in the differential diagnosis of special cases, the clinical fact is now well established that syphilis may cause genuine cases of general paresis, and that it may also produce cases greatly resembling the latter disease, but differing from it essentially by their curability and thus meriting the designation of pseudoparesis.

After this brief sketch of the general course and form which syphilitic insanity may assume, attention will be directed next to the special mental and physical phenomena.

The fundamental emotional tone is depression in most cases of syphilitic insanity. There is exaltation only in the rare instances of acute mania, or in certain advanced stages of syphilitic dementia with delusions of grandeur, and it is not difficult to understand why the cœnæsthesis should be depressed during such a painful state of the organic sensations as usually prevails throughout the disease. Among the early symptoms are irritability, culminating in alarming explosions of anger or in acts of violence. Suspicion, too, is heightened, and takes the form of delusions of persecution.

These delusions often arise from the many strange and annoying sensations to which the patient is subject, and which he seeks to explain by reference to external agencies. Thus the paræsthesiæ are attributed to electricity or irritating gases, which enemies use as means of torment.

The hallucinations of taste and smell, which may be due to local syphilitic processes, lead to delusions of poisoning or of foul odors, which patients believe are generated in their rooms at night to injure their health.

Hallucinations of sight and of hearing are also common, and they are often the result of specific lesions of the organs of sense ; their general character, furthermore, is disagreeable, like the prevailing emotional tone, and they sometimes re-enforce, and at other times they are the sole origin of, the delusions of persecution.

Insomnia is apt to be very persistent, and it is frequently associated with nocturnal headache. On the other hand, there are occasionally attacks of somnolence of hours' or days' duration, during which the patient appears stupefied and soon falls into a drowsy condition, if he be aroused for a walk or for conversation.

Vertigo is a common symptom, due, in most cases, to disturbances of the cerebral circulation, though it is occasionally connected with syphilitic middle-ear disease.

Syncope is also not infrequent, and cephalalgia referred to the vertex or to the frontal region is a troublesome symptom.

The epileptiform seizures are most often caused by gummata, and they are unilateral in many cases, and not attended usually by complete loss of consciousness ; they are also frequently followed by loss of power in the limbs on the side affected.

Apoplectiform attacks may usher in the insanity, but ordinarily they are among the later symptoms of the disease.

These convulsive seizures exert an unfavorable influence on the course of the mental disorder, and they usually leave the patient in a state of mental confusion and weakness.

Other physical phenomena that serve to complete the list of protean changes in this disease are paralyses of cranial nerves, loss of power in single muscles, or in one arm or leg, loss of sight or of hearing, ataxic aphasia and various defects of speech, due to muscular inco-ordination. Sensory disorders, such as neuralgias, anæsthesias, and paræsthesias, are seldom absent, but as the dementia progresses they cease to cause complaint on the part of the patient.

The apoplectiform attacks are not often attended by full loss of consciousness, and the hemiplegia and aphasia that follow are seldom permanent.

In fact, the whole course of syphilitic insanity is marked by remissions and exacerbations and sudden changes in symptoms.

The patient that is hemiplegic, aphasic, and in a stuporous condition one month, may appear, with the exception of some mental weakness, almost in a normal state some weeks later. The dementia progresses, however, with each exacerbation of the physical and mental symptoms, and it inevitably reaches a terminal stage in which the patient is seen to have lost all facial expression, all power of thought and of speech, and all spontaneity of movement.

This final phase of complete extinction of psychical functions may not be reached for many years after the first appearance of the mental derangement. In fact, this type of insanity is more variable in duration than most others, as it may last a few months, or ten years, or more before the patient sinks into apathetic dementia.

The length of time between the specific infection and the outbreak of the insanity is also extremely variable, for it is well known that cerebral syphilis may appear a score of years after the primary sore, and mental disorder, as already stated, may arise in connection with secondary or tertiary lesions.

Syphilitic insanity is one of the few types that have as definite a pathology as symptomatology. The pathological lesions act in the production of mental disorder in a reflex way as a local cause of irritation, or by pressure and destruction of cortical tissues, or by starvation of brain-substance through obstruction of arterial circulation, or by the complete withdrawal of a part of the cortex cerebri from functional activity (syphiloma), and the consequent disturbance of the consensus of cortical functions. Among the lesions are periostitis, caries, exostosis, pachymeningitis, meningitis, diffused and circumscribed gummatous growths, arteritis and syphilitic thrombosis, and encephalitis and ramollissement. The lesions that most directly cause the mental disturbances are the diffused gummatous infiltrations, the occlusion of cerebral vessels, and a chronic degenerative process of the cortical tissues.

Lesions of the spinal cord are also to be found in many cases, and they may be confined principally to the membranes or they may involve the substance of the cord. They give rise to paraplegia, to spastic paralysis, or to locomotor ataxia, and to a variety of sensory and motor affections.

The coats of the arteries of the brain are found greatly hypertrophied from arteritis, and vessels of all sizes may be thus affected. The occlusion of the artery may cause most extensive softening. Not infrequently the lesions are symmetrical and bilateral. The ganglion-cells are to be seen in every stage of degeneration, and the neuroglia and fibres undergo various pathological changes, or disappear in extensive areas during the destruction of brain-tissues. Space will not permit a detailed account of the histological changes of cerebral syphilis, and, so far as the pathology of the insanity is concerned, it is enough to know that the mental disorder occurs as the direct result of the brain-lesions, and that it is favorably influenced by such remedies as arrest the pathological processes of cerebral syphilis.

The diagnosis of syphilitic insanity must rest not only on the history of specific infection, but also on the actual presence of syphilitic lesions, which may reasonably be

supposed to bear a causative relation to the mental disease. Some writers, in fact, exclude syphilitic insanity. They state that among large numbers affected by specific disease very few become insane, but the same kind of specious argument would exclude epileptic, traumatic, and many other kinds of insanity. They also claim that this form of insanity has no special order of symptoms, but it has a characteristic disorder, and a suddenness and changeability in all the symptoms that may be considered highly diagnostic.

If the physician is called to pronounce an opinion in a case with something like the following medley of symptoms, he need not hesitate to diagnose syphilitic insanity. These symptoms are not all supposed to be present in a single case, and a few of them would suffice for a diagnosis, and they are chiefly as follows: Great irritability and violent outbreaks of temper, confusion of ideas and loss of memory, exacerbations of mania or of hypochondriacal melancholia, and a constantly progressive dementia, accompanied by cephalalgia, insomnia, vertigo, syncope, apoplectiform attacks, sudden and temporary paralysis of cranial nerves, loss of power in single muscles or in one arm or leg, loss of sight and optic neuritis, or loss of hearing, and sudden and unaccountable remissions in all the symptoms.

The readiness with which the symptoms yield to specific treatment may also prove useful in doubtful cases, though the same drugs may for a time influence the course of general paresis, and it is well to recall this fact in a question lying between the two affections. The differential diagnosis of these two diseases in the terminal stage can often only be made by the previous history and course of the symptoms.

The differential diagnosis between syphilitic insanity and organic dementia with hemiplegia may often be made by the youthful age of the syphilitic patient, and the absence of atheromatous arteries.

Inasmuch as a large per cent. of all cases of locomotor ataxia are of a syphilitic nature, its presence lends a certain probability to the syphilitic origin of the insanity.

There is one practical point to be kept in mind, and that is that in persons of a nervous temperament syphilophobia and a prolonged despondency are common symptoms of the syphilitic cachexia, and the diagnosis of melancholia in these cases would be a mistake.

The prognosis of syphilitic insanity is always grave. The chances of the recovery of mind are never good, and it is probable that a degree of mental impairment invariably results. The vast majority of cases pass into complete dementia, and a small minority recover a fair share of strength of mind and body, but they are very liable to relapses. Syphilitic insanity is not a self-limiting disease, and no instance of spontaneous recovery is on record, and if there be any hope of complete cure it lies in early and efficient antisyphilitic treatment. It is never safe, however, to predict very positively a favorable or an unfavorable issue in any given case, as most surprising remissions occasionally occur, and recovery of mind has been known to result after full dementia had been developed. The prospect of life, too, is most uncertain, for death may occur suddenly in an apoplectic attack, or the patient may drag out twenty years of demented existence.

The treatment of syphilitic insanity is singularly simple and clear, and it may almost be summed up in the two words—iodide of potassium and mercury. If among the hundreds of remedies for specific disease there be any that stand the test of time better than the two here mentioned, they may be employed, for the only hope is to cure the syphilitic affection and to arrest the cerebral changes. So long as there are active pathological processes in the brain it is useless to hope for mental improvement in the patient. The iodide of potassium should be given in large and continued doses in cases which have only tertiary symptoms, but mercury is the chief reliance in cases with secondary symptoms, and it is also of advantage in occasional cases of the tertiary class mentioned. Neuralgia and other painful symptoms call for the use of morphia, which is best given subcutaneously. Chloral may be of occasional service for the relief of the insomnia, and also of severe paroxysms of pain. The bromide may be given along with the iodide of potassium in syphilitic epilepsy. The pains in the bones and other painful affections are often best relieved by hot-air baths. Hygienic measures are of great importance.

As the course of syphilitic insanity is usually very protracted, it is generally most expedient to place the patient in a hospital for the insane, that he may have the constant care and oversight which his disease demands.

Theo. H. Kellogg.

INSELBAD is situated a few miles from Paderborn, in Westphalia, in a sandy plain, at an elevation of a couple of hundred feet above the sea. The principal spring, the water of which is chiefly used for drinking purposes, is the Ottilienquelle, the composition of which, per 1,000 parts of water, is as follows:

Calcium sulphate	0.085
Calcium carbonate	0.309
Calcium bicarbonate	0.453
Magnesium carbonate	0.036
Magnesium bicarbonate	0.056
Ferrous carbonate	0.0002
Ferrous bicarbonate	0.0004
Manganous carbonate	0.003
Manganous bicarbonate	0.005
Sodium chloride	0.771
Silicic anhydride	0.017
Total solid constituents	1.7356

The gases are carbonic acid, nitrogen, and oxygen. The temperature of the spring is 64.5° F. The composition of the bathing-spring (Badequelle) is very similar to the above. The Marienquelle is an iron water, containing 0.048 parts per 1,000 of ferrous bicarbonate. The waters of Inselbad are used for both drinking and bathing, and the nitrogen gas coming from the water of the Ottilienquelle is inhaled in various pulmonary complaints. The atomized water is also inhaled for the same purposes. There are good accommodations for swimming- and mud-baths. The spa is visited by patients suffering from diseases of the throat and lungs, and from rheumatism. There are also many visitors who frequent the place merely for purposes of rest and recreation. *T. L. S.*

INSURANCE: SELECTION OF LIVES. NOTE.—This article is not designed as a guide for conducting examinations; the examiner is supposed to be sufficiently skilled to act for the company which he represents. It aims to show what the company expects of him, however, and to present the matter as it is viewed from the company's standpoint, stating what selection has been, is, and should be, to insure prosperity.

HISTORY OF SELECTION.—Selection practically began in guilds and fraternities before the Christian era.

Candidates submitted to examination, and were required to be "holy, pious, and good."[1] The life tables of Dr. Halley, R.S.S., 1693, gave possibility to greater benefit than the mere burial of the dead, and the curious tables of births and funerals in Breslau were followed in 1698 by the Mercers' Annuity Life Company of Dr. Assheton.[2]

Yet life insurance, which for years after Queen Elizabeth's reign was prohibited by law, was practised in her time (prior to 1600), as shown by MSS. of legal proceedings.[3] At first selection was but cursory, and life insurance was regarded as a game of chance. Rates were fixed by the laws of chance, even up to recent date, and works on the subject were popular (Arbuthnot, 1692; De Montfort, 1703–14; Bernouilli, 1714; De Moivre, 1718; Thomas Simpson, F.R.S., 1740; E. Hoyle, 1754; Samuel Clarke, 1758; W. Painter, 1787; Quetelet, St. Rouse, Mitchell, *et al.*, up to 1860). Still there was selection; applications were personal, and a single vote excluded; if accepted by proxy, an extra charge was made.[2]

The Amicable of Great Britain (1706), insuring only between the ages of twelve and forty-five, required good health, and, in 1730, an oath to this effect. Charges were heavy, and payments ill defined, and the Equitable of

Great Britain was the result in 1762.[4] Its history gives the best history of selection up to the advent of insurance in America.

The goodness of the life grew in importance, and premiums were rated according to age; care and caution were enjoined by directors, and certain ages and occupations were heavily overcharged. In 1762 a declaration of health was required, signed by two known witnesses, one of them a physician. The directors voted in secret session, one vote rejecting, and profit was the ruling motive.

In 1770 eight full days were required after application for careful inquiry; and in 1779 the consulting actuary proposed a medical adviser, owing to the danger from unhealthy lives which might be accepted under the stimulus of the company's profits. Rise in value of investments postponed this, forfeitures grew infrequent, and mortality more favorable; premiums were reduced, and between 1780 and 1790 it is evident that commissions were paid for new business, for protests appeared against the practice as bribery.

Extra rates were charged in 1828, to protect against gout, small-pox, and military life, and in 1829 beer-retailing and hernia were included.

The paying of commissions had become a feature of the business by 1820, and this new danger was met by the appointment of medical examiners. The chief reason for this, however, was clearly the advent of the new science of auscultation and percussion, by which a physician alone could detect the otherwise undiscoverable beginnings of disease of the lungs. Just prior to this (1818), life insurance gained footing in America (Massachusetts Hospital Insurance Company), but the new era opened with the Mutual Life of New York, in 1843. The New England (1844), the Mutual Benefit (1845), the New York Life (1845), the State Mutual (1845), and the Connecticut Mutual (1846) soon followed; eight others, still in business, started in the next decade, ten in the next, and three in the next, by which time (1876) there were in England one hundred and fifty-two companies doing life business.

The history of selection may be traced in the experience of any of the early successful companies, and that of the Mutual Benefit, with which I have been connected for twenty years, will serve as a guide. Medical examiners were employed at the outset, and their opinion was final. Good health and appearance in applicant, and no evident tendency to disease, were alone required. Family record and remote diseases were of minor importance; even the history of scrofula or threatened phthisis did not always reject.

Examinations were cursory, as auscultation and percussion were not widely understood, although their founder (Laënnec) had been dead for twenty years (1826).

Printed questions, with certificate of friend, agent, physician, and examiner, formed the application. Hereditary disease in the family, and personal experience as to gout, small-pox, military service, dropsy, liver complaint, spitting of blood, and consumption, formed the chief points of inquiry. So long as the friend, physician, and examiner could be relied on, however, selection gave good results; but physicians soon learned the disadvantage of testifying against their patrons, and by 1876 their certificates were omitted, friends avoided any objectionable features, and the ordinary examiner found loss of practice the penalty of rejection. He had, moreover, the enmity of the solicitor or agent, and a less scrupulous or more ignorant man soon filled his place. Their references to brother physicians were often reciprocal, and, of course, favorable. With such a state of affairs the commission for business was a bid by a company against its own welfare.

The Mutual Life adopted, in 1867, the practice, still in vogue, of employing medical referees. These are the best physicians obtainable, and are paid for selection of each examiner, and are independent of all interested parties.

The Equitable, Germania, Ætna, State Mutual, Connecticut Mutual, and Mutual Benefit adopted the system in 1870–76.

So thoroughly corrupt was the old system that in one company, in a single State, eighty per cent. of the examiners were found unqualified, and the influence of such a condition was felt in the mortality for years. From 1864 to 1868 increased commissions and competition increased the danger of imperfect selection; the family record was then required in detail, including grandparents and in some companies the collateral branches.

The expense of new business, moreover, demanded a better mortality, and searching questions and analysis of urine gradually led up to the applications now in use. Differing in companies only in minor points, they aim to obtain a knowledge of family and personal disease or tendency, and a true picture of the physical condition; the whole being subject to the scrutiny of a medical board versed in the significance of disease. A copy of the application is returned with the policy. With two and three examinations by different physicians, large amounts ($100,000) on a life are now assumed by a single company.

Mention should be made of the attempt to insure all lives by graded rates, by the American Popular (1866). Every care was exercised, all available literature searched, and prizes offered for essays on subjects bearing on such a course, but lamentable failure followed; for if the ill are accepted the well will not apply. Some of the works alluded to are given below.*

The assessment and co-operative companies, which have flourished and decayed in large numbers, have practised a kind of selection, growing more rigid within the past five years. One of the most stable, "Knights of Honor" (report, 1883), experienced considerable loss on the first one thousand cases, clearly due to ignorance or carelessness of examiners. Provident and prudential companies, which are outgrowths of regular life insurance, require medical selection (the latter only on amounts over $150) and limit all to $500; the temptation to deceive on small amounts being small, and inspection of policy-holders frequent. The Prudential of London (1848) and the Prudential of this country (1876) have had remarkable success.

Necessity of Selection.—The chief points can be briefly stated without argument; they are:

First, the intervention of middle-men pecuniarily interested.

Second, the fact that only auscultation and percussion can detect incipient disease.

Third, the surrender of policies.

The influence of commission has been alluded to. The majority who insure are coaxed or harassed to do so by parties pecuniarily interested in their acceptance—brokers, solicitors, and middle-men employed by the agents. The necessity, therefore, of having a disinterested person, responsible only to the company, is self-evident. That he should be a man of integrity and experience, versed in methods of detecting hidden disease, and therefore a physician, is also evident.

He should be, and is, paid alike whether he recommends or rejects a risk. The custom of paying commissions began in England late in the last century, and, as stated, was regarded as a bribe. It was, and is said still to be, small—ten per cent. on first, and five on other premiums, or compounded to twenty-five per cent. on first only.

In this country it has been as high as seventy per cent., and is now said to be between twenty and forty on first, and varying rates on subsequent premiums; but it is impossible to state accurately, as many devices are employed to avoid the appearance of large payments.

In France and Belgium it is said that the commission sometimes absorbs the first and part of the second premium. As an item of expense, it may be approximately known by comparing agency commissions and premium receipts in a company's annual reports. The medical expense is usually about one-twelfth that of commission account. Some companies in England pay no commissions.

* Longevity (Rush, 1783); Anecdotes of Old People; Profession and Longevity; Temperament and Life Insurance; Methods of Attaining Long Life (Cornars); Longevity (Bacon); Health and Longevity (Sinclair); Prize Essay on Longevity (Oxford); Longevity (Maclay), etc.

The Equitable of Great Britain stated, in 1869, that by not paying commissions it had saved and divided $9,200,000.

The chief necessity for selection grows out of the surrender of policies. This is explained under the following head.

BENEFITS OF SELECTION.—There has been a prevalent belief that the effects of selection disappear after five or six years. This is true only in appearance, and is due to imperfect estimate of the effect of withdrawals. In this country they are probably due to mixed causes unconnected with health, and have less injurious effect than in foreign companies. Mr. James Meikle[5] (Actuary of the Scottish Provident) gives the following comparative statement, adjusted for 1,000,000 entrants :

	Dead.	Discontinued.
English	157,560	268,913
German	108,104	276,581
American	45,267	418,315

This shows that the withdrawals in Germany exceed those in England by three per cent., while in America the proportion is very much greater—fifty-six per cent. Mixed motives for so large a discontinuance may be fairly inferred ; and this belief is confirmed by the character of our people and experience. Under the system of extending insurance after lapse, according to the value of the policy, each member is informed of the number of years each payment after two will carry his insurance, and theoretically the sick would be most likely to avail themselves of this ; but since the adoption of the plan by the Mutual Benefit the rate of mortality has been far below the expected rate—thus the rate of actual to expected deaths was, in 1879, 0; 1880, 54.7; 1881, 76.4; 1882, 79.7 ; 1883, 65.0.

Experience on paid-up and lapsed policies, heretofore, also shows this. The general experience of the Mutual Benefit has been eighty-five per cent. of the American table; on paid-up policies only eighty-two per cent. The Connecticut Mutual, eighty-four per cent. general; eighty per cent. paid up. The John Hancock, on younger lives, seventy-three per cent. general; seventy-one per cent. paid up.

That considerations of health have greater weight in foreign companies may be inferred from a comparison of the following tables, although different mortality tables are used.

EXPERIENCE OF ENGLISH LIFE COMPANIES, COLLECTED BY THE INSTITUTE OF ACTUARIES.[6]

Summary of all ages (*old* actuaries' table).

Years of Insurance.	Mortality.
Under one year	42.2
One year	68.0
Two years	85.0
Three to five years	98 86
Six to ten years	102.85
Eleven to fifteen years	107.22
Sixteen to twenty years	103.95
Twenty-one to twenty-five years	103.23
Twenty-six to thirty years	102.53
Thirty-one to sixty-three years	101.73

The mortality appears to rise above the table after the sixth year, reaching a maximum from the eleventh to the fifteenth.

Mutual Life, New York (*new* actuaries' table).

Years of Insurance.	Mortality.
Under one year	50.3
One year	63.2
Two years	71.1
Three to five years	79.7
Six to ten years	82.1
Eleven to fifteen years	80.1
Sixteen to twenty years	83.3
Twenty-one to twenty-five years	92.6
Twenty-six to thirty years	68.6

Connecticut Mutual (American table).

Years of Insurance.	Mortality.
One to five years	79.2
Six to ten years	89.3
Eleven to fifteen years	86.4
Sixteen to twenty years	88.7
Twenty-one to twenty-five years	87.0
Twenty-six to thirty-two years	81.5

Mutual Benefit (American table).

Years of Insurance.	Mortality.
One to five years	78.9
Six to ten years	84.8
Eleven to fifteen years	87.4
Sixteen to twenty-five years	91.2
Twenty-six to thirty-five years	93.3

Subdivision on ages thirty-one to thirty-five shows a decrease to 80.5.

The rise is in this country not above the table, but is noticeable ; and if the figures actually meant what they appear to, selection would protect but a few years, and scrutiny back of the personal condition is superfluous. Eliminate, however, withdrawals as they occur, separate the ages into groups, and compare then the mortality at each age with the expected mortality, and the whole aspect is changed. Mr. Higham[7] is believed to have been the first to demonstrate the importance of this; his conclusion is that selection projects its benefits to one-half the difference between the age and eighty. Mr. Bartlett, Actuary of the Mutual Life, New York,[8] gives as his conviction that its advantages diminish at all ages with duration of policy—very rapidly at young ages, decreasing slowly at middle life, and among older insurants probably never disappears.

Mr. James Meikle, Actuary of the Scottish Provident,[9] arrives at almost the same conclusion.

Mr. Sprague, Vice-President of the Institute of Actuaries,[10] appears to have made the most elaborate and conclusive investigations, and shows a law of increase on ages forty-six to eighty up to certain periods, followed by decrease varying with each age, well marked on ages fifty-six to seventy-five, less so on forty-six to fifty-six and seventy-six to eighty, and below forty-six and above eighty a steadily progressive rate. He corroborates the now prevalent belief of actuaries, that, excluding the effect of quite recent selection, ages twenty-one to twenty-five give greater mortality in subsequent years than other ages, and states that Mr. Higham's favorable views are in reality not favorable enough.

I have reduced his statements to a table in comparison with Mr. Higham's.

DURATION OF EFFECTS OF SELECTION.

Ages.	Higham.	Sprague.
25	27½ years.	30 years.
30	25 "	30 "
35	22½ "	40 "
40	20 "	30 "
45	17½ "	20 "

The benefits of selection are best shown, from another standpoint, by the experience of the Australian Provident. By its last report (1885), it rejected over thirty (30.7) per cent. of applications. In this country the average is ten per cent. It admits what are here called first-class risks as first and second, and on the latter charges premium at an average of three and a half years advanced age. Still further, it makes the second class largely a majority ; 33.43 per cent. of its policies are, moreover, issued as endowments, always the most favorable line. As a consequence its rate of mortality is almost phenomenal—thus, on the first class, numbering 82,729, the rate is but 66.6 of the H^m table ; second class, 113,210, rate, 79.8. If all had been taken at actual age, the rate would have been but 74.4.

The following table may be compared with those already given ; it shows the same increase after the sixth year :

Australian Provident Life (*new* actuaries table).*

Years of Insurance.	Mortality.
Under one year	47
One year	56
Two years	56
Three to five years	56
Six to ten years	65
Eleven to fifteen years	67
Sixteen to twenty years	78
Twenty-one to twenty-five years	69
Twenty-six to twenty-nine years	39

This company, moreover, has many single-payment as well as limited-term policies ; thus, these are compared with two other companies as follows :[11] Australian Provident Life, 5.37 per cent. of total issue ; Standard, 1.96 per cent.; Scottish Widows, 1.02 per cent. ; thus showing that the circumstances of the insured are more than usually good.

We cannot escape the conviction that selection is felt throughout the period of insurance, and that withdrawals

* Calculated approximately by Mr. Miller, Actuary of the Mutual Benefit Life.

Insurance.

may yet affect the mortality in this country, as age makes the business more stable, as it does in Great Britain. Both make a careful scrutiny into the antecedents of an applicant as important as his physical soundness.

Principles of Selection.—Of any number of persons, we know how many will attain a given age, how many will die each year, and the mathematical value of the chance of any to attain his expectancy; but to know which ones will do so is impossible; to decide which are most likely to do so is selection. Heredity, habits, occupation, residence, and hidden disease, complicated by the intervention of interested parties, and self-interest, with the danger that, once accepted, a withdrawal of the sound may increase the ratio of the diseased, present a serious problem.

All should be sound at starting, and to be sound is not necessarily to be free from blemish, but from disease, slight or severe, which may impair future health, or the integrity of organs necessary to the prolongation of life. The examiner should be assured, by the modern devices of his art, that there is no disease nor indication of hidden trouble, as of brain or cord, liver, kidneys, blood-vessels, bones, or glandular system. To a company the applicant is as he is presented by the examiner, who should therefore be versed in physical diagnosis, fearless and explicit in statement, and unbiassed in judgment by agent or applicant. Lacking either, he is unfit. He should, moreover, examine the applicant in quiet and alone.

If he, as a presumably disinterested party, fully, clearly, and fearlessly presents the whole case, the company can apply the results of its experience and observation, and make a safe selection. That all examiners do not do this, complicates the problem.

Proposition as to Selection.—A man's chance of attaining the tabular expectancy, is the chance plus the ordinary uncertainty of life, and equals the tabular rate, plus or minus the advantages of birthright, present soundness, experience of disease or injury, occupation, and residence.

It is impossible to give a fixed value to each, but approximate values can be readily ascertained.

Birthright in Selection.—Birthright, in a life insurance sense, is the inheritance either of a diathesis predisposing to disease, or a strong constitution and longevity. Older than Hippocrates, yet much assailed, this doctrine is verified by overwhelming modern testimony and experience,[12] and is practically applied in the breeding of cattle and the development of plants. The inheritance of disease may be of ancestral or acquired taint, and the grounds for this belief will be hereinafter given.

Cancer and syphilis are familiar examples, and while inheritance of the former was denied by so eminent an observer as the late Willard Parker, of New York, many others concede it. Lichtenstein gives twelve per cent. of his own cases, and collected 1,127 from Paget, Cooke, Sibley, Lebert, *et al.*, with seventeen per cent. hereditary. Mr. Sibley says eight per cent., Velpeau thirty per cent., Sir James Paget twenty-five per cent. The difference depends probably upon want of knowledge of grandparents, atavism being the rule rather than the exception. Ages most affected are given under "personal experience," and are important in estimating risk.

A tendency to tumors (abnormal hyperplasia) is hereditary (Obermeier).

As to syphilis, fully one-third of the children of syphilitic parentage die before maturity.

Manifestations on the skin and mucous membranes are usually confined to infancy; those of bones and periosteum extend to childhood; while dactylitis syphilitica and disease of the cornea and teeth, may appear as late as the twentieth year. Cases are recorded still later.[13]

Some authors believe that scrofula is due to this taint (Gross), which, if true, leaves no period of life exempt.

Diatheses as a Guide to Selection.—The diatheses (neuropathic, strumous, gouty, bilious, lymphatic) bound more or less clearly the lines of transmission of disease.

The neuropathic individual is usually of slight physique, quick of intellect and speech, subject to minor disorders and overwork, but inclined with prudence to long life.

Neuralgia,* neurasthenia,† hysteria, alcoholism,[14] epilepsy,[15] neuromata,[16] progressive muscular atrophy,[17] and pseudo-hypertrophic paralysis (often considered identical),[18] locomotor ataxia,[18] and somnambulism[19] in the parents may appear in him in the same form, or as epilepsy, migraine, phthisis, chorea, or insanity. The latter is hereditary in perhaps a majority of cases (Reynolds says twenty-five to fifty per cent.; Moreau, as high as ninety per cent.).

Suicidal insanity is especially so.

Transmission is most frequently from father to son, and mother to daughter, and personal resemblance to the other parent does not alter it. The experience of the New York State Asylum, quoted by John Mann,[20] gives 54.6 per cent. sons from fathers, and 45.3 from mothers, while daughters from mothers stand 54.4, and fathers only 45.4. And as to resemblance, Moreau[21] says that of 22 females insane, eighty per cent. resembled the father, but inherited from the mother; and of 142 males, 66.6 per cent. acquired from the father, but resembled the mother.

Congenital deafness is hereditary, but a majority of the offspring, according to the report of the Pennsylvania Institute for the Deaf and Dumb, March, 1884, will hear.

The same authority says that there are more deaf and dumb from close kinship marriages, than from marriages of the congenitally deaf. Life companies, however, weigh only the hazard from accident, and decline where deafness is intense, whatever its cause. Paralysis due to brain-lesions occurs most frequently from a mixed diathesis of the nervous and gouty, or lymphatic, or strumous. The lesion is now believed to be due to miliary aneurism from periarteritis, rather than to atheroma. There is unmistakable kinship with disease of the heart and kidneys, although one case in a family is not significant. Thus, among selected cases of this kind, I have found, out of 177 deaths but eight per cent. with similar disease in ancestors. This mixture of diatheses favors early degeneration of tissue, and the multiplied diseases that follow, but the degeneration of old age has no significance to offspring.

Early degeneration of blood-vessels is hereditary (Billroth), and, from a long experience and the study of 1,332 cases, I believe the inheritance to be from father to son, and mother to daughter. The apoplectic build is no longer believed in (Flint). Of 90 deaths I found but eighteen per cent. inclined to corpulence.

The gouty diathesis stamps the individual with vital energy and a tendency to self-indulgence. As life advances he is liable to disease of the heart, Bright's disease, degeneration of tissue, bronchitis, and chronic disease of mucous membranes, yet is frequently long-lived. The inheritance occurs in from fifty per cent. (Garrod) to ninety per cent. (Scudamore).

Of 51 cases collected by myself, forty per cent. seemed to possess an hereditary character.

Atheroma of vessels and dilatation of the left cardiac ventricle readily follow overtaxation or indulgence, and fatty degeneration of the heart, any wasting disease (Quain, Hayden, Balfour).

About seventy-five per cent. of deaths occur after forty years of age. Valvular disease, with or without rheumatism, is frequent, and also interstitial nephritis; while all forms of Bright's disease may appear through several generations, although authors differ as to the croupous form (Tyson). Chondromal disease and affections of liver, stomach, and joints, calculus, disease of bladder, and erysipelas, appear till eliminated by several generations of mixed marriages.

The bilious diathesis entails a tendency to frequent complaining, a clouded skin, weak digestion, and susceptibility to malarial affections. A feeble resistance allows organic changes, and but fair prospect of longevity.

The stomach and liver suffer from self-indulgence, and particularly from intoxicants.

* Anstie, 71 out of 83.

† Thirty cases of my own.

Cholelithiasis (gall-stones) appears to favor this diathesis (Franconneau Dufresne, Von Schneppel, Machlachlan), and the following shows its heredity.* In one family, both parents being subject to attack, it appeared through four successive generations and five families; none of the children being free from hepatic disorders, and many subject to hepatic colic.

In a second family the mother transmitted the disease to three sons and two daughters; two dying during an attack.

In a third family the father transmitted it to two children; one dying early, the other being subject to attacks at fifty.

In a fourth family, with both parents affected, two only out of eight children suffered. It is proper to add that Frerich denies the relationship of gall-stones to any particular diathesis.

Diseases of the liver are frequent in strumous families; and the term liver disease, in an application, is often a cover for consumption, cancer, or cirrhosis. This diathesis and the gouty are often allied, and diabetes and chronic dyspepsia are common to both.

The strumous diathesis is a familiar inheritance. It is apt to entail a clear, fair complexion, a quick and precocious intellect, but not enduring mental powers, and early degeneration. Long life is exceptional, but occurs from mixed marriages. Consumption is its most frequent manifestation, and its tendency to be transmitted is marked.

Of 2,978 males insured under the age of twenty-five, from families where one, two, and rarely three, cases only had occurred, I found after fifteen years that 3.4 per cent. of the deaths were from consumption; of 5,039 between twenty-five and thirty, 15.6 per cent.; and of 20,000 over thirty, 18.4 per cent.; while of 7,141 with no consumption in the family, the same interval gave but 1 per cent.

The ultimate difference in mortality would doubtless prove greater; and while corrections for lapses would alter the figures, it is extremely unlikely that they would alter the ratios. The ages most affected by consumption will be given below.

Pollock [22] says that 30.16 per cent. of cases are inherited, and [23] that sixty per cent. are probably so. The "Brompton Hospital Report," 1849, shows the probability of transmission by sex thus: Sons from fathers, 59.4 per cent.; daughters, 43.5 per cent.; daughters from mothers, 56.5 per cent.; sons, 40 per cent.

Where both parents have had consumption the question of contagion or infection might be of interest. The possibility of this is more generally conceded than formerly, since the discovery of the tubercle bacillus, but even before that it had been verified by experience.[24] It could not, however, with safety be considered by a life insurance company. The outcroppings of struma in a family record are seen in caries of bones, glandular swellings, chronic wasting, ulcers, skin diseases, and a multitude of organic diseases arising from tubercle.

The lymphatic diathesis gives a large frame and easy temperament, with tendency to passive diseases and early degeneration; and in later life affections of the heart, brain, and kidneys, under slight exciting causes. It appears rather a union of other diatheses than an independent one, but often entails consumption and short life.

Longevity, as an inheritance, is shown by testimony and experience, and the individual will survive disease, exposure, and accident to a singular degree.

From printed questions recently sent to 200 men of seventy-five and upward I obtained clear and full replies from 100, and give the result: 5 were seventy-five, 21 were seventy-six, 19 were seventy-seven, 14 were seventy-eight, 8 were seventy-nine, 9 were eighty, 10 were eighty-one, 3 were eighty-two, 4 were eighty-three, 1 was eighty-four, 2 were eighty-five, 1 was eighty-eight, 1 was eighty-nine, 1 was ninety, 1 was ninety-five.

In 70 per cent. one parent had survived seventy years; in 47 per cent., eighty years. In 88 per cent. a parent or grandparent had survived seventy years; and in 73 per cent., eighty years. In 50 per cent. a grandparent had passed eighty years. In 81 per cent. a brother or sister had survived seventy years.

The families were prolific, and averaged between six and seven children. Including grandparents there were 1,276 members, 1,078 accounted for, and 269 living. Only 40 cases of consumption had occurred, 3.6 per cent. of those accounted for, and 4.9 per cent. of total deaths, as compared with 10 to 15 per cent. in the community at large; 28 cases of heart disease (nineteen families), 2.6 per cent.; 27 cases of apoplexy or paralysis (twenty-five families), 2.5 per cent.; 26 cases of cancer (seventeen families), 2.4 per cent.; Bright's disease in three families only, and insanity in but two. The chief causes of death were inflammatory or zymotic. Deaths in infancy were infrequent, only 6.9 per cent. under ten years of age. The size of the families and the freedom from diseases dreaded by life companies are remarkable features.

Transmission of acquired disease is disputed; but as what appears to be acquired may be the evidence of latent or reversionary heredity, it is so regarded by life companies. That if acquired it may be transmitted is probable, first, because acquired instincts and habits are so;[25] second, because lesions of nerve-centres are so;[26] third, because lead-poison, traumatic epilepsy,[27] the alcoholic taint with tendency to epilepsy, or insanity and idiocy from conception during intoxication are so. Acquired rheumatism and the gouty affections from sudden rise from poverty to affluence, consumption, syphilis, and cancer certainly appear so in life-insurance experience.

In estimating the value of a family record, two points are of especial importance, viz., the possible pathological kinship of the diseases shown, and the fact that indefinite and evasive answers are frequent; thus dropsy, typhoid fever, measles, liver disease, childbirth, debility, and old age are often but synonyms for tubercular disease.

PERSONAL CONDITION IN SELECTION.—*Personal condition, age, and experience of disease* are weighed in connection with family tendencies. Young men have undeveloped records, and, as already shown, do not yield a favorable mortality; the middle-aged are the best; old men, however sound, should belong to long-lived families. The age is important in connection with the fact that, in spite of prevalent belief, consumption, cancer, apoplexy, paralysis, and disease of the kidneys show increase of mortality with advance of years, being greatest after fifty and sixty. Thus, in corroboration, out of 10,000 living at each age the mortality is shown:

Age.		Würzburg.[28]	N. Y. City.[29]	M. Ben. Life.	U. S. Census.	M. Life Exp.[30]
From Consumption.	20 to 25......	30.2	70	22	23	24
	25 to 30......	36.7				
	30 to 40......	41.1	72	20	27	20
	40 to 50......	48.4	65	14	27	17
	50 to 60......	67.9	83	14	31	14
	60 to 70......	93.1	115	27	40	18
	70 to 80......	61.7	150	37	79	30
	80 + ...	25.8	.....	....	..	.....
From Heart Disease.	20 to 30	....	7 5	1.5	..	1.2
	30 to 40......	....	9	1.7	..	2
	40 to 50......	....	12.7	5.3	..	4.1
	50 to 60......	....	22.7	14.5	..	10.6
	60 to 70......	....	85.3	33.5	..	36.7
	70 + ...	....	89.9	82.8	..	73.2
From Disease of Nervous System.	20 to 30......	....	8.7	3.1	..	5
	30 to 40......	....	13.5	7.5	..	8.3
	40 to 50	....	19.4	16.4	.	14.9
	50 to 60	....	38.9	34.6	..	28.3
	60 to 70......	....	82.9	79	..	69.4
	70 + ...	....	200.4	....	..	133.6

The figures for cancer and disease of kidneys are omitted for want of space, but a similar increase prevails. From cancer, twice as many deaths occurred in the Mutual Benefit Life between fifty and sixty as between forty

* Given personally from the experience of the late Dr. Jackson, of Newark, N. J.

and fifty, seven times as many between sixty and seventy, and ten times as many after seventy.

Females, as a rule, live longer than males. Of 27,003 deaths in New York City, 111 were over ninety—77 females and 34 males.

Soundness has been already defined in a previous part of this article.

Height and weight should approximate the average. Light-weights are unfavorable; rapid or recent loss is suggestive of carcinoma, diabetes, or phthisis, and after fifty especially so (Machlachlan). Most companies reject all twenty-five per cent. below, or forty-five per cent. above, the following standard:

Height.	Weight.	Chest.
5 ft. 1 in	120 lbs.	34.0 in.
5 ft. 2 in	125 lbs.	35.1 in.
5 ft. 3 in	130 lbs.	35.7 in.
5 ft. 4 in	135 lbs.	36.2 in.
5 ft. 5 in	140 lbs.	36.8 in.
5 ft. 6 in	143 lbs.	37.5 in.
5 ft. 7 in	145 lbs.	38.1 in.
5 ft. 8 in	148 lbs.	38.5 in.
5 ft. 9 in	155 lbs.	39.1 in.
5 ft. 10 in	160 lbs.	39.6 in.
5 ft. 11 in	165 lbs.	40.2 in.
6 ft.	170 lbs.	40.8 in.
6 ft. 1 in	175 lbs.	41.5 in.

The girth of abdomen should not exceed that of the chest on expiration. The expansive power of the chest should be at least two inches. With auscultation and percussion the examiner should be familiar, and report exactly what they reveal for the information of the home office.

As already stated, an applicant is as he is presented by his application, and statements may have a force not intended. The following, not incompatible with apparent health, are weighed by a company as to their possible significance, viz.:

Albuminuria, occasional: A possible forerunner of organic disease.

Abdomen, prominent: Obesity and attending degeneration.

Acne facialis and alopecia: Syphilis or gout.

Amputation of limbs: If for injury, accident; if for disease, recurrence.

Benign tumors: Growth and pressure, operation, possible malignancy.

Blindness, congenital: Danger of accident; *from disease:* other development.

Bladder, irritable: Lithiasis, cystitis, disease of stomach, liver, kidneys, or lower bowel, enlarged prostate, stricture.

Carbuncles: Diabetes.

Catarrh, nasal: Scrofula, syphilis, frequently deranged liver.

Cataract: Diabetes, premature senility.

Chest abnormalities (pleuritic adhesions, empyema, hydrothorax, cicatrices from wounds, projecting sternum, flatness or contraction, depression below clavicles, deficient expansion, weak respiration, rotation from spinal curvature): All a tendency to future disease.

Chorea: Disease of heart or spinal cord.

Cicatrices, of scalp: Epilepsy; *of neck:* struma or syphilis; *of chest:* wound of thoracic organs.

Clearing of throat or *short cough:* Chronic pharyngitis, relaxed palate from gouty tendency, laryngeal phthisis, strumous tendency, disease of ear.

Colic: Hepatic or renal calculus, mesenteric disease.

Complexion, florid: Intemperance; *injected vessels:* gouty kidney; *pallor:* cancer or Bright's disease, anæmia, heart disease, dyspepsia, phthisis.

Constipation, chronic: Organic disease of primæ viæ, congestion or disease of liver, stricture, plethora, and danger to cerebral vessels.

Deafness (even without active disease): Danger from accident.

Defects of speech: Disease of brain, pharynx, larynx, thoracic aneurism.

Depression of cranial bones: Epilepsy; *of nasal ridge:* phthisis, or syphilis.

Discoloration of the skin: Disease of suprarenal capsules or liver, syphilis.

Dysphagia: Paralysis, stricture, cancer.

Dyspepsia: Diabetes, lead poisoning, disease of liver, spleen, pancreas, or kidneys, ulcer or cancer of stomach (a frequent forerunner of phthisis, or cancer, in life insurance experience).

Dyspnœa: Disease of heart, lungs, larynx, or trachea, enlargement of glands, aneurism, tumors, affection of brain, kidneys, or stomach, anæmia, pleuritic or cardiac effusions, Addison's disease; *if inspiratory:* some variety of stenosis or bronchitis; *if expiratory:* asthma, emphysema.

Ears, ringing or *throbbing in:* A possible cerebral or pharyngeal disease; *discharges from:* otitis media, a frequent forerunner of cerebral abscess or meningitis (see W. W. Gull: "Reynolds' Syst.," vol. ii., p. 557).

Eyes, dimness of vision: Disease of kidneys; *unequal pupil:* tumor of brain, injury to nerve-centres; *Richardson's pupil:* locomotor ataxia; *strabismus, not congenital:* injury of nerve-centres, organic disease.

Facial muscles, rigidity of, or *unequal action:* Paralysis.

Fistula, not traumatic: Phthisis, even in the obese.

Glandular enlargements: Scrofula, syphilis.

Goitre: Cardiac disease, danger from pressure on pneumogastrics.

Glycosuria, occasional: Probable forerunner of organic disease.

Headaches: Disease of kidneys, gout, chronic meningitis, chronic dyspepsia, toxæmia.

Hernias, multiple: Debility, atrophy.

Hay fever: Possible symptomatic dyspnœa from bronchitis, cardiac disease, or aneurism.

Joints, enlarged: Gout, rheumatism, syphilis.

Limbs, pains in, numbness, tingling, incoördinate motion, disturbed sensation, easy fatigue, contracted flexors: Disease of brain or spinal cord, malaria, lead, or the opium habit.

Palpitation, intermittent or rapid pulse: Obscure thoracic disease, as of heart or coronary arteries, deranged nervous system from excesses (venereal, alcoholic, or narcotic), anæmia, toxæmia, debility; *abnormally slow pulse:* basilar disease; *high arterial tension:* Bright's disease.

Piles, bleeding: Affection of liver, gout, apoplectic tendency.

Prostate gland, enlarged: Cystitis, rectal disease, premature senility (a frequent cause of chronic cystitis, or pyelitis in the old).

Sciatica: Disease of pelvic organs, or cord, lithiasis, injury.

Skin diseases: Struma, syphilis, disease of internal organs from suppression of chronic disease.

Spinal curvature: Short life.

Spinal pains, dorsal: Affection of stomach, liver, pleura, or kidneys; *lumbar:* kidneys, ureters, rectum, or cord; *sacral:* rectum or cord (any may be simply myalgic, or due to spinal neurasthenia).

Testicle, enlarged: Recent orchitis, malignant disease; *drawing up of, with pain:* calculus.

Urethra, irritable, or *stricture of:* Cystitis, pyelitis, operation.

Varicocele, if large: Danger from operation.

Varices, if large: Obstruction to circulation by pelvic disease, chronic ulcer.

Many of the above should reject, they all bear relation to family record, and the ages at which diseases most prevail.

PERSONAL EXPERIENCE IN SELECTION.—*Personal experience* relates to former injuries, habits, functional disorders, and diseases with sequelæ, or likely to recur.

Penetrating, or *contused, wounds* of *vital organs, hæmorrhages* (pulmonary, gastric, nasal, hepatic, renal, or even hæmorrhoidal), may be significant. If from the air-passages the best selected cases, and after long immunity, yield a grave mortality.[30]

Vertigo, objective or subjective, *cerebral congestion, sunstroke, tinnitus aurium, discharge* from the ear, *para-*

lysis (not clearly peripheral in origin), and *scarlatina* or *diphtheria*, if recent, may all, or any, yield subsequent disease.

Habits of indulgence are of special importance. Indulgence, although discontinued, may have injured kidneys, liver, stomach, or brain.

Spirits, malt drinks, or narcotics, once used to excess, render return of habit probable in proportion to the age at which excesses occurred, and the probability is greatest under neuropathic tendencies.

The opium, chloral, or hashish habit is rarely if ever reformed, and the victim usually deceives as to its continuance. The daily use of spirituous or malt drinks is properly a habit, and except in small quantities and intermittent, is prejudicial to long life. If a necessity at meals, it may indicate poor digestion, a weakened system, or the craving which precedes greater indulgence. Only one author has attempted to give the amount that can be eliminated daily (Bartholow, two ounces alcohol). Vigorous health is implied, but experience shows that many could not tolerate one-fourth this amount. Intermittent excesses after twenty-five forebode persistent indulgence.

Occupation and Residence in Selection.—These may destroy the best inheritance, or nullify the worst; but while a consumptive inheritance may remain latent in a favorable locality, a company cannot afford to assume that it will do so.

Climates subject to epidemics of cholera, yellow, or malarial fever; alluvial or new colonial districts, where privation may develop inherited tendencies; frontier life which exposes one to hazard from Indians, and where a low value is placed on human life, cause an extra risk, over which an extra charge throws but an arbitrary and uncertain protection.

The extra hazard from occupation varies from makers of explosives, aëronauts, miners and blasters, submarine divers, caisson workers, etc., to wool-carders, firemen, marble polishers, roofers, and others more or less liable to disease or accident.

All occupations subjecting to accident, explosion, noxious vapors, or *to fine dust* liable to enter the lungs, *are extra hazardous*. Mariners always furnish a grave mortality. Locomotive engineers, firemen, brakemen, and freight conductors, are usually rejected by standard companies. The changeable character of occupations in America renders it impossible to make comparison with English experience, but we have, in the Provost Marshal's Report of our Civil War, sufficient material for judgment, and the results are not in accord with prevalent opinion.

Space permits only brief quotations from the facts elaborated. Five hundred and one thousand and two were examined for enlistment under draft; 28.2 per cent. were rejected—the largest number (39.4 per cent.) in Massachusetts, the smallest (17.6 per cent.) in New Jersey.

Out of 75 occupations, *consumption* rejected in the following order per 1,000: Editors, 68.4; architects, 43.6; physicians, 39.6; public officers, 31.1; tailors, 31.9; teachers, 31.3; agents, 31.1; druggists, 30.5; lawyers, 30; merchants, 30; pedlers, 27.9; cabinetmakers, 25; jewellers, 24.5; railroad men, 23.6; millers, students, stonecutters, shoemakers, and printers, only from 14 to 16; soldiers, miners, boatmen, brickmakers, plumbers, sailors, laborers, firemen, and musicians, only from 2 to 9.6 per 1,000.

Inebriety rejected in the following order: Engravers, 12.2; ostlers, 11.6; hatters, 6; lawyers, 5.4; firemen, 3.8; tailors, 3.5; physicians, 3.2; papermakers and hangers, 3.1; sailors, 3; innkeepers, 2.8; cabinetmakers, 2.7; blacksmiths, shoemakers, distillers, gunsmiths, bakers boatmen, iron-workers, factory hands, druggists, harness-makers, tanners, tobacconists, laborers, and soldiers, only from 2.6 to 1.6 per 1,000. There were no rejections, strangely, among dentists, brokers, liquor dealers, musicians, porters, and students.

Disease of heart rejected in the order: Physicians, 66.3; brokers, 56.9; photographers, 45.7; papermakers and hangers, 44.1; jewellers, 43.7; engravers, 42.7; editors, 41; teachers, 40.5; grocers, 37; down to architects, 31.7, and lawyers, 31.4. Laborers, miners, firemen, distillers, butchers, iron-workers, soldiers, cooks, musicians, and tanners, from 11.8 to 4.6 per 1,000.

Chronic rheumatism rejected in the order: Liquor dealers, 28.5; stone-cutters, 9.4; public officers, 9.4; physicians, 8.9; porters, 8.8; distillers, 8.6; bar-keepers, 8; millers, 7.6; watchmen, 7.2; inn-keepers, 7.1; clergymen, 7; tailors, 6.4; printers, 6.3, etc.; singularly, none among brickmakers, coppersmiths, musicians, plumbers, and tanners.

Disease of kidneys rejected in the order: Brokers, 12.6; upholsterers, 10.9; architects, 7.9; papermakers, 6.3; grocers, 5.4, etc.

Among many occupations showing no rejections are bakers, boatmen, brickmakers, firemen, tanners, watchmen, masons, and ostlers.

From these facts, occupations appear to have in this country, aside from the danger of accidents, less weight than heretofore supposed, although none the less important in connection with family record or personal tendencies. Thus, lumbermen or plasterers, of rheumatic diathesis; millers and shoemakers and printers, of consumptive families; distillers with neuropathic tendencies, etc., would prove more or less unfavorable; and experience makes one other grave exception in case of liquor dealers. Companies have come to regard all connected with the business as at extra risk (see early history as to beer-retailers in England).

An examination of 60,000 policies * shows brewers and distillers alone below the tables, 71.13; saloon-keepers and liquor dealers, 160.61; hotel-keepers, 155.68; saloon, hotel, and liquor dealers, 157.31.

The following would seem a fair order as regards risk. Commercial travellers for liquor houses, saloon-keepers and retailers, young men in wholesale business, bar-keepers, drivers of beer-wagons, hotel-keepers, brewers, grocers who retail, wholesale dealers and distillers, over 45.

Conclusion.—This article being, in itself, a summary rather than an argumentative essay, no recapitulation is presented, but I would, as a conclusion, say that in the application of the principles enunciated certain points of importance should be kept in mind, viz.:

First. That the matter of heredity, while still to some minds in question, may be settled by even a casual reading of any of the stock-breeders' reports issued of late years to buyers of blooded cattle. Their cardinal rule, "like begets like or the likeness of some ancestor," is undoubtedly correct, both as to physical and mental peculiarities and as to tendency to disease.

Second. An applicant for insurance is usually biassed in favor of the soundness of his genealogical record, and the agent, as a layman, would lead him to make statements widely different from those that a physician would elicit, aside from the influence of self-interest that might actuate the former. The value of the record, therefore, depends largely on the questioner.

This is true also of the personal record, and the examining physician is in consequence the only proper person to obtain and fill out both.

Third. Manifestations of tendency to disease are not always the same in succeeding generations; for example, a man may have mild gouty trouble with his joints and fail to see any connection between this and the Bright's disease, apoplexy, or fatal affection of the heart or stomach of his parents. The man too fond of alcoholics is usually unaware that the insanity, chronic cerebral disease, or even the inebriety of his ancestors, has special significance to him; while the applicant with catarrhal affections, or disease of the lymphatics and impaired digestion, exhibits a tendency to the phthisis of mother or sisters as unmistakable as an apex pneumonia with its resultant consolidation.

Fourth. It is easier to estimate the value of the prospect of life at middle age than earlier, because of the development of the family record, aside from the security afforded by definite settlement of character and other personal features of a case. For example, a young man at twenty may show a family apparently free from he-

* Mutual Benefit Life.

reditary taint, while at fifty the number of deaths from consumption or other transmissible disease may so clearly exhibit tendency to disease as to render him unsafe for insurance; on the other hand, apparent feebleness at twenty might bar insurance, which at fifty, with examples of longevity in older brothers and sisters, would be fully warranted.

Fifth. The actual mortality from consumption, heart disease, apoplexy, paralysis, and Bright's disease increases, as has been shown, with age.

Sixth. There are popular fallacies as to insurability, more or less fixed, but yet untenable—*e.g.*, that a man is safer because he has passed the age at which his parents died; that after thirty-five he has become less liable to consumption; that because all lives could be insured with safety under the tables of mortality, therefore any could be; that selection protects only a few years; that heredity is of minor consequence to a sound man; that this soundness is all that is necessary for safe insurance (individuals of the vegetable, animal, and even the mineral kingdoms have qualities inherent that determine their period of decay); that a man who has for years indulged in alcoholic stimulants or narcotics can escape deterioration of the eliminating organs—the liver, kidneys, skin, or lungs—or can, after middle life, reform at will.

We may epitomize the matter by saying that while of a given number a known proportion will live to a stated age, the particular ones who will do so can only be approximated. Those who have the seeds of disease inherited or acquired are certainly the least likely; and selection has become weighted with dangers not inherent, viz., competition, solicitation by, and intervention of, parties pecuniarily interested, and the withdrawal of healthy lives.

The fact that the very numerous withdrawals in this country have been *indiscriminate* has, however, rather contributed to the prosperity of companies hitherto; but as this is not likely to continue, and is a hazardous ground for prosperity, the value of selection must become more and more evident, and this by features unfamiliar to laymen, but familiar to the company and its examiners—viz., inheritance, personal condition, and tendencies to disease.

In all instances open to fair difference of opinion, limited insurance upon endowment plans is a matter of individual consideration.

Edgar Holden.

[1] Tompkins: Ass. Reg. Fr. Soc., 1873. [2] Pocock, 1842, p. 93.
[3] Hallowell: Ass. Mag., 1872.
[4] See Hist. Eq. Soc. and Walford's Ins. Cyclop. E.
[5] Annual Address, 1884–85. p. 40.
[6] Thos. B. Sprague, Ass. Mag., vol. xv., p. 328.
[7] Ass. Mag., vol. i., p. 190. [8] Exp. M. Life, 1875, p. 18.
[9] Annual Address, 1884–85. [10] Ass. Mag., 1870, vol. xv., p. 328.
[11] Exp. A. P. L., 1885.
[12] Darwin, Galton, Ribot, Miles, et al., and see Index Catalogue of the Surgeon-General, U. S. A.
[13] Arch. Dermat., January, 1877, and April, 1883; Amer. Jour. Med. Sci., January, 1879.
[14] Moreau: Phys. Mort. [15] Northnagel, Echeverria, Reynolds.
[16] Hitzig: Ziemssen, vol. xv., p. 825.
[17] Trousseau, Friedreich, Eulenburg, Ziemssen, vol. xiv., p. 111.
[18] Bramwell, p. 79. [19] Ribot. [20] Med. St. Life Ins., p. 87.
[21] Bucknill and Tuke, p. 62. [22] Prog. of C., p. 75.
[23] Ibid., p. 341. [24] Amer. Jour. Med. Sc., July, 1878.
[25] Ribot: Heredity, p. 19. Miles: Stock Br., p. 40.
[26] Richardson: Prev. Med., 1884.
[27] Richardson: Field of Dis., p. 513.
[28] Dr. Struck: Age and Sex, p. 96. Berlin, 1884.
[29] Exp. M. L. [30] Exp. Mutual Life and Mutual Benefit.

INTERCOSTAL NEURALGIA. This is a form of neuralgia in which the anterior primary branches of the dorsal nerves are principally affected. In some cases the posterior branches are also the seats of pain, when the malady is termed dorso-intercostal neuralgia, but most commonly it is limited to the anterior branches, and is thus strictly intercostal neuralgia. The front and side of the chest are most frequently affected, but sometimes the pain extends as far as to the lower part of the abdomen, to which the branches of the lower intercostal nerves are supplied. In most cases the pain is limited to one side, and, for what reason it is difficult to say, this is, in the larger proportion of cases, the left side. Not uncommonly the affection is associated with other forms of neuralgia, and, perhaps, most frequently with brachial neuralgia, in consequence of the blending of the first dorsal with the four lower cervical nerves to form the brachial plexus. In general, not more than two or three of the intercostal nerves are affected at the same time. An interesting fact in the history of intercostal neuralgia is the frequency with which trophic disturbance occurs along the course of the painful nerves, constituting herpes zoster. This association of cutaneous eruption with nerve-pain is by no means limited to intercostal neuralgia, as it occurs not uncommonly in connection with other nerves; but it is more frequently met with in intercostal neuralgia than elsewhere. It is remarked by Erb that a true neuritis exists in such cases, and that this is the explanation at once of the pain and of the eruption; this is, however, by no means proved.

Symptoms.—Pain is the most prominent symptom in this as in other forms of neuralgia; generally it is of a dull and tensive character, but not uncommonly, and especially when zoster accompanies the neuralgia, it is acute and even burning. It follows the course of the affected nerves along their distribution to the back, the side, and the front part of the chest, but it is felt often with special severity at certain points known, from the observer who first designated them, as Valleix's points. These are at the back, by the side of the spinal column where the nerve makes its exit; at the side, where the lateral branches issue to the skin; and in front, either close to the sternum, where the anterior perforating branches come through the muscles, or lower down over the rectus muscle of the abdomen. The pain is often aggravated by pressure at these points, and sometimes the sensitiveness of the skin is so great that even the contact of the clothes can hardly be endured. The patient's position is often characteristic of the disease, as he leans toward the painful side so as to relax the muscles of the chest, and thus lessen tension of the thoracic and abdominal walls. The respiration is also modified to a great degree, being often almost entirely unilateral, the respiratory muscles being used as little as possible on the painful side. Corresponding with these symptoms are the auscultatory phenomena, the respiratory murmur being feeble and suppressed in consequence of the diminished movement of the chest-wall. When the trophic filaments of the painful nerve are involved, the vesicular eruption of herpes occurs along the course of the nerve; but this complication requires separate consideration as Herpes Zoster.

Diagnosis.—The diagnosis of intercostal neuralgia is sometimes attended with difficulty. Pleurodynia, or rheumatism of the intercostal muscles, closely resembles intercostal neuralgia, but may in general be distinguished from it by the history of rheumatism in other parts of the body, and by the absence of special pain at the three points characteristic of the neuralgic affection. The situation of the pain in intercostal neuralgia, and the suppressed and feeble breathing accompanying it, may suggest the first stage of pleurisy, from which, however, it is distinguished by the friction-sound of early pleurisy, and by the fever attending that disease.

Etiology.—Exposure to cold or damp is probably a common exciting cause of this affection, especially among those who have a constitutional proclivity to neuralgia.

Malaria seems often to occasion it. Not uncommonly it accompanies pulmonary consumption, and is then found chiefly on the same side with the affected lung. Aneurism of the aorta may give rise to this form of neuralgia by causing pressure directly upon the intercostal nerves.

Among the predisposing causes sex is very noticeable, the malady occurring three or four times more frequently among women than among men.

Treatment.—The treatment of intercostal as of other forms of neuralgia comprises measures for the relief of pain, and for the removal of the cause of the affection. When pain is exceptionally severe, the most prompt and potent means of relief is the use of a hypodermic injection of morphine, either in the arm, which suffices in

most cases, or at the seat of pain, which sometimes appears to give more perfect relief. The hypodermic injection of twenty or thirty minims of a four-per-cent. solution of cocaine sometimes acts promptly as an anodyne, but in the writer's experience the relief has been only transient. Counter-irritation by blisters over the painful points is often of value, and the local application of chloroform does good both by a counter-irritant and an anodyne action.

Faradization along the affected nerves is sometimes of avail in the same way, and the galvanic current may be very effective in relieving the pain—the anode being placed on the spinal column, and the cathode on the painful points at the side and front of the chest. In extreme cases, when other means have failed, section of the affected nerve is a measure to be considered, as in some cases it has afforded relief.

The most important remedies to be directed to the causes of the malady are tonics and antiperiodics. In accordance with the aphorism that "neuralgia is the outcry of a starved nerve," it is often associated with and dependent upon anæmia, and in such cases iron is of signal efficacy against it. It matters little what the preparation is, the tincture of the chloride, Vallet's mass, or one of the soluble salts of the metal may be used.

The malarial influence is a fertile cause of this as of other forms of neuralgia, and in cases having such an origin quinia is demanded. When the condition is somewhat chronic, arsenic is especially beneficial, and often acts best when combined with iron.

When the neuralgia is associated with disturbance of the trophic nerves and consequent herpes, the same measures are required for the relief of pain. Vesication over the origin of the affected nerves, beside the spinal column, is thought by some to check the spread of the herpes.

Samuel C. Chew.

INTERMITTENT FEVER. SYNONYMS.—Febris intermittens, malarial intermittent fever, fever and ague, chills and fever, paludal fever.

DEFINITION.—A malarial affection characterized by regularly recurring paroxysms of fever, usually introduced by a chill and ending in a sweat, these paroxysms being followed by a period which is entirely free from fever, and which constitutes the intermission.

Inasmuch as the subject of malaria in general has been assigned to more competent hands than those of the present writer, and will be treated of under another heading, it only remains for him to deal with the clinical aspects of intermittent fever, merely premising that this disease depends upon malaria as its cause, and is found wherever the malarial poison exists. It may, indeed, be safely asserted that intermittent fever is the typical form in which malarial infection manifests itself. In any malarial region, or among any body of men exposed to malarial influences, the number of cases of intermittent fever will far exceed those of continued, or so-called remittent, fever, or of any other form of malarial affection. It attacks the new-comer, sometimes the sojourner of a night only, while still it follows with relentless tread the oldest resident. It touches lightly with its tertian or quartan chill, and is readily subdued by quinine; or it grapples its victim to the death in a pernicious paroxysm, which need never be repeated.

In common with many other observers, I hold it true that new-comers in a malarial region, especially in the more highly malarial, tropical, or subtropical regions, are most likely to be seized with the continued form of fever, while older residents suffer from the intermittent form. This rule, however, has innumerable exceptions on both sides. It is probably true that the lighter grades of malarial infection, in unacclimated subjects, result in simple intermittent; the heavier, in pernicious intermittent or continued fevers. Longer residence in such regions undoubtedly results in a certain tolerance of the poison, hence the lighter or intermittent form in the *habitué*, although here also the inevitable law of compensation obtains, and longer residence leads to a condition of chronic malarial cachexia deplorable in its results.

Another reason why so large a proportion of those newly arrived are seized with the graver forms of fever is doubtless because of their neglect of many ordinary precautions, to be alluded to again under the head of *prophylaxis*, and because many older residents are constantly warding off malarial outbreaks by the use of quinine. There is no doubt but that the negro race enjoys a comparative immunity from the effects of malaria.

CLASSIFICATION.—Intermittent fever may be divided into two general classes, viz.: 1. Simple intermittent. 2. Pernicious intermittent. The so-called masked intermittents (Fièvres larvées) may be classed as simple.

Types or Varieties.—Both these classes again may be divided into varieties or types, according to the frequency with which the paroxysms of fever or other malarial manifestations recur. When the paroxysm occurs daily, or once in twenty-four hours, it is called *quotidian*. When it occurs every other day, or once in forty-eight hours, it is very stupidly misnamed *tertian;* and when it occurs every third day, or every seventy-two hours, it is with equal stupidity called *quartan*. If we are to retain these misnomers, let it be remembered that the tertian intermittent does not recur every third, but every second day; and the quartan does not recur every fourth, but every third day. A better plan would be to take the lead in correcting this mistaken nomenclature, giving the name *secundan*, or *alterdian*, to the form now called tertian, and giving the name tertian to the form now called quartan.

These three forms are the most common; the first two, viz., those in which the fever recurs every twenty-four or every forty-eight hours, greatly preponderating over the third form.

Instances are also reported of intermittent fever recurring every fifth, sixth, seventh, or eighth day, but these are mere rarities. Certain complications or reduplications of type, however, are not so very infrequent, usually taking one of the following forms and names: The *double quotidian* is that form in which there are two daily paroxysms, occurring, of course, at different hours of the day, and usually differing from one another in severity and other characteristics. The *double tertian* (according to our old nomenclature) consists of two series of tertian paroxysms, the one occurring on the first and third days, the other occurring on the second and fourth days. Thus there is a daily paroxysm, and yet it is not of the quotidian type, because the paroxysms of each succeeding day do not resemble each other in the hour at which they occur, nor perhaps in other characteristics, whereas the paroxysms of every alternate day do thus resemble each other. In other words, the first- and third-day attacks are alike, but are unlike those of the second and fourth days, while those of the second and fourth are like each other. For instance, on the first and third days the attack may begin at 9 A.M., having the three stages of chill, fever, and sweat, the entire paroxysm lasting nine hours; while on the second and fourth days the attack may not begin until 3 P.M., the chill may be wanting, and the entire paroxysm only last four hours.

When two paroxysms occur on one day and none on the next, and this rhythm is preserved, it is called a *duplicated tertian*. Two paroxysms on one day and one on the next has been called a *triple tertian*. A *triple quartan*, on the other hand, implies the occurrence of paroxysms on three successive days, each one of which differs from the other two; but when the series is repeated in the second three days it is found that there is a resemblance or identity, respectively, between the paroxysms of the first and fourth, the second and fifth, and the third and sixth days.

Some claim to have still further followed out these complications of form, but it hardly seems worth while to do so here. The essential point is not to let these irregularly regular forms mislead us into the belief that we are dealing with something else than intermittent fever. It must also be remembered that in the simple quotidian or tertian form it is not very unusual for the paroxysms regularly to anticipate or postpone the hour of their recurrence. Thus a daily or an every-other-day

paroxysm may regularly come an hour or two hours earlier than it did the time before, or, in another instance, each paroxysm may come an hour or more later than the preceding one.

The relative frequency of quotidian and tertian intermittent fever differs in different parts of the world, the general rule being that the quotidian type prevails in the hotter, the tertian in the more temperate, climates. This law of geographical distinction is well shown in the following table, quoted from Colin, by Sternberg:[1]

Place.	Total number of cases.	Remittent, per cent.	Quotidian, per cent.	Tertian, per cent.	Quartan, per cent.	Irregular, per cent.
Vienna	3,125	....	36	42	7.6	3
Algeria	4,849	12	62	24	0.5	...
India	5,617	91	7	1	....	....

In looking at this table it must be remembered that it represents only those admitted to hospital at the points named, not the total number of persons attacked with intermittent and remittent fever in a given community or military command. No one can suppose that ninety-one per cent. of all fevers occurring in the Presidency of Bengal, during twelve years, were remittent fever, but is forced to the conclusion that intermittent cases, as a rule, are not admitted to hospital. The testimony of other writers confirms this conclusion. Sternberg[2] gives the following quotation from Sir Joseph Fayrer's work on the climate and fevers of India:

"Tertian seems to be most common in Europe, then quartan, and last quotidian. In Africa, the West Indies, and India the quotidian is most frequent. In Burmah, according to Murchison, 83.5 were quotidian, and 1.6 tertian. In India, according to Waring, the observations of several medical officers, in various stations throughout India and the Tenasserim provinces, show that of 2,574 cases of ague 1,822 were quotidian, 595 were tertian, 29 quartan, 118 double tertian, 10 irregular; and he further states that of 53,753 admissions of European troops, 51,287 were quotidian with 646 deaths, 2,097 tertian with 12 deaths, 2,369 quartan with 2 deaths. Dr. Burton Brown says: 'At least ninety-five per cent. of our cases of fever at Lahore are intermittent quotidian agues, about three per cent. tertian, and the rest quartan ague, remittent fever, and enteric fever.'"

The following tables are also given by Sternberg (*op. cit.*, p. 141).

Cases of Intermittent Fever in the Army of the United States during the Civil War of 1861 to 1865.

	White troops.		Colored troops.	
	Cases.	Per cent.	Cases.	Per cent.
Quotidian	447,258	51.77	63,992	53.79
Tertian	375,170	43.44	51,045	42.91
Quartan	41,223	4.78	3,928	3.29

Total Number of Cases of Intermittent Fever in the Army of the United States for Eighteen Years prior to the Civil War (excluding the two Years of the Mexican War).

	No. of cases.	Per cent.
Quotidian intermittent	51,623	52.6
Tertian intermittent	44,857	45.6
Quartan intermittent	1,757	1.8

These tables practically show the relative proportion of the different types in the Southern and Western States of our Union, those in which malarial diseases are most prevalent. Statistics gathered in the Northern States would undoubtedly show a larger proportion of the tertian variety.

Simple Intermittent Fever.—*Period of Incubation.*—This period is very variable, differing, no doubt, according to the virulence or intensity of the poison to which the individual has been exposed and the extent of the exposure, and also differing according to the susceptibility of the individual. The nearest we can come to a rule is to say that, usually, a period of from one to three weeks elapses between exposure and the outbreak. Instances are not wanting, however, in the more intensely malarial regions, where fever has followed within the first twenty-four hours after exposure. In many cases, also, there is good reason to believe that the period of incubation is much longer than three weeks. At some time during this period, usually within a week of the outbreak of the fever, the patient complains of general *malaise*, a sense of being tired and listless, loss of appetite, often slight frontal headache, or a dull pain in the back with occasional darting pains in the limbs. The tongue is generally foul, the taste bad, the bowels constipated, and the urine scanty, high colored, and irritating. There may even be nausea and vomiting. Many a person living in a malarial region and familiar with these prodromal symptoms, or warned by those more experienced, will at this stage take a few full doses of quinine and very likely avert the impending attack.

The Paroxysm of Fever.—This naturally divides itself into three stages: First, the stage of chill; second, the stage of fever; third, the stage of sweating. These all properly belong to the paroxysm of fever, inasmuch as there is an abnormal rise of temperature from the beginning of the chill to well-nigh the end of the sweat. The duration of the several stages differs considerably in different cases. On an average the chilly stage lasts from fifteen minutes to an hour, the hot stage from three to six hours, and the sweating stage from four to eight hours.

The Stage of Chill. After more or less of the prodromal symptoms already indicated, or sometimes without the occurrence of any of these, the patient is seized with chilly sensations, which may amount to nothing more than a feeling of chilliness running up and down the back, but which are more likely to develop into distinct and pronounced rigors. He wants additional clothing piled upon him, trembles or shakes enough to shake the bed, while at the same time he complains of severe headache and pain in the back. His hands and feet are cold to the touch, his finger-nails blue, while yet the thermometer under his tongue shows a temperature of from 102° to 104° F. The pulse is small and rapid. There is often considerable thirst. Nausea and vomiting are not infrequent. Occasionally there is much complaint of præcordial distress and dyspnœa. The voice is faint and tremulous.

The Stage of Fever. After a variable period of chill, hot flushes begin to be felt, at first alternating with chilliness, but soon asserting themselves more and more, until the patient throws off his extra clothing and complains of burning heat. Thirst now increases. The hitherto pale and shrunken face becomes red and turgid, the carotids throb, the radial pulse is full and hard, the extremities feel as hot as the rest of the body, although the thermometer under the tongue may not show any higher temperature than during the chill. Headache increases, though the backache often diminishes. The patient grows quite restless, and may even become slightly delirious. During the progress of this stage the temperature usually rises one or two degrees.

The Stage of Sweating. After several hours of fever, with a dry skin, some moisture begins to show itself, and this quickly increases until the patient is bathed in perspiration. The face loses its flush, the mouth its dryness. The pulse soon grows softer and less frequent, the violence of the headache diminishes, restlessness disappears, and the patient very likely falls into quiet sleep. The sweating may continue for several hours, lessening in profuseness, and during this time the temperature of the body gradually falls toward the normal. It is a mistake, however, to suppose, as the laity usually do, that in this or other febrile affections the fever is over as soon as sweating begins. The thermometer often shows no fall of temperature during the first hour or two of sweating.

The Intermission.—Now follows the characteristic feature of this form of fever, viz., the intermission. Its duration is, of course, governed by the type of the fever, that is, by the question of whether the paroxysm is going to

recur in twenty-four, forty-eight, or seventy-two hours, or whether there are to be two paroxysms in a day. During the intermission the temperature remains at the normal. In many cases the patient feels quite well, eats, sleeps, and goes about his ordinary avocations. In others, however, especially after the more prolonged or severe paroxysms, he complains of weariness, dizziness, vague, wandering pains, and loss of appetite. In either event, unless the proper treatment is adopted, another paroxysm of fever will supervene at its appointed time, and the period of its recurrence will indicate what type of intermittent fever the patient is suffering from.

The above description applies to a regular, typical paroxysm of intermittent fever, but it will surprise no one to encounter deviations from this course. In the first place, we must not lose sight of the complicated or duplicated types of fever described above, which may at first sight seem to give us an entirely irregular period of recurrence. Then, too, it is not unusual for the different stages of a paroxysm to deviate from the rule as to their duration or severity. Either one of the three stages may be unduly prolonged or greatly abbreviated, while the first or third stage may be entirely wanting.

Dumb ague, as it is popularly called, is that form of paroxysm in which there is no chill, the hot stage being the first. This is more common among the older residents in malarial regions.

Sometimes an attack of intermittent fever will be so shrouded by intercurrent symptoms as to mislead the observer. There may be so much congestion of the bronchial mucous membrane, with short, difficult breathing, slight cough, fine mucous râles, and even a catching pain in the side, as to suggest the invasion of pneumonia. Violent vomiting and diarrhœa at the outset of the paroxysm may pass for a mere attack of cholera morbus. Severe pain in the back and limbs, often referred especially to one joint, which the patient is unwilling to move, crying out with pain when he does so, closely simulates rheumatism. In all such cases the unwary practitioner may flatter himself that he has been very successful in "breaking up" an attack of one kind or the other, only to find it recur in full force at the end of its appointed time.

In children under two years of age, and often in those of the age of three or four, there is no such thing as a shaking chill, and the first thing that may be noticed by the attendants is the fever. Careful observation, however, will detect the stage of chill by the fact of the lips and nails becoming blue, the nose and extremities cold, and the face pale, and eyes sunken. Sometimes the child will vomit two or three times in succession, and then it wants to go to sleep. After a little while the face grows flushed, and the surface of the body hot; the child becomes quite restless, throwing itself about in the bed; and in a certain number of cases convulsions supervene. Other children, again, pass from the cold to the hot stage without waking, but, on the contrary, fall into a profound sleep or semi-comatose condition, from which they gradually emerge during a brief sweating stage. Children are more liable to quotidian than to tertian attacks, and during the intermission they do not seem well, but are peevish, and perhaps drowsy, with a poor appetite and some disturbance of the stomach and bowels.

Special Symptoms.—It may be well to refer here to a few incidental symptoms not mentioned in the above description of a paroxysm of fever, and which are, indeed, common to various forms of malarial disease. The *tongue* is usually somewhat swollen, so as to look thick, and its edges are marked by depressions corresponding to the teeth. It is only because the tongue is swollen and pressed against the teeth that it receives the scalloped edge which has been so learnedly discussed by some writers. It is usually coated, having either a bluish-white, lead-colored hue, or a more yellow tinge. It is never dry and brown in simple intermittent, but in the graver forms of remittent fever it cannot be distinguished from the typhoid fever tongue.

The spleen is enlarged and tender during the paroxysm, returning to its normal size in the intermission, but in persons who have suffered for a considerable time from malarial intoxication, whether showing itself in one form or another, this organ remains enlarged, often attaining an enormous size, filling the whole left side of the abdomen.

The urine, as already stated, is abundant in quantity and limpid during the cold stage, while it is scanty and concentrated during the hot and sweating stages. Sternberg (*op. cit.*) quotes Ringer in favor of an increase in the quantity of urea during the paroxysm, to the extent of from two hundred to five hundred per cent. above the normal. He also cites several observers as having found temporary glycosuria, as well as albuminuria, during attacks of intermittent fever.

A *herpetic eruption*, usually appearing on the face, about the mouth, is a very common accompaniment of this disease. It may occur very early, before the first paroxysm of fever, or it may not show itself until after a number of paroxysms have passed and when, perhaps, they are pretty well subdued by treatment. Sometimes, especially in children or in those having a very delicate skin, erythematous patches may appear during the hot stage, which may easily be mistaken for *tâches cérébrales* or the beginning of some eruptive disorder.

Pathological Anatomy.—Simple intermittent fever seldom or never being directly fatal, it has hitherto been impossible to determine what are its lesions. The most quickly fatal forms of malarial disease are the pernicious intermittents, therefore we may look to them as probably giving the lesions directly due to acute malarial infection.

Speaking of these, Sternberg (*op. cit.*, p. 172) says: "It seems probable that the essential lesion, which clinical observation would teach us to seek in the nervous centres, has thus far escaped our researches, and that the morbid changes noted are to a great extent, if not altogether, secondary to changes in the living portion, the protoplasm, of the histological elements—nerve-cells, of the cerebrospinal and sympathetic ganglia. We have no reason, however, to suppose that these changes by which the vital activity of a living nervous element is reduced or annihilated are demonstrable by the microscope, and in the absence of any such demonstration must content ourselves with recording the morbid lesions which are visible to the naked eye, or with the aid of the microscope. . . . The leading fact in the pathology of *the blood* in intermittent fever, as well as in other forms of malarial disease, relates to the abundant destruction of the red corpuscles, and to the presence of black pigment, which is evidently derived directly from the coloring matter of the disintegrated corpuscles. . . .

"The dark pigment formed in the blood is deposited in the various organs and tissues of the body, and especially in the spleen, the liver, the kidneys, the lymphatic glands, the brain and spinal cord. It may also be demonstrated in the integument and in serous membranes, where it marks out the course of the blood-vessels in the walls of which it is deposited. . . .

"The changes in the *spleen* in pernicious intermittent fever are said by Colin to be as constant and as characteristic as are the changes in the intestinal glands in abdominal typhus. These alterations consist in softening and pigmentation of the organ. The softening is less marked in the case of individuals who have succumbed at the end of a long series of intermittent attacks, in whom the spleen is often greatly hypertrophied and indurated. . . . Pigmentation of the spleen, even when its parenchyma is diffluent, is said by Colin to be a characteristic feature which makes it possible to distinguish between the spleen of a victim of pernicious intermittent and the softened and dark-colored spleen of some other affections, *e.g.*, typhoid and scarlet fever. . . . In hypertrophy of the spleen from chronic malarial poisoning, especially when the immediate cause of death is not a pernicious febrile attack, the organ is unnaturally hard and friable instead of being softened. This is due to an excessive development of the fibrous tissue of the capsule and trabeculæ of the organ, and in some cases to inflammatory exudates. . . . The lesions appertaining to the *nervous system* correspond with those found

elsewhere, viz., hyperæmia with or without œdema, and occasional hæmorrhagic extravasations of small size together with pigmentation.

"In sthenic persons who have succumbed to a comatose pernicious paroxysm, the brain is intensely hyperæmic, and a considerable amount of serum is found in the ventricles. The meninges are also injected, but present no evidence of inflammation. In the algid form the substance of the brain and cord is said to be pale, bloodless, dry, and tough (Hertz).

"Occasionally evidence of inflammation is found when the pernicious attack has not been quickly fatal, but this is the exception, and should be considered a sequela or complication rather than a direct result of the malarial intoxication."

For a discussion of the question of micro-organisms in relation to this disease the reader is referred to the article on Malaria.

Treatment.—Something can undoubtedly be done in the way of *prophylaxis*, and this is especially important for those who have newly arrived in a malarial region. Many lives are sacrificed through the neglect of simple precautions, the victims falling a prey to a pernicious intermittent or a remittent fever. Malarial influences are most active at night, in low lands, and near the ground. Therefore the importance of seeking as elevated a site and one as far removed from river-banks as possible. It is better to sleep in the second story than on the ground floor, and it is often suicidal to sleep out-of-doors. Indeed, it is well to avoid being out at all after dark or before the sun is high in the morning, or taking long walks or rides before breakfast. All great fatigue or unusual exertion is to be avoided, as are also excesses of every kind. Prophylactic doses of quinine are also to be recommended, one or two grains three times a day. It has repeatedly come within the experience of the writer that in parties of men newly exposed to malarial influences those who took such doses of quinine escaped, while those who refused succumbed to some form of malarial attack.

Treatment during the Paroxysm.—In ordinary attacks of simple intermittent fever no treatment is required during the paroxysm, and the patient may be allowed to follow his own inclinations in the matter of being covered or uncovered, taking hot or cold drinks, having hot bottles applied to his feet, cold cloths to his head, etc. In the more severe attacks, where there is more than ordinary general prostration and distress, or the patient suffers greatly from headache, or pain in the back and limbs, it is a good plan to administer a full dose of opium during either the stage of chill or of fever. This may be either the deodorized tincture of opium or a Dover's powder by the mouth, or, if there is nausea, a hypodermatic injection of morphine.

The effect will be to alleviate the suffering, and, perhaps, to shorten somewhat the first or second stage. A full dose, forty to sixty grains, of bromide of potassium, will answer the purpose if there is not severe pain. In case there is any reason, from the previous history of the patient or the nature of his present attack, as shown by unusually high temperature (over 105°) or grave nervous symptoms, to fear that it may prove pernicious in character, thirty grains of quinine should be given in one dose during the cold, or early in the hot stage. A single large dose is far more effective than repeated smaller ones, and less likely to disturb the stomach and aggravate the headache.

During the Intermission.—The entire treatment of a case of intermittent fever is usually conducted during the intermission, the object of course being to prevent the recurrence of the paroxysm. In some cases where there is a badly coated tongue with sluggish action of the bowels and clay-colored stools, it is well to begin the treatment with a few small doses (gr. $\frac{1}{4}$ to $\frac{1}{2}$) of calomel every two or three hours, followed by a saline cathartic at the end of twelve or twenty-four hours, or ten grains of the pilula hydrargyri, with two or three of compound extract of colocynth, may be given at bedtime. But it is very important that no time should be lost in this preliminary treatment to the exclusion of quinine, for the two can, to the very best advantage, be used at the same time. As soon as one paroxysm is over, it is time to begin taking quinine to prevent the next one. Where the type of the fever has not been determined by the occurrence of more than one paroxysm it is well to assume that it is quotidian, and treat it accordingly.

The full effect of a five- or ten-grain dose of quinine is felt in from two to four hours after its administration. Suppose the chill of a given paroxysm to have begun at 10 o'clock A.M., and the sweating to have ceased at 6 or 8 o'clock P.M. I should have that patient take ten grains of quinine at midnight, ten at 4 A.M., and ten at 8 A.M., and should expect thus to avert the second paroxysm, which would be due at 10 A.M. of that day. If successful in this, I should give no more during that day, but repeat the same programme during the second night. Having thus prevented two recurrences, I would then put the patient on five grains of quinine three times a day for a week, and after that drop to two grains three times a day, which should be continued for a month, if the patient remains in a malarial region. If thirty grains in three doses did not prevent the recurrence of the chill on the day following the first paroxysm, I should mass that amount and give it either in two doses of fifteen grains each, one at 3 A.M. and one at 7 A.M., or in a single dose at 7 A.M.

No one who has tried it can have any doubt with regard to the frequent efficacy of large doses of quinine where smaller ones fail, nor is the discomfort caused by the large dose as much greater as would be supposed. Persons who have lived in a malarial region for some time and taken a good deal of quinine can tolerate, and actually require, larger doses than newcomers. In the case supposed above, it might easily be that in a person who had but recently come into a malarial region, five-grain doses every four hours would have sufficed to avert a recurrence of the chill.

It is perhaps wise to try this, provided one does not adhere to the smaller doses too long if they fail. As to the method that used to be taught in New York twenty years ago, of administering two-grain doses every few hours to break up chills, it is and always was sheer nonsense, as applied to a decidedly malarial country.

There are two plans, then, for the administration of the requisite amount of quinine during the intermission: the one to give it in five-grain doses every four hours, beginning toward the end of the sweating stage, the other to give it in two or three ten- or fifteen-grain doses at the same interval, but so arranged that the last dose shall come two hours before the expected attack. I prefer the latter. Professor Austin Flint, Sr., and most of the older writers lean to the former method; Sternberg rather favors the two-dose plan, but puts his doses too far apart in my opinion (bedtime and morning); Hertz advises one or two large doses shortly preceding the chill time; Bartholow prefers one full dose of fifteen or twenty grains preceding the chill time.

Method of Administration of Quinine.—A solution of quinine is doubtless the most certain method for internal use, but is objectionable on account of its intense bitterness and its liability to cause vomiting. The most practicable and at the same time the most efficient method is to enclose the dry powder in gelatine capsules or in wafers. All ready-made pills are to be avoided, on account of their possible insolubility.

The syrup of yerba santa is the best vehicle for disguising the taste of the drug, and is therefore valuable in case of children or others who cannot swallow capsules.

When rejected by the stomach the drug may be given in enema, double the amount being used here that would be given by the mouth. I have very little faith in the endermic method, or the quinine and vaseline inunctions used by some. The hypodermatic use of quinine, however, has much in its favor. It is prompt and certain in its action, and is sometimes the only method that can be employed. The objection to its use is the considerable danger of abscesses forming at some of the points of puncture. From one-fourth to one-half of the dose ordi-

narily given by the mouth is required by this method. A solution of five grains to the drachm of water, with the addition of a few drops of dilute sulphuric acid (just enough to make it dissolve), is about as strong as it is well to use. (See also the article on Hypodermatic Injections.)

When speaking of quinine simply, one is understood as referring to the sulphate of quinia, the salt in most common use. Other salts of the alkaloid are equally efficacious. The bisulphate is more soluble, so also is the hydrochlorate, though the latter is said by some not to be as uniform in strength. The bromide and the valerianate of quinia are preferred by some on account of the supposed benefit to be derived from their respective acids.

Next in value to the quinia salts are those of the other alkaloids of cinchona, viz., quinidia, cinchonidia, and cinchonia. Their value has been thoroughly tested by several commissions appointed for this purpose in India, the result of whose investigations proves that these are all of equal, or nearly equal, value with the sulphate of quinia. The sulphate of quinidia is equally effective in the same doses with that of quinia, but is very apt to cause gastric distress, vomiting, and purging. The sulphate of cinchonia is effective in somewhat larger doses than quinine, but is also more liable to disagree with the stomach. The sulphate of cinchonidia produces the same effect as quinine, in doses that are twenty-five per cent. larger than those of the latter, without any disagreeable effects. I have myself had considerable experience with the cinchonidia salt, and have obtained thoroughly satisfactory results from its use in five- and ten-grain doses. Used on myself, ten- or fifteen-grain doses are not in any way to be distinguished in their effects from the same doses of quinia.

There is a good deal of talk among the laity about intolerance of quinine in certain persons. Undoubtedly the degree of susceptibility to the drug, and especially to its unpleasant effects, differs greatly in different persons, but I have never found anyone to whom I could not give what was to them an effective dose, provided I could conceal from them the knowledge of what they were taking.

The remedy next in rank to the cinchona alkaloids in the treatment of intermittent fever, though far below them, is *arsenic*. It is more effective in cases of chronic malarial cachexia, and is very valuable, when used in combination with quinine and iron, in all old and obstinate cases of intermittent fever. It has, however, also been successfully used alone in the treatment of acute cases, especially by some French physicians. They give as much as half a grain of arsenious acid in solution in the course of a day, during the intermission, with very good results. The same treatment has been successfully employed in India, care being taken to select patients with no gastric or intestinal irritation. It is important that the remedy be used largely diluted, and where desirable it may be combined with small doses of opium. As a rule, its action in preventing the recurrence of paroxysms of fever is much slower than that of quinine.

A few years ago the *Eucalyptus globulus*, an Australian tree, threatened to dispute the palm with the cinchona family as an antimalarial remedy. The leaves of the tree are the part used, and either a tincture or an alcoholic extract of the same is prepared. Various conflicting reports have been made by equally good authorities on the value of this remedy in intermittent fever. That it will cure a certain proportion of cases, and do so promptly, there can be no doubt, nor do there seem to be any ill effects following its use. I have had no experience with the drug, and the data at my command do not justify me in recommending its use as long as the cinchona products are so effective and so cheap.

Iodine has also been highly lauded as an antiperiodic in malarial affections. Ten to fifteen drops of the tincture, in half a glass of sweetened water, three or four times in the twenty-four hours, will undoubtedly sometimes cure intermittent fever. This is worth remembering if one is where no quinine is within reach. I believe that the administration of iodine in this form, or in liberal doses of some of the iodides, is of great value in chronic malarial infection, with its accompanying enlargement of the spleen.

Many other remedies have also been lauded as specifics in intermittent fever, and some of them doubtless are of real value; but it is not worth while to give space to them all in this work.

Masked Intermittents.—Under this head fall a variety of obscure affections, usually non-febrile in character, having a distinct periodic recurrence, and being curable by quinine. Prominent among them are periodic neuralgic attacks, usually in the form of one-sided supra-orbital or infra-orbital pain, with throbbing of that side of the head; sometimes a one-sided conjunctivitis and swelling of the lids. After a few hours all these symptoms will entirely disappear, to recur again regularly in quotidian or tertian form. Or the pain may be along the track of the maxillary nerves, superior or inferior, or of the sciatic or the intercostal nerves. In the latter case both patient and physician may suspect pleurisy, and flatter themselves they have cured it, until, on the second or third day, it promptly recurs.

Many other nervous disturbances, as choreiform seizures, temporary paralyses, etc., occur with periodic regularity in malarial regions, and yield to treatment by quinine. Although some authors protest against it, the conclusion is very natural that such attacks are of malarial origin. I have myself seen a well-marked case of amnesic aphasia in a young man, which occurred regularly on the afternoon of every other day three times, after which he was put on ten-grain doses of quinine, three times a day, without any further recurrence of the trouble. There was no apparent rise of temperature in his case, although the thermometer was not used, and he felt in general good health.

In all such cases, and many others that cannot be here enumerated, the entire absence of all symptoms during the greater part of the time forbids the thought of any organic lesion, while the regular periodic recurrence of these symptoms, and the fact of their yielding to anti-malarial treatment, is proof enough of their malarial origin. Here, too, as in the chronic malarial poisoning spoken of above, the best results can often be obtained by treatment with a combination of arsenic, iron, and quinine, the proportion of the latter to be increased until the result is attained.

Pernicious Intermittents.—In a certain number of cases the malarial poison acts upon the nervous centres in such a way as to cause the most profound and dangerous nervous disturbances—coma, syncope, etc.—or to cause serious congestion and disturbance of other organs, such as the lungs or abdominal viscera. These cases either terminate fatally in the first paroxysm, or the dangerous symptoms recur with even greater violence in a subsequent paroxysm, which is almost sure to prove fatal. Hence they are appropriately called pernicious intermittents. In the nomenclature employed by the Medical Department of the United States Army all the varieties of pernicious intermittents are grouped under the name of "congestive intermittent fever," and in common parlance they are called "congestive chills." The line, however, should be sharply drawn between these acute, fulminant attacks, which are properly called pernicious, and those inflammatory complications which may arise in any intermittent fever, as pneumonia or entero-colitis, and carry off children, the aged, or the enfeebled.

In some cases pernicious intermittents seem to be directly traceable to unusual exposure to malaria on the part of the individual, as, for instance, by sleeping out of doors, or being engaged in turning up the soil in some intensely malarial region. More frequently, however, such exposure, especially in those unacclimated, will result in pernicious *remittent* fever, while pernicious intermittent paroxysms attack those who have already given evidence of malarial intoxication in a milder form.

In the majority of instances there are no prodromal symptoms of the pernicious attack, but it either strikes the patient like lightning out of a clear sky, or else it follows a few simple intermittent paroxysms. Sometimes,

however, the paroxysm preceding the pernicious one is said to be unusually severe, or the pernicious attack is immediately preceded by unusually severe headache, drowsiness, convulsive twitchings, or incessant vomiting.

The most common form of pernicious intermittent is the *comatose* or *apoplectic* form. This is rather more liable than some of the other varieties to be preceded, during the intermission, by drowsiness, hebetude, or severe headache. The chill may be more or less complete. During the hot stage the patient falls into a stupor or coma. He lies there with flushed face, pupils dilated and fixed, breathing stertorous, pulse sometimes fast and sometimes slow, muscles completely relaxed, skin dry and hot, temperature in the axilla 104° or 105° F.

This may last for six, twelve, or twenty-four hours, sometimes even for several days, the pulse and vital forces failing until the patient quietly ceases to breathe. Or at the end of a certain number of hours he may gradually rouse himself, confused in his ideas, still complaining of headache, perhaps even confused in speech, and with paresis in some one of his extremities, all these symptoms, however, gradually disappearing during the intermission.

Instead of pursuing the course described above, the coma may be preceded by violent delirium, even mania. Or the delirium may end in sudden collapse and death, or in sleep and recovery without the supervention of coma. Again, in other instances there will be nervous manifestations showing the involvement of the spinal cord as well as brain, such as clonic or tonic forms of spasm, of the eclamptic, epileptic, or tetanic variety. The more varied and violent the forms of nervous disturbance the more unfavorable the prognosis.

Two forms of attack, which are found especially in tropical climates, are the *choleraic* and *dysenteric*. In the former there are burning thirst, severe vomiting, watery stools, cramps in the calves of the legs, finally collapse, and death with all the signs of asphyxia. In the dysenteric form serous, mucous, and bloody stools occur during the paroxysm, and disappear during the intermission. This is not so dangerous, and is often met with in this country.

The *cardialgic* form is that in which the paroxysm is accompanied with severe, burning, contracting pain in the region of the stomach—enough to make a strong man scream—usually occurring during the stage of chill. After its subsidence, or after relief has been obtained by opiates, the rest of the paroxysm pursues the ordinary course.

An interesting form of attack is that called by Hertz *intermittens perniciosa pneumonica*, though its gravity would hardly seem to warrant classing it among the pernicious forms. He says ("Ziemssen's Cyclopædia," vol. ii., p. 611): "During the chill and the hot stage the patients are seized with dyspnœa, they cough much, without expectoration, and complain of the most violent pain in the breast. The pulse soon becomes full, rust-colored sputa appear, dulness on percussion and increased vocal fremitus are manifest, while auscultation reveals at first crepitant rhonchi, then bronchial breathing and bronchophony. During the sweating stage a decided remission of the fever takes place, as well as an abatement of the symptoms, subjective and objective, which may almost entirely disappear during the intermission that follows. In case of a renewed paroxysm, however, of the quotidian or tertian type, these symptoms will recur. The infiltration will now increase somewhat in extent, and remain stationary during the intermission. . . . If timely recourse to treatment by quinine is neglected, these cases are apt to end fatally at about the fourth or sixth paroxysm."

I have seen similar cases myself in this country, presenting all the symptoms and signs given by Hertz, excepting the rusty sputa and the well-defined, circumscribed dulness on percussion. The crepitant râles were very distinct and unilateral, disappearing entirely after the abatement of one paroxysm and reappearing with the next one, which was also marked by a distinct chill. I was of the opinion that it was catarrhal rather than croupous pneumonia, the more so as all signs of it disappeared under liberal doses of quinine.

Hertz has also seen a pleuritic form, with distinct friction sound coming and going with the paroxysms.

One more variety remains to be considered, viz., the *algid intermittent*, a very grave form, chiefly confined to the tropics. The attack begins with the usual chill, which is not specially prolonged nor severe. During or after the hot stage, the patient grows as cold as marble (the temperature in the mouth falling to 86° or 88° F.), while at the same time he complains of burning heat within, and of thirst. The skin is pale or livid, and covered with a cold sweat, the pupils are dilated. The pulse is very slow and often irregular, respiration is also very slow and shallow. Consciousness is maintained perfectly almost up to the moment of death, the patient does not suffer at all, and seems strangely indifferent to his surroundings and his danger. Convalescence is said to be very slow, while death often occurs in the first or second attack.

The pathological anatomy of these different forms of pernicious intermittent has been sufficiently indicated in the paragraph on that subject under the head of simple intermittent. There is still a good deal to be learned on the subject.

As regards *treatment*, while individual symptoms may be handled on general principles, the essential thing for the life of the patient is that he be immediately and profoundly brought under the influence of quinine, and be held there for several days. To this end it is well, and often absolutely essential, to begin its administration immediately, as soon as the patient is seen, during the very height of the paroxysm, whatever it may be. Fifteen- to twenty-grain doses of quinine by the mouth, every four to six hours during the first day, or two days, will not be too much. Owing to the frequent inability to swallow, or to the vomiting, as well as owing to the great importance of having the drug promptly absorbed, these are the cases in which the hypodermatic injection of quinine is of the utmost value. Five, ten, or fifteen grains may be injected under the skin according to the urgency of the case, and repeated every few hours until the patient is able to take it by the mouth. The practitioner who fails to recognize the real nature of the case before him—that is, its malarial nature, and who goes on to treat apoplexy, or "fits," will lose his patient.

Chronic Malarial Infection, or Malarial Cachexia.—This is a condition very often met with in malarial regions; sometimes in those who have suffered with innumerable paroxysms of intermittent fever, sometimes in those who have never had a chill, but have long been subjected to malarial influences.

Persons so affected may complain of every imaginable symptom known to medicine, but they will almost all agree in the following: loss of appetite, a bad taste in the mouth, indigestion, a constant sense of weariness, unrefreshing sleep, dragging pains in the loins or small of the back, shortness of breath on exertion, and vague pains in the joints or muscles of the extremities. Their bowels are usually regular. Such persons are usually more or less emaciated, pale, and sallow. The pulse is a little rapid, there is no elevation of temperature, and generally there is nothing periodical about the case. The spleen is usually enlarged and somewhat tender on pressure, or may even be spontaneously painful in certain positions of the body, or after lying in one position for some time. In the severer forms the sallowness is greater, amounting to actual jaundice, the urine is scanty and often icteric, the bowels are irregular, the abdomen is often greatly distended, and finally there may be œdema of the face and extremities, while the general feebleness of the individual and his cachectic appearance are most marked.

Much more might, and perhaps should, be said on this subject, but I must content myself with only a few words concerning treatment. Many such cases still need quinine along with their other treatment, but most of them will be found to have lived on this drug for years, as well as to be thoroughly familiar with the domestic use of calomel or blue mass, and various cathartic "liver pills." They will, however, be greatly benefited by the judicious

administration of arsenic in ordinary, not in antiperiodic, doses, combined with iron and nux vomica, or by the use of the mineral acids, especially the dilute nitro-hydrochloric acid. Iodine preparations also do them good for a while. Eucalyptus is said by Bartholow to be more valuable in malarial cachexia than as an antiperiodic. Care must be taken to aid the digestion, and to insure a sufficiently varied and nourishing diet. Above all things, if possible, such people should be induced to move away, even if only for a time, and if only for a short distance, from the place where they have become thus contaminated with malaria. *Edward W. Schauffler.*

[1] George M. Sternberg, M.D., F.R.M.S., etc.: Malaria and Malarial Diseases. New York: William Wood & Co. 1884. [2] Op. cit., p. 138.

INTERTRIGO (*inter*, between, and *tero*, to chafe). A skin affection produced by the rubbing or chafing of contiguous surfaces. The disease is a form of erythema. It is apt to occur in fat persons and children, and is commonly met with in the axilla, neck, groin, between the thighs, and about the genitalia, in both men and women. Sometimes the irritation gives rise to the exudation of a fluid, partly perspiration, whose acridity increases the local mischief; and presently an offensive raw surface is produced, giving out a muciform or puriform fluid. Intertrigo simulates eczema, but the origin is evidently from the friction of two surfaces; the secretion is not that of eczema, it is thin, muciform, stains, but does not stiffen, linen, and results from a mucoid degeneration of the tissues (T. Fox).

The treatment of intertrigo consists in a separation of the opposing surfaces, thorough cleansing, and the application of black wash or some mild astringent ointment. Powders often disagree, especially if there be any discharge. *Arthur Van Harlingen.*

INTESTINAL OBSTRUCTION; PATHOLOGY. Syn.: Ileus; Fr., Occlusion intestinale; Ger., Darmverschliessung.

Under this term are included all those cases in which the contents of the intestinal canal are obstructed in their onward passage by causes or conditions arising within the abdomen or pelvis.

This condition, the old name for which was ileus, is one which was recognized even by the oldest writers. Other names, having reference to the suffering accompanying it, were passio iliaca, miserere, etc. Before a knowledge of pathology existed, the term was applied indiscriminately to all cases presenting the well-marked indications of sufficient obstruction to the onward flow of the intestinal contents. Subsequently, however, it was found that a great many very different conditions were capable of giving rise to the symptoms of ileus. Thus, with advancing pathological observation, definite classes have been made having a distinctive anatomical basis, and to which special designations have been given. At the present day, with a case before us in which we recognize the existence of an obstruction, we endeavor to go still further, and to ascertain, as far as possible, the location, the cause, and the nature of the trouble. As will be realized from the remarks to follow, to accomplish this is, in some cases, not difficult; in others it involves the highest knowledge and acumen, and in not a few is really impossible.

Impermeability of the intestinal canal is sometimes congenital. The most common cause for this consists in improper development of the fœtus, resulting in atresia of some part. That most frequently affected is the region of the anus and rectum. The usual varieties are, a complete rectum with the integument continuous where the anus should have been formed, and, secondly, the rectum terminating in a blind pouch at a greater or less distance from a properly formed infundibulum for the anus. These conditions are treated of more at length elsewhere. Congenital atresia has also been found in the large intestine (specially at the sigmoid flexure), and much less frequently at certain points in the small intestine—in the duodenum oftener than in any other locality. In the majority of these cases, a fœtal peritonitis has played the part of originating cause.

Exclusive of such congenital cases, the most convenient classification is that based upon the anatomical cause. Thus we may distinguish three principal groups:

I. *From compression*—the canal more or less completely obliterated by pressure from without.

II. *From obstruction*—the canal blocked up by obstructions within its lumen.

III. *From constriction*—obstruction by causes which, starting from or involving the wall of the intestine, narrow the lumen of the canal, either directly or by accompanying distortion.

I. Obstruction to the Intestine by Compression from Without.—Under this heading we would include all those conditions of so-called "internal strangulation of the intestine."

It is curious to observe the extraordinary ingenuity which seems to be exercised by the bowels in finding various ways of developing an obstruction. Thus, most complicated lists of the varieties of internal strangulations are to be found in the large works upon the subject. A great many, however, are of purely anatomical interest, and they can all be made to fall within a few classes, in each of which the mechanism of the occlusion is similar. The following division is mainly founded upon that adopted by Mr. Frederick Treves in his recent monograph upon intestinal obstruction.

1. Strangulation by peritoneal false ligaments and cords formed from the omentum.
2. Strangulation by diverticula.
3. Strangulation by normal structures abnormally attached.
4. Strangulation through slits and apertures in the mesentery, omentum, or peritoneal bands.

These internal strangulations, like those met with externally in hernia, almost always affect the small intestines. The symptoms produced are practically the same in the whole group, and are those characteristic of the strangulated hernia of the surgeon—the only difference between the two being that, in the one case, the obstruction takes place entirely within the abdomen, and in the other at or near one of the external openings.

1. *Strangulation by Bands.*—It is common enough to find cords or bands traversing some part of the peritoneal cavity. These have been formed most commonly during, or rather subsequently to, attacks of subacute or chronic peritonitis, principally localized in some particular region. They may, possibly, in some cases, be congenital. The *modus operandi* by which they follow upon an attack of peritonitis is sufficiently obvious. The plastic exudation everywhere poured out induces soft adhesions of parts which may have happened to be brought together—different knuckles of intestine—a knuckle of intestine and the internal surface of the belly—a point of the bowel and some solid organ, etc. As the inflammation subsides, movements become more vigorous and extensive, and parts previously approximated may thus become once more widely separated, with the result of drawing out the plastic matter into bands or cords, which finally become tough and resisting. The existence of such bands is a standing menace to the safety of the complicated intestinal tube in its constant peristaltic windings. These ligaments are of all possible thicknesses, being sometimes not larger than fine whip-cord, in rarer instances, as large as the little finger. They sometimes present the appearance of broad, flat bands. It is the rule to find one ligament of this kind only, although, of course, numerous old adhesions are likely to exist at the same time. By means of these bands or ligaments, then, a portion of bowel may become incarcerated or strangulated, generally in one of two ways—either by slipping beneath the false ligament, or else by being caught in a noose or loop formed by it.

Strangulation under the false ligament. In this case, it is necessary that the ligament be not too long, and that it be stretched along some part, such as the posterior abdominal wall, the brim of the pelvis, etc., which is firm and resisting. Strangulation will seldom occur if the

arch thus formed be large enough to admit more than two, or at most three, fingers. The strong mesentery, or a lump of adhesions, or a solid organ (as the uterus), sometimes affords the required basis for the compressive action of the band.

Strangulation by loops, or nooses. For this occurrence the ligament must be long and (sometimes, at least) loose, and attached by its two ends only. When these conditions exist, a knuckle of intestine can keep slipping past the noose without becoming caught. If, however, a loop be projected stiffly forward by reason of some adhesive inflammation at its base, then the noose has a much better hold, slipping back is prevented, and actual strangulation occurs. It is thought that this is the real explanation of many of these cases. The plainest knot consists in the formation of a simple ring upon the lax band, through which the loop is forced and becomes jammed. The same result is brought about by a loop of the bowel falling over a loose cord, twisting round, and then becoming straightened out; for the effect of this is to cause the knot thus produced to firmly encircle the neck of the strangulated part. These are the simplest forms. Owing, however, to the complicated movements of the parts to which the bands may be attached, it is possible to have a variety of peculiar knots formed—fuller description of which does not seem called for, the results being in all cases identical. The omentum itself, sometimes bands stretching from the omentum, may cause strangulation in exactly the same way as that just described. As a result of inflammation, the omentum may be rolled up into a thick, solid cord, which may prove to be the strangulating medium. Omental ligaments are much coarser and thicker than the bands resulting from peritoneal adhesions. Such omental ligaments may result from a pelvic peritonitis having attachments about the pelvis, or from typhlitis with attachments in the iliac fossa; but the most common cause of omental adhesion is peritonitis about a hernia (especially femoral). Thus the most frequent point of attachment of an omental band is about the femoral ring.

2. *Strangulation by Diverticula.*—The typical diverticle, and the one usually met with, is the so-called Meckel's. This is situated at an average distance of from one to three feet above the ileo-cæcal valve. It is always situated opposite the mesentery, and has all the layers and other characteristics of the small intestine. Its depth varies very much—from a mere shallow, blunt projection to as much as ten inches, the average being about two and a half or three inches. Its end is usually free, but sometimes it continues as a solid cord which normally terminates at or near the umbilicus. Occasionally the parietal termination would seem to have become free, and to be then left to float loosely within the abdomen. Such a loose cord may again acquire a fresh attachment to almost any part. Strangulation may occur beneath these, exactly as in the case of the ordinary peritoneal bands before described, or they may form snares or knots, just as the latter also incline to do, through which incarceration may take place. A peculiar possibility with these structures is the twisting up of a loose-ended diverticular band. This is probably feasible only when the ligament in question is furnished, as not very rarely happens, with a pretty considerable rounded or clubbed extremity, which is capable of holding the knot firmly when it becomes accidentally folded inward. These bands may also cause strangulation by kinking, or by the effects of traction. The mechanism of the latter processes will be alluded to later on.

3. *Strangulation by Normal Structures Abnormally Attached.*—The commonest form falling under this head is that in which the appendix vermiformis has become fixed by its free end to the cæcum, ileum, ovary, etc. It is said that a very long appendix may even be wound round in a spiral fashion, through which helix the hernia may be thrust. A Fallopian tube may serve a similar purpose, and a portion of mesentery may be so fixed as to form a narrow arch against the posterior wall of the abdomen.

4. *Strangulation through Slits or Apertures.*—Slits in the mesentery are most common in the portion attached to the lower ileum. From what has been actually observed of the results of traumatism, it is inferred that in a great many cases where such slits or rents are observed they are to be traced to some previous injury. Some may be congenital. They vary in size from a very small orifice to a tear large enough to admit several fingers. These remarks apply as well to the rarer cases in which the omentum is similarly affected. Perforations at the base of an appendix epiploica, and through the broad ligament of the uterus, have both been known to have caused incarceration of intestine.

There still remain to be mentioned some other conditions which differ slightly from the typical ones just described, but which equally produce strangulation or a more slowly occurring obstruction of the bowel. Thus it occasionally happens that some heavy coils of intestine will *fall over* a tight ligament, and become strangled by their own hanging weight. What is known as "acute kinking" is brought about by a false ligament continuing to contract and thus to drag upon its point of attachment to the bowel. This occurs most frequently in connection with the diverticular ligaments. If a point of the bowel be adherent to the abdominal parietes and to the solid viscera, the point thus fixed may become the apex of an acute angle into which the tube becomes bent. Acute bending in this way may be the cause simply of delay in the propulsion of the contents, or it may eventuate in a complete obstruction. It is liable to occur in connection with old herniæ which have been reduced, and with operations within the abdomen. Acute bending is also the principal cause of obstruction in those cases where opposed surfaces of the same loop of intestine have become fastened together and, being thus fixed, impermeability has resulted.

As with herniæ in general, so with these internal strangulations, the part involved is almost invariably the small intestine. The recorded cases where the large bowel was involved are extremely few. The obvious reason for this is that the conditions requisite for strangulation to take place are the capability to form a loop, or knuckle, and free mobility—which conditions are not fulfilled by the large intestine, except occasionally in the sigmoid flexure. The ileum (especially its lower part) is the section most frequently implicated, and the danger decreases in rapid proportion as we pass upward from this part toward the duodenum, where it may be considered *nil*. It is the ileum, whose coils lie habitually low down toward the pelvis, and are in the vicinity of the cæcum and appendix, which is thus most frequently involved by the results of the inflammatory processes that are notoriously common in this locality. From it also springs the Meckel's diverticulum, which is a frequent source of trouble.

The amount of bowel which is strangulated varies greatly. Where an overlying ligament or a small slit is the cause, the knuckle is often very small. Where nooses or knots have become tied up, they may have included very extensive segments of the intestine.

The *modus operandi* of these different conditions in producing obstruction no doubt varies. Sometimes a violent effort will suddenly force a portion of intestine beneath the neck of a ligament or band. Here, as in hernia, the obstruction is instantly produced, and the symptoms are at once developed. When, however, a segment has been invested by a noose or knot, this may not be sufficiently tight to cause obstruction at first. The effect, however, of the partial constriction is to give rise to secondary changes which, in a short time, tighten the ligature and equally obstruct the lumen. Congestion is set up, which swells the walls of the tube; gases collect and distend it; fæcal matters pass into it from above and cannot escape downward; increased peristaltic movements are excited, which are liable to twist it at the fixed point.

Volvulus.—The conditions requisite for the production of a definite twisting of the bowel upon itself are such that it is very seldom met with, except at the sigmoid flexure. Here the bowel may either be twisted round upon its mesenteric attachment (which is the commonest), or it

may be bent round a neighboring coil of the small intestine. The longer the sigmoid loop and the smaller the mesenteric root, the more liable is this to occur. It by no means follows that occlusion must result from such twisting, and indeed there can be little doubt that this has often occurred, yet again righted itself. But if other forces come into play to prevent this, then the volvulus remains fixed and impermeability results. The chief of these are an unusual size and weight of the flexure caused by constipation of some standing, leaving it full of fæces and distended with gas. Gases will also collect above the point of a partial obstruction, the pressure of which still further prevents the straightening of it out. Twisting of a section of small intestine is very rare. The mechanism by which this takes place is essentially the same as that which applies to the sigmoid flexure. A portion of mesentery becomes stiffened by chronic inflammation, thus throwing forward a section of the tube upon a stem which, under favorable circumstances, is capable of being twisted round. A profuse diarrhœa has been noted in several of these cases as the immediate or direct cause of the accident.

Other forms of twisting which remain to be mentioned are the following: Intertwining or knotting of two intestinal loops. This is usually a twisting up of the sigmoid flexure with a coil of the ileum. The former must be of unusual length, and the latter must have a mesenteric attachment more than commonly loose, permitting free motion to the coil. The ileum then falls across the flexure, and by the subsequent movements a firm knot is tied. Another form is that of twisting, not around the mesenteric attachment, but around the longitudinal axis of the bowel itself. This accident is sufficiently rare, and is confined almost exclusively to the cæcum and ascending colon, where the mesocolon has permitted of an unusual degree of mobility. The striking feature of these cases has been the enormous distention of the cæcum, which often fills the entire mesogastrium.

Intussusception or Invagination.—This process consists essentially in the slipping of one part of the intestine into the part immediately adjoining. Protrusions of this kind through the ileo-cæcal valve are in every way represented by what is so commonly seen in young children under the name of prolapse of the rectum. In other parts of the canal the procedure may be compared to the inversion of the finger of a glove. Intussusception is common compared with other causes of intestinal obstruction. It is estimated that it furnishes one-third of all the cases. The necessary result of pushing one portion into its neighboring section is to give an inner tube contained within an outer tube, so arranged that everywhere mucous membrane is opposed by mucous membrane, and serous membrane by serous membrane. For convenience of description, the external layer is often called the sheath, or intussuscipiens; the innermost layer, the entering layer; and the middle, the returning; the whole contained part, intussusceptum. Invagination may occur at any part of the intestine, but has certain well-recognized favorite localities. The varieties may be thus divided on this ground: (1) Enteric; (2) colic or rectal; and (3) ileo-cæcal. The enteric are most frequent in the lower part of the jejunum and in the ileum, being of extreme rarity in the upper parts of the small intestine. The colic invaginations may occur at any part of the great intestine, but are most frequently met with in connection with the transverse and descending colon and the sigmoid flexure. Those which occur in connection with the ileo-cæcal valve are of two kinds, ileo-cæcal proper, and ileo-colic. The ileo-cæcal is very common, the ileo-colic very rare. In the former case the valve forms the apex of the intussusceptum, and is pushed forward by a mass of ileum behind it turning in the cæcum, and perhaps the colon, as it advances. In the latter the ileum becomes inverted through the ileo-cæcal opening, and the apex is formed by a part of the lesser bowel itself. When once an invagination has occurred, it continues to grow by continually drawing upon the outer layer or sheath. In this way, whatever point has originally formed the apex of the intussusceptum will remain so to the end, no matter even if the inturned mass become many inches or feet in length. The best example of this is seen in cases of the ileo-cæcal variety, where the valve, as the point of the invagination, may traverse the whole length of the colon, and finally make its appearance through the anus. The most marked exception to this statement is found in the ileo-colic variety, where, as already stated, the process resembles that of rectal prolapse, more and more of the ileum dropping through the ileo-cæcal valve, and adding to the mass in the colon.

A special form of in-bending of the bowels is frequently met with at autopsies, where there have been no symptoms of obstruction. These are called the invaginations of the dying, and are supposed to occur during the irregular muscular actions of the agonistic period. They are most common in children, especially those who have died from affections of the central nervous system. No difficulty is experienced in separating these from true obstructive invaginations. They are always very small, are free from any trace of congestion or inflammation, interfere little with the lumen of the bowel, and can be reduced by being lightly drawn out.

The changes in position of a portion of bowel becoming invaginated are materially influenced by the attachment of the mesentery. This, at first, is much dragged upon, but as the inversion proceeds the traction is less than might be supposed, because in reality the mesentery acts as a radius, taking the vertebral column as its fixed point. The effect of the mesenteric fastening is to bend the intussusception from a straight line, throwing its convexity against the outer side of the sheath. The mere sliding of one portion of bowel into another (often much larger one) will not necessarily occlude the lumen materially, but whenever this takes place it brings in its wake such other disorders as will more or less surely and rapidly lead to complete, or at any rate very definite, obstruction. The compression of the vessels causes congestion, œdema, and inflammation, which will swell the invaginated part, and the bending of the intussusception, already alluded to, may of itself be sufficient to obstruct the inner tube. At first an invaginated portion of bowel can be withdrawn without difficulty; after a time, however, in almost any case, this becomes impossible of accomplishment, *i.e.*, it has become irreducible. Such incarceration of the displaced bowel is the result of various changes in the parts. The chief one of these is the formation of adhesions. The time at which these form is very various, as sometimes none has been found even after the trouble has existed for a considerable time; but there are generally extensive adhesions in all cases which might be classed as chronic. Among other possibilities giving rise to irreducibility might be mentioned great bending of the intussusceptum, peculiar twisting or contortion of the same, and such swelling and thickening of its extremity as must prevent its extrusion. The presence of a polypus at the apex will have the same effect. Very great fæcal accumulations above the invagination are not generally seen, because the obstruction is always imperfect for some time, permitting of the passage of some of the fæcal matters. The sheath not uncommonly shows the result of injurious pressure and vascular disturbances in the shape of ulceration, and sometimes gangrene with perforation. The intussusception becomes the subject of severe structural alterations. In the more acute cases there is great congestion and œdema, with hæmorrhages into the tissues, and very frequently there is actual gangrene. In the more chronic, there is infiltration with much thickening of the layers of the cylinder, owing to persistent inflammation of a low type. The swelling is often much greater at the apex than elsewhere, owing to the great compression of its vessels and its freedom from counterbalancing pressure. The most radical and most important change is gangrene. Gangrene is more common in acute cases, although it has been observed in chronic also. By this means the entire intussusception may be separated at its neck, and even ultimately thus discharged by the bowels. The portion of bowel thus separated may measure even several feet in length. It

sometimes makes its appearance with the serous surface outward, sometimes with the mucous. It seems pretty certain that, in the former case, the bowel did not unroll itself after complete separation, but that, during the process of consecutive separation of the layers, the result naturally produced was inversion of the invaginated part. If the gangrenous process begin at the apex it will probably spread and destroy the intussusception, which then passes away in an unrecognizable form in the shape of shreds and fragments. It is in chronic cases that this is most frequently found.

As regards the causation of intussusception, the point most clearly demonstrated is that it depends essentially upon irregular action of the muscular wall of the intestine. The commencement of the formation of an intussusception is made by a portion of narrower (contracted or spastic) bowel being projected into a wider (dilated or paretic) portion below. To accomplish this it would seem to require only a slight exaggeration of the occurrences which actually take place during normal peristalsis. Among the circumstances which might lead to such an exaggeration are to be mentioned the following: Considerable distention by gas of a section of the bowel toward which the contractile wave is travelling; fixation from any cause of this distended part, so that it cannot be pushed along; and then, lastly, during the existence of these conditions, some muscular effort involving the abdominal parietes. At first the extent of bowel involved is always quite small, but owing to the excited peristaltic movements it rapidly increases, chiefly by the inversion of more and more of the outer layer. Continuous prolapse of still more bowel from above also adds to the mass, but in almost every case this is found to play a very subordinate part to the dragging over of the intussuscipiens.

II. Obstruction of the Intestinal Canal by Foreign Bodies.—*Obstruction by Gall-stones.*—It would, at first sight, appear absurd to expect a gall-stone to be the cause of blocking up of the intestinal canal. That an object which was capable of passing along the comparatively minute ducts leading from the liver should be sufficient to obstruct the far greater canal of the intestine, would seem very surprising; but the elasticity of the gall-ducts must be allowed for, as stones of very considerable diameter can pass through them. Moreover, if a stone of great size be arrested in these ducts, it may in time ulcerate through, and thus escape into the intestine. At any rate, very large gall-stones, finding their way into the bowels, can usually be safely passed through them, and finally evacuated. A recent case occurred to the writer, where a young woman, with persistent jaundice and hepatic pain, developed symptoms suggestive of local inflammation and ulceration—among other things, a highly septic condition. After months of suffering, a gall-stone measuring one and a half inch in diameter was passed per rectum, and a complete recovery ensued. In exceptional cases, however, such a stone may become arrested, and cause symptoms of partial obstruction—again move onward and recovery ensue—or it may cause a complete obstruction. If this is persistent, it is fatal; but, not seldom, the obstacle is removed even after severe obstructive symptoms have lasted for some time. The shape of the stone is of importance, as, of course, a long and narrow one will pass easily, while a circular or square one of similar weight might be caught and stuck fast. The most frequent location for an impacted gall-stone is close to the ileo-cæcal valve, where the intestine undergoes a marked diminution in its calibre and is more steadily fixed by its short mesentery. If it pass this spot and reach the colon, it may even yet be once more arrested in the curves of the sigmoid flexure. In the latter situation it might cause symptoms of temporary obstruction, but a fatal event from this cause has only been known to occur when the stone lay in the small intestine. There is nothing special in the symptoms arising from this form of obstruction. They are those of rapid onset and acute character if the impaction be high up, and less acute and severe according as it is seated lower down in the canal, and as the process of closure takes place more deliberately. Lodgment of a stone may take place soon after an attack of hepatic colic, or not for even several weeks after. In those cases which do not prove fatal, the stone usually passes per anum; but relief may be afforded in other ways. Suppurative inflammation may be set up, and through the fistula thus established the calculus be discharged.

Obstruction by Intestinal Stones.—Enteroliths are among pathological curiosities. They have been found in the cæcum, in the sacculi of the colon, and in the rectum. The one most frequently met with is composed chiefly of phosphates mixed with a small amount of organic matter. There may be but one or several. What are called oat-stones are solid but light bodies, composed of the closely felted fibres and husks of oats, and such like rough vegetable food, smelted together with a certain amount of phosphates. The long-continued use of certain mineral drugs, especially magnesia and chalk, may also cause firm masses of residue to remain in the intestines. Obstruction by intestinal stones is very rare. The presence of these formations is generally associated with emaciation and vague abdominal symptoms, and it is only after these may have lasted for a long time that actual obstruction is likely to be declared.

Obstruction by other Foreign Bodies.—Insoluble substances which may have been swallowed are apt to become glued together and form masses of considerable size. Of these may be mentioned grape-skins, fruit-pits, rinds, etc., also scraps of bone, and hard things of that kind. Foreign masses are quite capable of causing temporary occlusion and no doubt many of the cases of supposed recovery from ileus have been occlusions by a removable cause of this kind. If they be delayed very long at one part, they are liable to cause ulceration with its resulting cicatrization, and hence may play a causative part in the development of subsequent cicatricial contraction of the intestine.

Obstruction of the Intestinal Canal by Fæcal Masses.—Ileus paralyticus. As implied by the latter term, the necessary factor in this case consists in a want of proper propulsive power on the part of the intestine. If this loss of power become complete in a section of the bowel, then a true obstruction occurs with the attendant symptoms. In the paralyzed section fæcal matters go on collecting, and finally form a solid plug which no effort from above will be sufficient to dislodge. The intestine above becomes dilated and below contracted, both of which conditions still further confirm and aggravate the mischief. The irritation of the presence of these masses produces very commonly ulcers, which are found both in the cæcum and colon and in the ileum. From the unhealthy action at the bases of these, chronic peritonitis is set up, which also helps to disturb the normal state of things. Ileus paralyticus is most common in the large intestine. Fæces are naturally delayed in the cæcum and ascending colon, and while here become solidified. If, therefore, from prolonged constipation (or other cause) an obstruction is experienced at the rectum or sigmoid flexure, the parts at the commencement of the large bowel will be much distended, for the ileo-cæcal valve will remain perfect, and they will be called upon to bear a further strain from the constant additions to their contents made by the still active ileum. The quantities of fæces that may then accumulate within the great intestine are truly amazing—reports of masses weighing ten or fifteen pounds being apparently quite authentic. The causes of chronic constipation are very various. Hereditary tendency, want of exercise, undue solidity of the fæces, deficient nervous influence, as in hypochondriasis and other nervous disorders, etc. Other conditions, also, having an influence in this direction, are related to the actual state of the bowel itself. Thus we may meet with infiltration from peritoneal inflammation—weakening from chronic intestinal catarrh—and displacements of the large intestine (such, *e.g.*, as the M-shaped colon or unduly tortuous sigmoid flexure).

III. Obstruction to the Intestine from Constriction.—This class may be held to include all morbid conditions of the bowel which have led to a definite

narrowing of its lumen. The term will, therefore, take in cicatricial narrowings and all the various forms of neoplasm, together with narrowings the result of old peritoneal adhesions. The word stricture is very commonly applied to most of these cases, and the strictures are divided into two great classes, the cicatricial and the cancerous.

Cicatricial Strictures.—The contracting fibrous tissue which replaces the solution of continuity resulting from an ulceration or a local gangrene, will necessarily, if favorably disposed, produce a certain degree of stenosis of the bowel. Everything will depend upon the extent and situation of the originating lesion. A small patch of ulceration placed longitudinally can have but very little contracting effect, while, on the contrary, one of similar dimensions placed transversely may greatly, or almost completely, occlude the tube when cicatrized. The worst cicatrices, therefore, are those which are annular; the least injurious those which occupy the long axis of the bowel. The principal forms of intestinal ulceration which cause stricture are the dysenteric, the typhoid, the catarrhal, and the tubercular.

Dysenteric ulceration often ends in stricture. Naturally, it is the deep ulcerations of the diphtheritic form, either epidemic or sporadic, which are most prone to form strong, contracting cicatricial bands. These may exist at several points. Corresponding with the usual localization of the diarrhœal process, this form of stricture is most commonly met with in the colon, sigmoid flexure, and rectum—sometimes, indeed, the whole large intestine is more or less involved. The flexures of the colon are the points where the stenoses are most frequent and most severe. Some of the worst strictures ever seen are the sequence of dysentery, and yet, even a tight stricture found at the autopsy may not have caused any symptoms during life. This is accounted for from the fact that diarrhœa is likely to persist, and thus no solid matters are called upon to pass through the narrowed opening. If the ulceration be extensive, a remarkable appearance is given to the colon. The numerous separated patches of ulceration heal and contract, and in that way squeeze up the mucous membrane between them, causing it to project forward; stiff, callous folds and bands are also produced, and add to the irregular aspect presented. These singular pathological changes have, it is thought, sometimes been mistaken for malignant disease.

Typhoid fever, although its essential lesion is an ulceration of the bowel, yet very rarely indeed ends in stricture. Evidently the main cause of this immunity lies in the longitudinal direction of the ulcers, and the absence of much cicatricial tissue necessary for the healing of the majority of them. It is quite true, however, that very vast and very deep ulcers of irregular outline, and not infrequently encircling the bowel, are not uncommon. No very satisfactory explanation has yet been given of the remarkable immunity from stricture after typhoid fever characterized by such extensive ulcerations.

Catarrhal ulcers are mainly confined to the cæcum and the colon (particularly at the flexures). They have sometimes received the name of stercoral ulcers, being caused by the mechanical and chemical irritation of arrested fæcal masses. They may occur from simple chronic constipation, or be found as one of the results of an obstruction in the bowel farther down. Stricture is not very infrequently caused by the cicatrization of one or more of these stercoral ulcers.

Tubercular ulcers are almost invariably placed around the gut, but yet are seldom the cause of any severe degree of stenosis; the milder forms only are those which heal; the more severe, which are usually associated with tuberculosis elsewhere, never heal.

It must not be supposed that every cicatricial stricture can be readily placed in one or other of these classes, for not a few have been observed where neither the previous history nor careful examination of the scar could determine the nature of the ulcer by which it had been produced.

As regards locality, cicatricial strictures of the lesser bowel are situated mainly in the middle or lower parts of the ileum. In the colon fifty per cent. are in the sigmoid flexure.

Cancerous Stricture.—Cancer of the intestines, as a cause of stricture, is nearly always primary, although the wall of the bowel may be involved secondarily, or by extension from a neighboring part. The form of malignant growth which is most frequently met with is the cylindrical epithelioma, all other varieties, such as scirrhus or encephaloid, being either very rare, or possibly even doubtful. In true cancerous strictures of this kind we find the gut at the affected part suddenly constricted, the constriction being chiefly annular, but a small part of the bowel longitudinally being involved. The internal surface shows a firm projecting band, usually more or less ulcerated, and sometimes a distinct, raised, everted border terminates the raw surface in a very characteristic manner. The lumen may be very narrow, obliterated perhaps to the size of a crow-quill, or even of a small probe.

We shall now consider separately the *symptoms* produced by these various forms of intestinal obstruction.

The classical features of *occlusion* of the bowel are all specially exemplified in a case of acute internal strangulation, and are practically identical with those resulting from a strangulated external hernia. Generally speaking, the symptoms set in suddenly and without any apparent exciting cause, but are sometimes perhaps traceable to the effects of a purgative, or to some error in diet. Pain is sudden, and is at once severe, the region specially complained of being about the umbilicus, although it may be more diffused. It is paroxysmal, with distinct intermissions, and is often accompanied by an expulsive feeling like a labor-pain. At this stage its real nature may not suggest itself, and it may be looked upon as a rather severe colic of the ordinary kind. Purgatives are naturally resorted to, but fail to give the expected relief. If the stronger cathartics be then employed, their effect is also negative, or, more probably, the distress is materially increased by their action. Injections will bring away only small scattered bits of hardened fæces. Eructations and vomiting soon begin, and before long the latter becomes frequent and distressing. The abdomen becomes swollen, hard, and resonant; the features are first expressive of pain and anxiety, then drawn and haggard, the extremities cold, the fingers livid, the pulse very small and frequent, respiration shallow, and the diaphragm stationary. In this collapsed condition, death rapidly ensues, the mental faculties remaining clear to the last.

The pain is due to a combination of causes. The first in operation, no doubt, is the rupture or tearing of the peritoneum by the constricting force. Later on, there come into play the tumultuous and irregular peristaltic movements excited in the intestine, *i.e.*, the muscular structures of the bowel, at short intervals, make violent efforts by contraction to overcome the obstruction, and this necessarily causes pain of a colicky nature. Along with this is the distress produced by increasing distention of the gut by flatus collected above the seat of the constriction, and after a time the additional pain referable to the occurrence of peritonitis, local or general. At first there is no tenderness—in fact, the pain may be actually relieved by pressure—but this condition is, of course, entirely altered as soon as distention is at all considerable, and especially after the onset of any degree of inflammation. In the last stages pain and vomiting may be entirely arrested; this is the result of paralysis of the bowel, and consequent arrest of all peristaltic movements.

Vomiting occurs early (reflex), just as it does after any sudden injury to the abdomen. It is kept up, however, by other causes, chiefly from the mechanical effect of arrest of the intestinal contents, and from the onset of inflammation. The vomiting dependent upon the arrest of the contents naturally occurs early or late, according as the obstruction is situated high up or low down. It is also directly influenced by the irritability of the patient, and by the degree to which the alimentary canal has been subjected to the irritation of purgatives or drastics. With

a constriction high up, the ejecta are generally deeply and persistently stained with bile. If it be in the ileum, the vomited matters not uncommonly soon begin to have a foul smell, and, if opium be freely used and remora induced, a decided stercoraceous odor may be imparted to them. If it be in the lowest part of the ileum, or in the colon, stercoraceous vomiting is almost sure to occur. It was formerly held that the ileo-cæcal valve would prevent stercoraceous vomiting from an obstruction in the colon. This idea has, however, been completely disproved. It has been shown that, under these circumstances, the great distention necessarily produced destroys the functions of the valve, and permits of free regurgitation of fæcal matters. There are strong reasons for doubting the old theory of anti-peristalsis, which was invoked to explain stercoraceous vomiting. Moreover, such a reversal of the normal movements is by no means necessary to explain the occurrence. It is very evident that, after the contents have accumulated to a considerable amount above the seat of obstruction, every muscular action (on the part of the abdominal walls, the stomach, or the bowel itself) which tends to drive them against this obstruction must of necessity have the effect of forcing them in the only direction in which they can go, viz., upward. The probability is that, under the influence of these various forces, a current is driven downward along the peripheral part of the tube, while the central portion is occupied by a return flow, travelling with similar velocity in the opposite direction.

Constipation may be said to be complete from the time that the obstruction is established. Spontaneously, or by the use of enemata, some fragments of fæces may be passed, but these are always extremely scanty and are not followed by any further alvine evacuations. An exception to this occurs occasionally where the obstruction is very high up, when a moderate diarrhœa is sometimes observed.

Acute obstruction is not only characterized by the symptoms we have been describing, but its onset is usually accompanied by more or less definite indications of shock or collapse. This collapse is certainly induced mainly by the sudden injury to the peritoneum and intestinal walls, and not by the mere fact of a sudden obstruction; *i.e.*, it is traumatic, and precisely the same as we see after wounds of, or blows upon, the abdomen. The result of such traumatism is a profound effect upon the sympathetic system, which betrays itself by evidences of marked vascular disturbances and disordered action of important organs, coldness, lividity, and profuse perspiration, small and rapid pulse. Its degree (it is sometimes rapidly fatal) depends upon the impressionability of the patient (most declared in the very young and in the very old), the suddenness of the strangulation, and the extent to which the peritoneum is involved. This sudden and profound collapse has sometimes led to its being mistaken for the onset of true cholera. It is more apt to be severe when the trouble is situated in the small than when in the large intestine; this is owing to the closer association of the former parts with the great ganglia of the sympathetic. The secretion from the kidneys is notably diminished in all cases marked by much vomiting and great collapse. As these conditions are chiefly fulfilled when the obstruction is high up in the intestine, it is in such cases that oliguria, or, exceptionally, complete anuria, is witnessed. Beyond this, the symptom possesses no special diagnostic significance. In many cases a combination of the above symptoms would probably be sufficient to establish the diagnosis, but it is generally necessary to have the corroborative evidence obtained by an examination of the abdomen. Information of the highest importance is procured in this way. Fluid contents, but more particularly gases, will collect in continually increasing quantities above the occluded part. Distention or meteorism, therefore, results. The lower down the trouble, the greater the meteorism, and, as the case progresses, the distention is still further augmented by the effects of peritonitis and paralysis of the intestinal muscle. The abdominal distention often quickly becomes general, but, in not a few cases, the meteorism is confined to certain definite localities. Observations, therefore, on this point, may have strong diagnostic value, but they are open to certain fallacies which it is necessary to avoid. Thus, strictures near the termination of the alimentary canal may cause distinct mapping out of the various segments of the colon, with depression in the central parts of the belly; but this cannot be depended upon, owing to the variable situation of the sigmoid flexure and colon, distention of which may thus cause general tympanites. So, an occlusion in the lower ileum or cæcum may cause projection of the central parts occupied by the small intestine, with comparative flaccidity of the areas occupied by the colon; but this, perhaps after only a short time, cannot be depended upon, because the distention soon becomes uniform everywhere. In cases where we have to do with tympanitic distention of the abdomen from various causes, we often see a good deal of turmoil going on among the coils of the intestines, and these contortions are usually accompanied by more or less borborygmi. It is, however, in cases of complete obstruction of the bowels that we meet with the most marked demonstration, both visible and palpable, of the abnormal movements which are going on within the abdomen. There is an excessive peristalsis intermittently excited in the parts immediately above the constricted spot; these coils are specially swollen out with gaseous and fluid accumulations. The consequence of this is, that, by careful inspection of the abdomen, we can frequently see the swollen coils of intestine rise into prominence beneath the abdominal parietes, a strong wave of vermicular action pass along them, and then, after a few moments, subside as before, the process being accompanied by a gurgling sound. In the acute cases this sign is always to be looked for, but it is not at all so constantly met with as in the chronic obstructions. In acute strangulation, palpation reveals nothing but the hardness of the distended abdomen—a tumor will not be found. The cases in which the presence of tumor is to be looked for will be considered later in this article. Percussion sometimes assists in mapping out the distended portions of the intestine from the rest, but quite as often gives a uniformly tympanitic note over the swollen belly. Sometimes the dependent parts may be dull from the presence of fluid, which dulness may vary with position. Doubt may thus arise as to the existence of ascites.

Diagnosis. — Acute occlusion may be mistaken for strangulated hernia, cholera, irritant poisoning, peritonitis from perforation, hepatic or renal colic. Whenever a patient presents symptoms of strangulation of the intestine, it is the duty of the physician, *in every case*, to examine carefully all the points where an external hernia could possibly occur—even the unlikely orifices should not escape. Endless cases have been reported showing the necessity for this absolute rule, and, if required, we could add a few from our own experience. This duty is not complete without a digital examination of the rectum—latent disease of this part may prove the cause of suddenly developed obstruction. A case recently reported from a French source exemplifies this. The patient, being admitted into a Parisian hospital, was treated for an internal strangulation. The autopsy, however, showed that he was the subject of a painless carcinoma of the rectum, which had been suddenly occluded by fæcal matters. If known, it could have been relieved by colotomy, but the rectum had not been explored.

As regards cholera, not only the absence of diarrhœal flux, but the presence in rather a marked degree of the very opposite condition of constipation, are usually quite significant in connection with the other accompanying symptoms. It is only in times of epidemic that an approach to such an error is possible. The symptoms arising from irritant poisoning generally differ quite enough from those of acute obstruction to enable the diagnosis to be made; but cases have occurred where the post-mortem alone has been sufficient to determine the point with certainty. The symptoms of hepatic and renal colic are generally sufficiently significant in themselves, but a possible source of error from these affections should be borne in mind. Without doubt many cases of suspected ileus

are really conditions of aggravated colic, to which possibly at times may be added real symptoms of obstruction from some temporary cause, generally accumulation of fæces.

Internal strangulation of the intestine, unless removed by surgical assistance, must be looked upon as a condition tending positively to a fatal termination, the most common being by general peritonitis, with or without perforation. The vast majority of all such cases die, generally after having run a short and very painful course. The exceptions to this rule are so few as to serve merely to substantiate the general statement. In these instances where spontaneous recovery has taken place, we are left in uncertainty as to the actual cause of the trouble and the means by which relief has been obtained. It is conceivable, however, that the natural efforts might be sufficient to counteract almost any of the varieties of occlusion. Bands may give way, a noosed knuckle of intestine may slip out again, a volvulus may untwist, an invaginated portion may slough off, a foreign body may become dislodged. A patient is not, however, safe after apparent recovery of this kind, for there still remain the dangers of the peritonitis becoming general, of the occurrence of gangrene and perforation, and of a return of occlusion either from contracting adhesions or from a recurrence of the condition causing the original attack—dangers which are very real and must enter into the prognosis.

The higher the seat of the occlusion, generally speaking, the more acute the course—the only striking exception being in the case of volvulus of the sigmoid flexure, which may proceed as rapidly as an obstruction in the duodenum. The average duration of all cases is about six days, the extremes varying from twelve hours to thirteen or fourteen days.

Volvulus, which, as already mentioned, is chiefly found at the sigmoid flexure, occurs much more frequently in men than in women. Of twenty cases by Mr. Treves, sixteen were men. It is an affection of advanced and middle life, a majority of the patients being between forty and sixty. The cause for this is probably the greater liability of persons of this age to suffer from constipation. Most of the persons who suffered from this accident were known to have been habitually constipated, generally for a long period before the occurrence of the obstructive attack. The constipation may or may not have given rise to symptoms, such as spells of colic with vomiting and perhaps distention of the belly. The onset is usually sudden. Abdominal pain, some collapse, vomiting, and soon distention. When the onset has been less abrupt, there has been persistent constipation for a time, followed by uneasiness in the belly, developing into actual pain, then nausea and vomiting, and finally tympanitic distention. The pain, though a marked feature, is apparently not so intense as in many of the cases of strangulation of the intestine by bands. It is persistent, but exacerbated at intervals, its severity being usually in proportion to the acuteness of the case. In the later stages, its features become lost in the picture of a general peritonitis. The vomiting is by no means early, is not a specially prominent symptom, and rarely becomes stercoraceous. The constipation is generally positive and absolute from the very first. Collapse is usually considerable, but depends greatly upon the severity and acuteness of the onset. Tenesmus occurs in a considerable number of cases of volvulus of the sigmoid flexure, and, in a few, it has been observed to a very distressing degree. Abdominal distention is probably more marked and reaches great dimensions from volvulus more frequently than from any other form of obstruction. If seen early, the swelling may be observed to be localized in the umbilical and epigastric regions, inclining to the left side, but, before very long, the tympanites becomes more diffuse, and the belly is uniformly and enormously puffed out. In primarily acute cases, coils of intestine are not visible through the abdominal wall; but the phenomenon can occasionally be witnessed when the volvulus is secondary to some disease of a chronic nature which has caused partial obstruction. It is sometimes useful to employ enemata for diagnostic purposes. In volvulus of the sigmoid flexure it would be found that such a quantity only of water could be injected as would suffice to fill the rectum alone. Volvulus tends invariably to a fatal issue, the average duration being about six days. It is thought that, once a volvulus has become fairly established, it cannot spontaneously relieve itself. The symptoms arising from volvulus of the small intestine are substantially the same as those just described, the chief points of difference being that the vomiting is earlier and stercoraceous matters more likely to be brought up. These cases also may be either acute or chronic.

Invagination.—The symptoms of intussusception or invagination are often very vague and the diagnosis difficult, but in other cases the occurrence is marked by special peculiarities in the symptoms as compared with other forms of obstruction. The initial symptom will probably be a sudden and severe griping pain in the region of the umbilicus. This lessens after a time and then continues at intervals, in a remittent fashion. There is not necessarily any tenderness at first—on the contrary, pressure may even give relief—but this feature is soon lost. Vomiting may develop early, but, though often absent in the beginning, is pretty sure to occur later on. There is no immediate constipation, the bowel below continues discharging its contents, and, moreover, the lumen of the intestine is only partially occluded, and a certain amount of fæcal matter still passes through the narrowed opening. Sometimes there is even some diarrhœa.

In either case, however, there is almost invariably an admixture of blood with the stools. The quantity of blood may even be considerable, arising, of course, from oozing from the constricted and congested portion of the imprisoned gut. Following these early symptoms, the progress of the case depends largely upon the situation of the trouble, and is capable of assuming a markedly acute form, or a prolonged chronic course. In the lesser bowel strangulation is rapid, and signs of enteritis quickly develop. There is abdominal tenderness with fever, and constant vomiting sets in, while no fæcal evacuations occur, except, perhaps, blood-stained matters from the congested and, possibly, gangrenous intestine. In this way the patient may rapidly succumb after the manner of those suffering from acute internal strangulation. Again, the more violent symptoms may abate and, after the discharge of fœtid and bloody stools for a variable length of time, a gangrenous mass escapes entire, or in fragments, and the immediate dangers may be considered to be over. The symptoms of the chronic kind are more difficult to describe. Abdominal pain, of a not very severe character, is experienced from time to time, the intervals often being long—there may be no definite constipation—vomiting occurs only occasionally. After an uncertain interval vomiting becomes more frequent, and finally incessant, perhaps stercoraceous. Mucous and bloody alvine discharges are numerous, simulating perhaps a dysenteric diarrhœa. Death is generally brought about by gradual exhaustion. Although the general rule is as above stated, yet exceptionally acute strangulation may occur at the outset within the large intestine, and, on the contrary, a chronic intussusception may be found in the small intestine. The folding together of a number of layers of bowel, and the swelling which follows in the constricted part, necessarily produce a lump, or tumor, and one of the most constant and important signs of an intussusception is the recognition of this tumor. Except there be some physical difficulty in the way of the exploration of the abdomen, by reason of excessive fat or tympanites, or great tenderness, this can nearly always be detected on careful palpation of the abdomen. The nature of such a tumor can often be correctly surmised from its elongated shape, and occasionally by the perception of changes in its outline under the influence of peristaltic movements. Examination by the rectum will furnish a positive diagnosis, when the mass has descended low enough to come within reach. The apex of the intussusception presents a peculiar feel to the examining finger, which has been very commonly compared to a softened cervix uteri, with a somewhat patulous os. The principal points enabling a distinction to be

made between invagination of the large and of the small intestine are: (*a*) Tenesmus is common and often severe in the former, seldom present and not so marked in the latter; (*b*) hæmorrhage is much more copious in the latter; (*c*) obstruction, or occlusion, is a much more prominent condition in the latter; (*d*) the existence of a well-defined tumor, especially one felt *per rectum*, points to invagination of the large intestine. Invagination, more particularly ileo-cæcal, occurs largely among young children, including babes only a few months old. Probably one-half of the total number of cases are in children under seven years of age.

Obstruction from Fæcal Accumulation.—The subjects of this form of obstruction are generally persons known to have suffered from very infrequent movements of the bowels. Very large evacuations are obtained from time to time by the use of aperients, and very often the individuals are liable to occasional attacks of what appears to be a diarrhœa. This is, in reality, a slight catarrh set up by the irritation of the fæcal masses. Such a state of things may last a long time without producing any symptoms, or, at most, slight abdominal discomfort. At other times marked digestive disturbances are induced, accompanied by loss of flesh, weakness, and tendency to hypochondriasis. From pressure upon the lumbar or sacral nerves, pains may be felt in the back, or sometimes along the back of the thigh. The distention of the abdomen may grow worse, and much discomfort with palpitation and perhaps dyspnœa be produced; eructations of a disagreeable character are apt to be troublesome; lastly, nausea or vomiting will occur. The latter will increase in severity and, if the condition remain unrelieved, will ultimately become feculent. Even prolonged cases of obstruction from this cause may be relieved spontaneously, or by remedies; but, failing this, all the other indications of acute ileus develop, and the patient dies. Cases are reported which recovered after two, or even three, months of absolute constipation. A condition differing from the above description is that in which the person suffers during a series of years from occasional attacks of acute obstruction, perhaps even accompanied by stercoraceous vomiting, which are as frequently relieved by procuring an evacuation of the bowels. In a certain proportion of cases of long standing, the fæcal accumulation can be made out through the abdominal parietes in the form of a tumor. This is usually in the cæcum, and is, therefore, most evident in the right iliac fossa and toward the outer half of Poupart's ligament. This tumor is usually painless, and feels uneven and hard. With reference to masses in the colon, allowance must always be made for possible displacement of the gut, owing to the weight of its contents. If the tumor can be indented, like dough, by the fingers, its nature is certain. When there is inflammation about the cæcum in such a case, the existence of some pain and tenderness may throw doubt upon its character, and I know of one instance in which a very able physician fell into the error of mistaking a fæcal collection in that situation for cancer. The prognosis in obstruction from fæces is, generally speaking, good; but the longer it has lasted, and the more severe the attacks, the greater the danger.

Stricture of the Intestine.—These cases are almost all of a chronic nature, and thus distinguished from those of occlusion, which for the most part present a strikingly acute onset and course. A constriction may be the result of an acute occlusion, the symptoms setting in suddenly, subsiding, and being replaced by those of a greater or less degree of stenosis. The opposite of this may also occur—a constriction which has been causing trouble for a long time may be suddenly blocked up, and then we have all the indications of acute occlusion. It is by no means to be supposed that every degree of constriction will produce symptoms. On the contrary, in certain situations narrowing may go on for a long time unperceived, and it will be only when this has attained a high degree that it will make its presence known. The more inspissated are the matters which must pass through the narrowed section of the tube, the sooner symptoms will arise, and *vice versa.* It follows, therefore, that strictures of the colon and rectum are those which will be soonest detected, and that serious diminution in the lumen may persist in the ileum and higher portions of the tube without causing any disturbance, perhaps, until a total obstruction occurs. The most obvious effect of a constriction consists in remora, or delay of fluids and gases of the intestines in the parts above the dam. Meteorism, therefore, is an important and very constant symptom. This distention of the belly will, of course, vary with the site of obstruction, being greatest when the lower sections of the bowel are occluded, and *vice versa.* It necessarily also is in direct proportion to the degree of constriction. The remarks made in a preceding paragraph with reference to the portion of the abdomen which is found to be distended, according as an obstruction occupies different localities, apply as well to these more slowly-developed strictures. It is, indeed, in the latter rather than the former that definitely mapped out areas of distention are conspicuous, as indicating the seat of the block. In these, too, we often have opportunities of observing the alternate distention and flaccidity of these parts in accordance with the varying state of the constricted bowel, which at one time prevents anything passing through, and then again allows of the escape of the dammed-up contents. During the period of distention, the individual complains of fulness and uneasiness with flatulence, and often of a good deal of colicky pain, which again pass off, with relief to the tympanitic condition. During the attacks it is quite often possible to see clearly, through the abdominal walls, the alternate rise and fall of the affected parts under the influence of the muscular movements of the intestines. These visible peristaltic movements are very striking, and have much diagnostic value. They are far more evident than in the acute cases, owing to the greater hypertrophy of the muscular coat of the bowel and to the emaciation, which is, of course, more frequent in these chronic cases. In this condition it is customary to hear numerous and loud borborygmi, which are often audible even when the listener is standing at some distance from the patient. A constricted state of the bowel is generally also declared by the existence of disturbances in the evacuations. The prevailing condition is constipation, which becomes more marked. The patient complains that when this lasts some days he suffers from distention, and the troubles dependent upon this; states that, after taking physic, these symptoms are much relieved, and that the evacuations produced are diarrhœal, but frequently extremely fœtid. Sometimes spontaneous relief is afforded upon the escape of numerous hardened scybala. It is not uncommon, with a constriction in the ileum, to have diarrhœa persisting throughout the course of the case, due to the increased peristaltic action set up. We are not specially concerned with strictures of the rectum, as these fall within the province of the surgeon, but it should be remembered that stenoses of this part are very apt to cause the appearance of peculiar ribbon- or pipe-stem-like fæces, which are of great significance. Persons who are the subjects of stricture of the intestine suffer before long in general health. If the disease be malignant, of course emaciation, anæmia, and debility are to be looked for. But, even without this element, there is an enfeebled state, want of energy, and irritability, with a decided tendency to be hypochondriacal. A stricture may slowly and progressively lead on to complete occlusion, or it may become suddenly occluded by the jamming of some foreign body into the lumen of the stricture. In the latter case, the symptoms will be similar to those of internal strangulation. Such cases are difficult to recognize, and except the history be sufficient, are quite likely to be looked upon as acute ileus. Mistakes are specially liable to occur in cases of strictures which have been practically latent until the sudden attack characterized by indications of complete obstruction. When we have to do with a progressively advancing stenosis, there is a constant struggle between the passive resistance of the delayed contents and the propulsive action of the hypertrophied bowel. Up to a certain limit the power of the latter is sufficient. When, however, this limit is reached, complete stasis results, and a collection (sometimes immense) takes place from the dam upward.

Such a condition may even yet be recovered from by the spontaneous softening of the fæces, or by the effects of medical treatment, even after the onset of marked symptoms of ileus. Considerations of this kind are sufficient to explain the cases in which we find an amount of alternating diarrhœa and marked constipation in the subjects of intestinal stricture. After a greater or less time complete occlusion results, with great distention of the weakened and semi-paralyzed intestine. In many instances, the original disorder is still further complicated by sloughings of the mucous membrane in the dilated part and the ulcers resulting therefrom. These may induce local peritonitis, or ultimately perforate and thus bring about a rapidly fatal issue. They may also be the source of foul infiltrations of the retro-peritoneal tissues, which may lead to fæcal fistulæ, or, again, to systemic absorption of putrid matters and the phenomena of septic poisoning. In malignant stricture death may occur simply from progressive wasting and debility, as seen in other forms of visceral cancer. In a certain proportion of cases of stricture there is the possibility of spontaneous recovery, either complete, or, at any rate for a time, by the formation of an external fæcal fistula. Or the same result may be artificially brought about by a surgical operation. Thus, if the existence of a stricture be determined with certainty, the prospects of a complete cure must be considered very small, and even partial recovery is quite exceptional. The diagnosis of a stricture of the intestine is sometimes easy, as, *e.g.*, when it is to be felt in the rectum. In other cases, a reasonable consideration of the clinical history affords some assistance. The most important antecedent fact, perhaps, is an account of a previous attack of dysentery. This is particularly to be sought for if the symptoms indicate disorder in the lower part of the large intestine. A previous attack of typhoid fever, or tuberculosis elsewhere, or typhlitis, or injury to the abdomen, cannot be said to possess any reliable significance. A great many ulcers of the bowels are latent, not declaring their presence by any recognizable symptoms. It must be remembered, too, that a very long period may elapse between the original lesion and the occurrence of any indications of a resulting stricture. Thus, after dysentery an interval of any duration, from one to several years, has been observed between the attack and the onset of obstructive symptoms. The medical history may, again, be purely negative, and the indefinite abdominal symptoms complained of may remain unexplained, being referred to chronic catarrh, tubercular ulceration, etc. Not infrequently, an undiagnosticated stricture has been discovered at an autopsy. *George Ross.*

INTESTINAL OBSTRUCTION; TREATMENT. In describing the treatment of this affection, acute and chronic obstruction will first be dealt with generally and after describing in detail the various remedies and methods employed, the special treatment of the individual forms of obstruction will be considered.

Acute Obstruction.—The treatment of acute obstruction is a subject surrounded with difficulties, and one about which there is a great variety of opinion. The men of the older generation rely entirely on the "rest, opium, and starvation" treatment, and hold that operative measures are seldom, if ever, necessary ; the younger generation, on the other hand, think that the treatment by "rest, opium, and starvation" is well enough as a tentative measure in the early period of acute obstruction, but as a curative method it is rarely successful, and that if relief can be afforded at all it will be by some form of operation.

The practitioner without much experience, looking into his text-book for guidance, might imagine, from the very exact description given of the symptoms peculiar to each form of intestinal obstruction, that the differential diagnosis is a simple matter, and that, should he meet with a case, he would only have to employ a certain method of treatment for a certain form of obstruction, and so relieve his patient, if relief were possible. In actual practice, however, the diagnosis of the special form of obstruction we have before us is by no means easy, and, in most cases, the exact nature of the affection cannot be determined except by laparotomy, or on the post-mortem table. The sermons preached daily by the morbid anatomists are valuable checks to the sin of diagnostic dogmatism in abdominal affections.

There are, however, certain general principles to be followed in cases where acute obstruction is evident.

In the early period of these cases purgatives should be strictly avoided ; enemata may be administered, but purgatives never. Opium, in full doses, should be given hypodermatically to allay pain and arrest the peristaltic action of the bowels. Food should not be given to the patient by the mouth, as it is always rejected, but the strength should be maintained by nutritious enemata. The sucking of small pieces of ice is often acceptable, as it quenches the thirst and allays vomiting.

If, after washing out the lower bowel several times, the fluid injected returns unchanged, and at the same time the vomiting continues incessantly, no relief can be hoped for by any other means than laparotomy. Delay in these cases is most dangerous ; we should not wait for the vomiting to be fæcal (that is evidence of obstruction of some duration), but open the abdomen at once, for the earlier the operation is performed the greater are the chances of success. In the fatal cases following operation this result is not, as a rule, caused by the laparotomy, but by its too late performance and the advanced condition of the grave changes in the bowel which result from the long-continued obstruction. This is especially apt to be so in those subacute cases due to intussusception, local inflammation, and hernia, where, the symptoms not being very urgent, operation is delayed till too late (Wheelhouse). Wheelhouse[1] says the previous history of the patient is important. "If he has had peritonitis, perityphlitis, enteritis, or other inflammations where lymph may be poured out and bands afterward form, the indications for operation are more urgent."

In those cases which have all the symptoms of a strangulated hernia, and yet no hernia can be made out externally, it is reasonable to suppose that the case is one of internal strangulation, which can only be relieved by operation, as reduction by taxis is out of the question.

In subacute cases which have lasted five or six days, many, if operated on, die of exhaustion, and, according to Mr. Treves,[2] in cases of intussusception, after death a process of spontaneous cure, nearly complete, has been found, and apparently was only arrested by exhaustion owing to the patient's inability to take food.

In chronic obstruction, where there is reason to believe that a stricture exists in the intestines, due to internal or external causes, it is very important that proper food should be taken, so that nothing that is not perfectly fluid or in a pultaceous condition should enter the bowel. The swallowing of all indigestible substances such as orange pips, plum or cherry stones, raisins, etc., should be strictly avoided. Should constipation be present, mild laxatives may be cautiously administered, or simple enemata, but *purgatives should on no account be given*. If the stricture be within reach, as, for instance, in the rectum, it may be dilated with bougies or incised. Excision of a cancerous stricture of the lower end of the rectum is an operation which has afforded very good results, and, if performed early, the life of the patient may be prolonged for years and his comfort not seriously interfered with. When almost complete obstruction occurs from narrowing of the lumen of the bowel by the increased growth of the stricture, then the question arises as to the advisability of establishing an artificial anus. If the growth can be felt through the rectum, left lumbar colotomy should be performed. Cancerous strictures nearly always occur in the large bowel, and, if the stricture cannot be felt through the rectum and the age and appearance of the patient indicate malignant disease, right lumbar colotomy should always be performed (Paul).[3]

If the stricture be in the small bowel the abdomen should be opened and an artificial anus established, or the affected portion of bowel should be resected and the divided ends sutured or fixed in the abdominal incision.

In cases of chronic obstruction which have lasted for months and the cause cannot be exactly determined, an exploratory incision is the proper procedure, for by the establishment of an artificial anus life may be, in many cases, much prolonged. When possible, in suitable cases, the operation should be performed early and before the system has become debilitated, as the better the condition of the patient at the time of operation so much the greater is the chance of success. Patients, as a rule, refuse operation till the discomfort of the obstruction is so great and their condition so deteriorated, that operation is only performed as a *dernier ressort*, with the hope of prolonging for a short time the life of the patient.

METHODS OF TREATMENT IN DETAIL.—*Rest, Starvation, and Opium.*—This treatment is of very old date, and many yet believe it to be the only treatment that should be pursued in cases of acute intestinal obstruction. It consists, in short, of entire abstinence from food, from physical exploration of the parts, enemata, etc., and the administration of opium or morphia. All are agreed as to the propriety of adopting this treatment in the early stages of acute cases, but, as already mentioned, surgeons of the present generation are not in favor of trusting to it implicitly, but in suitable cases recommend further treatment by operation.

Opium.—In cases of obstruction opium is the most valuable drug we possess; it not only allays pain, but arrests the peristaltic action of the bowels and gives to the inflamed parts physiological rest. Many cases of obstruction are recorded as being cured by the free administration of opium; it is certainly very probable that not a few cases of commencing invagination have ended favorably by its administration. But we must not trust entirely to opium, even when combined with rest and starvation. Opium has its dark as well as its bright side, and if given early in cases of obstruction it obscures the symptoms and so lessens the chance of making a diagnosis; the patient's condition, no doubt, improves, vomiting and pain may be less, the pulse better, and the skin moist; but at the same time the bowel may be in a gangrenous condition, and the patient only dies the easier from having been dosed with opium. Again, the lessening of the severity of the symptoms may so lull the suspicions of the medical attendant that operation is delayed and the patient deprived of his only chance of life. I repeat that opium is a valuable drug in the treatment of obstruction if used with discretion, and with a full knowledge of its effects; it is rarely curative, but always relieves pain and lessens the peristaltic action of the bowels.

Belladonna.—Dr. Brinton first introduced the use of this drug in the treatment of intestinal obstruction, because of its power to produce relaxation of the unstriped muscular fibres of the bowel. Many speak very highly of it used alone or in combination with opium, as it lessens the sickness and depression caused by opium given alone. It may be administered by the mouth, or atropine may be injected hypodermatically. It has been used externally on the abdomen in form of ointment or plaster. Belladonna is sometimes useful in cases of fæcal accumulation, but in cases of true obstruction it can be of but little service.

Enemata.—In cases of chronic obstruction of the bowels enemata are of considerable benefit; they are especially useful in those cases where vomiting occurs. In cases of obstruction due to fæcal accumulation enemata are particularly beneficial. Warm water is generally sufficient, by repeated injections, to clear out the large intestines, but in cases of impacted fæces enemata of sweet oil, with one drachm of spirits of turpentine to the pint, give extremely satisfactory results.

Enemata have frequently proved useful in effecting the reduction of an intussusception; to be of service they must be administered early and copiously. Some recommend that they should be administered with the patient in the inverted position.

In cases of acute obstruction the benefit of enemata is not so clear; many medical men in these cases object to them altogether, because they are liable to increase the peristaltic action of the bowels.

In certain cases enemata are inadmissible, and often injurious. They cannot possibly be of benefit in cases of intussusception where the invaginated bowel has reached low down, in stricture of the rectum, or in cases of volvulus of the sigmoid flexure; in this latter affection enemata only increase the amount of twisting, and so do infinite harm.

Mr. Treves[4] says that when once the bowel is stilled by opium, thirst may be relieved by copious enemata of hot water without increasing intestinal disturbance.

Some surgeons recommend that copious enemata should be given, in every case of intestinal obstruction, before any other method is tried. Dr. Illoway,[5] not content with the ordinary enema syringe or syphon apparatus, recommends the use of a force-pump which can throw a continuous stream; if this fail, then he advocates laparotomy. In reading over the account of the discussion on intestinal obstruction at the Liverpool Medical Institution,[6] the writer was much struck with some remarks of Dr. Barr, and thought that they applied to those cases of intestinal obstruction successfully treated by enemata. Dr. Barr said: "If you look upon all cases where you have got severe pain in the abdomen, constipation, and vomiting, with perhaps more or less shock, as cases of intestinal obstruction, then, no matter what line of palliative treatment you adopt, you ought to have a very good percentage of recoveries; but if you belong to a more exclusive school, and in your anxiety for accurate diagnosis eliminate all cases of colic, constipation, enteralgia, etc., then you will find you have a terrible disease left, which tends more frequently toward a fatal issue than to recovery."

If we were as certain of the correct diagnosis of the disease treated as of the successful result of the treatment in many of the reported cases, much confusion and difference of opinion as to the value of certain remedies in the treatment of intestinal obstruction would be avoided.

Enemata have been used for diagnostic purposes. If during the injection the fluid can be heard gurgling in the cæcum, it is almost certain that the obstruction is in the small intestine; if it is stopped at some intermediate point, it is probable the obstruction is at that spot.[7]

Metallic Mercury.—This very old method of treatment is now seldom practised, though comparatively recently it has been advocated by Matignon, of Paris, and cases of intestinal obstruction successfully treated by this means occasionally appear in the journals. The cases in which it is of use are those of old fæcal accumulation; for other forms of intestinal obstruction it should never be employed; it cannot possibly do good, and may do much harm.

Shot.—Dr. Maydieu,[8] of Paris, reports cases of ileus successfully treated by the administration of shot. He mixes seven ounces of shot with four ounces of olive-oil, and gives two drachms of the mixture every half-hour. This treatment may do more harm than good, and is mentioned merely as a curiosity. It replaces the treatment by bullets of the physicians of the sixteenth century.

Washing out the Stomach.—Kussmaul was the first to introduce washing out of the stomach for intestinal obstruction, and a number of successful cases are reported as the result of this mode of treatment. The good result is explained on the ground that evacuation of the distended bowel affords opportunity for the spontaneous reduction of a herniated or twisted loop of bowel. The temporary relief afforded is said to be very great, and the practice is so simple and harmless that it is worthy of a trial. Of course, the majority of cases of intestinal obstruction could not possibly be relieved by it.

Massage and electricity have been extensively practised in the treatment of intestinal obstruction and still have their advocates. It is now the opinion of most surgeons that in cases of acute obstruction, at any rate, they do more harm than good. The only cases of obstruction likely to benefit by them are those due to fæcal accumulations. E. O. Day[9] reports two cases of intussusception successfully treated by massage. He had seen ten cases

of this affection, and the only recoveries were the two treated by manipulation and massage.

Puncture of Bowel with an Aspirator Needle or fine Trocar.—This method has its advocates, and cases are reported where, after the bowel has been punctured and a large amount of gas and fluid fæces evacuated, the obstruction has been relieved. As a rule the procedure is not a dangerous one, but occasionally, owing to paralysis of the coats of the bowel, the punctures do not close, fæces escape, and a fatal peritonitis is the result. At best puncture is a proceeding in which the element of chance exists to a large extent; one can never tell whether the proper part is punctured, or whether the needle has not entered a portion of bowel bordering on gangrene. Mr. Treves [10] has met with several instances where perforation of the bowel, which had been previously threatening, took place immediately after the relief of the distended coil by puncture.

In some cases the needle has punctured the bowel below the obstruction, without, of course, relieving the patient.

Emptying the bowel above the obstruction may in certain cases relieve a portion of the gut which is in some abnormal opening or held lightly under a band, and may relieve obstruction due to kinking. In cases of stenosis where there is temporary obstruction it may give relief, and also in those cases of chronic obstruction which suddenly become acute (Treves).

Puncture of the bowel is a favorite method of procedure with veterinary surgeons for the relief of distended bowel in cattle. A very large trocar is used, and no evil results ever follow, owing to the immunity cattle have from peritonitis.

Dr. Larguier, of Paris, speaks highly of the continuous use of a trocar. He introduces a trocar five to six millimetres in diameter, and leaves it in the intestines two or three days. Sometimes fæcal fistulæ are formed (Treves). As this operation must necessarily be done at haphazard and is not free from danger, it cannot be recommended.

Laparotomy.—The operation of laparotomy for the treatment of intestinal obstruction is still in its infancy, but the time is not far distant when no case of intestinal obstruction will be allowed to die without an abdominal section having been performed for its relief. Surgeons are daily becoming more and more certain of the necessity of this operation in the majority of cases of obstruction; there is still some difference of opinion as to the cases in which it is suitable, and also as to the proper methods of its performance, but a larger experience will soon enable us to lay down definite rules for the guidance of surgeons. Schramm [11] has collected 190 cases of intestinal obstruction treated by laparotomy; of this number 64.2 per cent. died—the mortality before the introduction of antiseptics being seventy-three per cent., and after that time fifty-eight per cent. This mortality, though a very high one, will be considerably reduced when physicians realize the importance of advising early operation in these cases.

All are agreed that the operation should be performed with the strictest antiseptic precautions, and not a few advise it to be done with the spray. Great care should be taken to have aseptic sponges and instruments, and the hands of the operator and his assistants should be thoroughly cleansed with soap and hot water and nail-brushes, and afterward washed in bichloride or carbolic acid solution; particular care should be taken to have aseptic ligatures, and the abdomen of the patient should be thoroughly washed before the operation with an antiseptic solution. The incision should be made on the median line below the umbilicus, and should be long enough to allow the whole hand to enter the abdomen. Having opened the peritoneal cavity, after all hæmorrhage has been arrested the hand should be introduced through the wound, and the right iliac fossa first examined. If the obstruction be not found in cæcum or ileum, collapsed coils of intestine should be searched for. These are generally found hanging in the pelvis. If found, they can be passed through the fingers till the constriction is reached. Mr. Treves [12] advises that a large, warm, carbolized sponge should be placed in the pelvic cavity, as by this means much manipulation is saved. The intestines should, if possible, be prevented from extruding by means of warm flat sponges wrung out of hot water. The extrusion of intestines, if much distended, as they are almost sure to be, gives rise to considerable trouble, and if they cannot be kept within the peritoneal cavity, it would be well to incise the most distended portion and allow the gas and contents to escape. The incision should afterward be closed by a Czerny-Lembert's suture. If the obstruction cannot be made out by the introduction of the hand, it would be proper to allow the bowel to extrude and to make a systematic search. The extruded bowel should, of course, be protected by warm carbolized sponges. Mr. Greig Smith [13] says the most dilated portion of the bowel rises to the surface, and there is a great probability that the obstruction will be found near this point.

When the obstructed point is found, the intestine should be carefully examined; if of good color it should be returned, but if gangrenous it should be excised and the cut ends immediately sutured, or an artificial anus established. If the obstruction be due to constricting bands, these should be divided between two catgut ligatures. Should an intussusception exist, it may be reduced by gentle traction if the case be a recent one, but if the parts be tightly glued together by effused lymph, so as to render reduction impossible, the affected portion of bowel should be resected and sutured, or an artificial anus should be established. Occasionally in these cases the obstruction is found to be due to cancerous or other stricture, or to a peritonitis; if the former condition exists and excision is impossible, an artificial anus should be established above the obstruction; if the latter is the cause of the trouble, the peritoneal cavity should be washed out with a weak solution of warm carbolized water, 1 to 100, and after thoroughly cleansing the peritoneum with sponges the wound should be closed.

Occasionally it happens that the obstruction is caused by a perforated appendix or diverticulum; these have on several occasions been successfully excised and the bowel immediately closed with sutures. It is possible, nay, probable, that the cause of the obstruction may not be found, for it is by no means easy to thoroughly search the abdominal cavity (even if the whole hand is introduced) when the bowels are greatly distended; in such a case it is the duty of the surgeon to establish an artificial anus in the most distended portion of bowel, and to await results.[14]

Polaillon [15] advises lateral laparotomy in preference to the median incision in cases of intestinal obstruction; with this incision, he holds that the distended intestines are less likely to extrude, and that the wound is more easily closed. The lateral incision should be made in the inguino-iliac region, parallel to the fibres of the external abdominal oblique muscle. Here the lips of the wound close easily, and the diaphragm is less liable to force the distended bowel through the wound. This incision is all very well if the point of obstruction is diagnosed and is on one side or the other, but in the majority of cases we are quite in the dark as to the site of the obstruction, and for a systematic exploration of the abdominal cavity no incision is so convenient and useful as the median.

Enterectomy is called for in certain cases of intestinal obstruction; for instance, those due to simple and malignant strictures of the small intestine, neoplasms, irreducible intussusception, and also in those cases where on opening the abdomen the bowel is found to be in a gangrenous condition. It has been most frequently performed for the latter condition. After the affected portion of bowel has been resected, the question then arises as to the propriety of immediately uniting the divided ends of the bowel by suture, or of establishing an artificial anus by fixing them to the abdominal wound. The latter method, in cases of intestinal obstruction where the condition of the patient is by no means good, is probably the better one. The immediate suture of the bowel prolongs an already severe operation, and so lessens the patient's chance of recovery. By the establishment of an artificial anus the patient runs less risk of peritonitis, which so often follows suture, owing to some defect in the manner of performance of the

operation, thus allowing fæcal matter to escape into the peritoneal cavity, from non-union, insufficient sutures, or the development of gangrene at the suture-line (Treves).

If desired, when the patient recovers, and regains his strength, the artificial anus may be closed by a second operation. For the manner of performing resection the reader is referred to the article Enterectomy, under Intestines.

Enterotomy.—This operation for the relief of obstruction was first performed by Nélaton, and consists in opening the small bowel in the right loin, by an incision, a little above the crest of the ileum, parallel with Poupart's ligament. It has been performed many times with success, and is more suitable to the more chronic forms of obstruction where, owing to the disease being high up in the large intestine, left lumbar colotomy is unsuitable. The portion of bowel opened is generally the lower end of the ileum. It is also performed in those cases of intestinal obstruction where, after the abdomen is opened, the affected portion of bowel cannot be resected. In cases of recovery the patients complain bitterly of the situation of the fæcal fistula, as no apparatus seems to be able to keep in the discharges.

Treatment of Special Forms of Obstruction.—*Treatment of Internal Strangulation.*—If the obstruction be complete and the symptoms very acute, the immediate performance of laparotomy is called for. Whatever be the cause of the strangulation, laparotomy is our only hope of effecting a cure. Occasionally, but very occasionally, the patient may recover owing to the bursting of a constricting band or the spontaneous reduction of a herniated loop of bowel, but we should not wait for the chance of a cure being effected by nature. The immediate danger is too great, and the hope of a natural cure too slight, to justify us in postponing opening the abdomen and relieving the obstruction. There is no reason why these cases should be treated in any way differently from those of strangulated hernia when reduction by taxis has failed. Some go even further than this, and recommend that where this form of obstruction is suspected the patient should not be allowed to die without an exploratory laparotomy.[16] There is far more danger in operative interference being delayed until the period when it may be of no avail, than that a hasty and unnecessary operation should be done (Pilcher).[17] Opium may be given to relieve pain and lessen peristaltic action, but it is useless to trust to it as a curative measure. Enemata may prolong life, but cannot cure the disease. Its apparent improvement due to the administration of sedatives, etc., should not deceive the surgeon or encourage him to postpone operative measures.

Volvulus.—This occurs most frequently in the sigmoid flexure. Rest, starvation, and opium may delay the fatal issue, but will never relieve the volvulus. Enemata are injurious, as they tend to increase the twist by distending the bowel. Laparotomy is the only method of treatment that affords any reasonable hope of success, and, to be of benefit, it should be performed early. When performed, and the volvulus found, its reduction is by no means a simple matter, even after the distended bowel has been relieved by puncture or incision. If reduction is impossible, an artificial anus should be established. Treves[18] advocates the early administration of opium and the emptying of the rectum by enemata. "Laparotomy," he says, "is not likely to prove other than useless." If in the sigmoid flexure, he advocates puncture through the parietes, and failing relief by these means, the performance of left lumbar colotomy.

Intussusception (*Acute*).—There is no doubt that intussusception, if recognized early, before adhesions have formed, may be treated successfully without operation. It is unnecessary to state that purgatives are harmful, and that expectant treatment, where every moment increases the severity of the affection, is of no avail. Mr. Jonathan Hutchinson has said[19]: "I have not found any case recorded in which spontaneous return of a well-recognized intussusception occurred, and those in which art succeeded are comparatively rare." If we are certain that the case is one of acute intussusception, opium should be freely administered to allay the peristaltic action of the bowels, and so prevent an increase of the invagination; by the early administration of this drug spontaneous reduction may take place.[20] Should opium fail to effect a reduction, it nevertheless greatly improves the condition of the patient. Reduction should next be attempted by means of enemata or insufflation. Insufflation is looked upon as a safer method than the injection of water, for cases of rupture of the bowel are reported as having been caused by this latter method.[21] Bryant[22] says that inflation is under all circumstances hazardous and dangerous, although successes in exceptional cases are recorded, and he cannot recommend injections of water because of this great danger.[23] Notwithstanding these opinions, most surgeons are convinced that the dangers of inflation or injection are no greater than those of laparotomy. Insufflation should first be tried, but if this is not possible, then enemata should be administered.

Mr. Clement Lucas[24] advises the following method of inflation: "An ordinary bellows is connected with a gum-elastic enema tube by means of a piece of rubber tubing which is firmly wired at the end; around the end of the enema tube lint should be wrapped so as to make a conical air-tight base; the tube is inserted about three inches into the rectum, and the anus closed by a conical plug of lint. Further to guard against the escape of air, an assistant should press the buttocks of the patient close together; an anæsthetic should be administered." Mr. Lucas advises that inflation should be performed with the patient in the inverted position.

There are different methods of administering enemata: the ordinary enema syringe will do very well, but the fountain or siphon syringe is much better. The return of water is prevented by an assistant, who presses the buttocks of the patient firmly together. The water should be warm, and should be injected slowly and continuously. The difficulty of retaining the injected fluid may be obviated by the employment of Lund's elastic ring and handle.[25] This instrument was devised by Mr. Lund to prevent the return of air in insufflation, and so is suitable to cases where either air or water is injected.

Should the surgeon be fortunate enough to effect reduction by these means, the after-treatment is simple: milk diet, with small doses of opium to relieve pain and give rest to the parts.

Failing to reduce the invagination by inflation of air or enemata of warm water, operative measures should be at once resorted to—within twenty-four hours, if possible, and not later than forty-eight. Laparotomy by median section is the preferable operation. If, on opening the abdomen, reduction prove impossible owing to the firmness of the adhesions, the affected portion of bowel should be resected and the divided ends immediately sutured and returned into the abdomen, or stitched to the abdominal wound, and an artificial anus established. Dr. Heinrich Braun,[26] of Jena, has collected 63 cases in which an operation was done for intussusception. In 53 of these cases laparotomy was performed on 31 children and 10 adults; 4 children and 8 adults recovered. In 25 cases reduction was found to be impossible; all died. In 12 cases resection was performed, with a recovery in 1 case only. In 9 cases enterotomy was performed in preference to excision, and all died. In 10 cases enterotomy was performed without looking for the invagination, and every case was fatal. These results are certainly not very encouraging, but let us hope that with a greater experience of operations on the intestines, and an earlier resort to the operation in cases of intussusception, the results in the future may be very much better.

Widerhofer and Herz,[27] of Vienna, each report a series of ten cases of laparotomy for invagination, with three recoveries in each series, or a mortality of seventy per cent.

Weinlechner advocates median laparotomy within twenty-four hours in children and forty-eight in adults.

Other methods of treatment are advocated for acute intussusception. Kussmaul recommends the free washing out of the stomach. Busch[28] has practised massage three times with success. When low down, reduction by

bougies has been well spoken of by some, but this treatment is dangerous and cannot be recommended.

Weinlechner,[28] when the invagination is low down in the sigmoid flexure or in the rectum, has five times ligatured the invaginated portion by introducing a rubber tube and passing a ligature over it. Others,[29] when the invagination was low down, have cut off the invaginated portion, and then returned the bowel.

According to Mr. Treves,[30] seventy per cent. of all cases of intussusception terminate in death, and eighty per cent. of these within seven days. Elimination of the gut by gangrene occurs in twenty-four per cent., and no less than forty per cent. of the patients die of the immediate results of the separation, and many others, later on, of stricture, the results of the gangrene. Fagge[31] remarks that in those cases of natural cure the fatal result is postponed, not prevented.

Intussusception (Chronic).—Chronic intussusception is attended by a great mortality. Medicinal treatment is of little avail; opium and laxatives give temporary relief, and reduction has in rare cases been effected by inflation and enemata. The only means by which relief can be hoped for when the foregoing measures have failed is abdominal section. If, when the abdomen is opened, the reduction cannot be accomplished, the whole mass ought to be excised and an artificial anus established.

In some cases where the intussusception is low down and chronic, it may be temporarily relieved by the performance of a right lumbar colotomy.

Foreign Bodies.—The cases of obstruction caused by foreign bodies are not common. Gall-stones are most frequently the foreign bodies found. Free doses of opium should be given, followed by aperients, and, where complete obstruction exists, laparotomy should be performed, the intestine incised, and the wound closed with a Czerny-Lembert suture and the bowel returned. Some advise the establishment of an artificial anus in preference to returning the gut. Lange[32] reports a case of obstruction caused by impacted gall-stones and general peritonitis. Laparotomy was performed, but the patient died in eight hours. Dr. H. F. Beam[33] relates a case of intestinal obstruction caused by a calculus in the ileum the size of a walnut; it could be felt through the abdominal walls. An incision was made over the spot and the calculus removed. The patient made a rapid recovery.

P. J. Wising,[34] in recognized cases of ileus from gall-stone, recommends first the employment of purgatives; if these fail, then copious enemata of water. Simple enemata, he holds, are perfectly harmless, but those of an irritating character should be avoided. Opiates should be given, and the strength of the patient sustained by nutrient enemata. He does not advise early laparotomy, but says that, when everything else fails, it should be undertaken.

Fæcal Accumulation.—Obstruction due to fæcal accumulation is of occasional occurrence. The point of obstruction is generally in the rectum, which is filled with a hard, immovable mass, above which the bowel is much distended with semi-fluid fæces. The best means of relief are afforded by copious enemata of warm water administered in the knee and elbow position. Continuous irrigation by the siphon syringe is very efficacious, and, if employed for half an hour at a time, the hardest mass softens and gradually becomes disintegrated. The stream of water should be directed against the obstructing mass by means of a rectal tube. Before commencing enemata it is often advisable to inject a few ounces of olive-oil. Copious injections of sweet oil are advised by some, with spirits of turpentine in the proportion of one drachm to the pint of oil. Metallic mercury was a favorite remedy with the old physicians, and has lately been strongly advocated by Matignon, of Paris. Occasionally, when low down, the fæcal mass may be removed by scoop or spoon.

Colotomy has been performed in cases of obstruction due to fæcal accumulation. In most of these cases, however, there has been a mistake in diagnosis. It can only be rarely required in fæcal obstruction, and should not be resorted to till all other means of relief have failed.

Stricture.—The treatment of obstruction due to stricture is considered under Chronic Obstruction.

Francis J. Shepherd.

[1] British Medical Journal, April 18, 1885.
[2] Intestinal Obstruction, p. 420.
[3] Discussion at Liverpool Medical Institution, December, 1884. Reported in London Lancet.
[4] Brit. Med. Jour., August 29, 1885.
[5] American Journal of the Medical Sciences, January, 1886.
[6] Lancet, December 13, 1884, p. 1065.
[7] J. K. Fowler: London Lancet, June 30, 1883.
[8] Bull. de Therapie, May 15, 1870.
[9] London Lancet, vol. ii., 1885, p. 570.
[10] Intestinal Obstruction, p. 449.
[11] Archiv f. klin. Chirurgie, 1884, Bd. xxx.
[12] Brit. Med. Jour., August 24, 1885.
[13] Ibid.
[14] See case of Mr. Lawson, London Lancet, vol. i., 1879, p. 87.
[15] Gaz. Méd. de Paris, April 25, 1886.
[16] John Syer Bristowe, in Reynold's System of Medicine, vol. iii., p. 83.
[17] New York Medical Journal, February 20, 1886.
[18] Intestinal Obstruction, p. 498.
[19] Medico-Chirurgical Transactions, vol. lvii.
[20] See Opium.
[21] Weinlechner: Report of Discussion of the Society of Physicians of Vienna. Reported in La Semaine Médicale, April 7, 1886.
[22] Harveian Lecture, Brit. Med. Jour., November 22, 1884.
[23] System of Surgery, 4th edition, vol. i., p. 718.
[24] London Lancet, January 16, 1886.
[25] Ibid., 1869, vol. ii., p. 609.
[26] Archiv f. klin. Chir., 1886, Bd. xxxiii., Hft. 2.
[27] Quoted in La Semaine Médicale, April 7, 1886.
[28] La Semaine Médicale, April 7, 1886.
[29] Fuller in New York Medical Record, October 14, 1882.
[30] Brit. Med. Jour., August 29, 1885.
[31] Guy's Hosp. Rep., 1869.
[32] Medical News, January 16, 1886.
[33] New York Medical Record, October 17, 1885.
[34] Nord. Med. Ark., Bd. xvii., No. 18 (quoted in Centralblatt f. Chir., No. 20, 1886).

INTESTINAL PERISTALSIS. Intestinal peristalsis, *motus peristalticus, seu vermicularis*, is the name given to the peculiar rhythmical, successive contraction of contiguous muscular fibres of the intestine. Similar movements have been noticed in the heart, especially the auricular appendices (see The Heart, vol. i., p. 559), in the ureters, Fallopian tubes, and uteri of some animals, besides the very familiar movements of caterpillars, worms, and the like. In the intestines, as elsewhere, the movement is mainly accomplished by the circular muscular fibres, though it is modified by the longitudinal fibres and by the points of resistance offered by the attachments of the mesenteries. As a result of these other factors we notice, (1) true vermicular movement; (2) longitudinal contraction and relaxation of portions of the intestine, or gliding movement; and (3) rotatory or, rather, to and fro movements of individual coils (Fig. 1844), which may turn so completely over as to present first one flat surface of the attached mesentery, and then the other. This is called pendulum movement by Nothnagel, and he ascribes it to bubbles of gas meeting with the fluid contents.

The use of peristalsis is primarily to propel the food and waste matters onward from the duodenum toward the rectum. Subsidiary uses are, (1) to assist in mixing the food and digestive fluids; (2) to establish currents in the fluid contents of the upper part of the intestine which shall bring nutrient matter into contact with extensive absorbing surfaces; and (3) to enable the coils to turn and glide over one another, and thus accommodate themselves to the constantly varying internal pressure of the abdomen. Were it not for the latter important feature, circumstances like the accumulation of fæces, or flatus, a distended stomach, bladder, or uterus, tumors, abscesses, tight lacing, etc., would necessarily frequently result in intestinal occlusion or strangulation. Experiments are wanting to show what influence the contraction of the circular fibres may have upon absorption, by making the internal intestinal pressure greater than that of the surrounding blood-vessels and lymphatics. It has been suggested that absorption might be so favored, but if the intestinal wall squeezed upon its contents so hard, it seems that it must, at the same time, greatly compress its own blood-vessels and lymphatics. Undoubtedly, the capillaries included between the contracting muscular fibres must be momentarily compressed by a peristaltic "wave," and this may possibly affect to some extent the activity of the intestinal circulation. The emulsion of fat is said to be aided, not by the force of the contractions, but by the mixing and removal of the fluids.

Experimental Methods.—Many exhaustive experiments have been undertaken to make peristalsis graphic by means of delicate levers placed at intervals upon the surface of the intestine, the movements of which are readily traced by needles upon a revolving cylinder (the kymographion) covered with lamp-black. The natural difficulty is the extent and variety of the movement, for the several coils in slipping over one another will dislodge any delicate apparatus. Single loops have been carefully detached, with their portion of mesentery, through the vessels of which an artificial circulation is easily maintained for some hours (Ludwig, Salvioli). Kymographic tracings are in this way more easily obtained, while the method admits of the study of the action of various nutrient fluids and of drugs passed into the circulation. After devoting some time to the study of the levers, etc., the writer devised the better plan of adapting instantaneous photography to record the movements. The apparatus used and the method of experimentation is similar to that employed by the writer in taking the first instantaneous photographs of the movements of the heart (see article Heart, Movements of, vol. iii.), and the results are no less interesting and instructive. Reproductions of several of these photographs are here presented. Since these photographs were taken, the writer has had constructed a camera with a circular negative plate and shutter, revolved by a simple clock-work mechanism, with which he has successfully taken photographs at the extraordinary rate of ten per second, and it is believed that further study will soon throw more light upon the intimate nature of the peristaltic wave, which is at present so obscure. The

Fig. 1844.—Successive Instantaneous Photographs of Peristalsis (Thompson). The lower coil is seen to advance to a plane which in 3 is nearly at right angles to the position in 1. Simultaneously the principal upper coil is seen to recede in the opposite direction.

photographic method combines every advantage in its absolute accuracy and rapidity, the extent of the field of observation (not one or two coils, but the entire abdominal contents may be compared at once), and in the fact that it in no way interferes with any experiments simultaneously conducted, such as the application of any variety of stimuli and the study of the action of drugs. First, the intestine is exposed, and normal peristaltic waves are photographed ; and then a drug of some sort is given to the animal, and the resulting modified waves are recorded. The second-hand of a watch may be kept in the field of view and simultaneously photographed, to show the rate at which the contractions follow.

THE STIMULI which excite peristalsis are naturally those which excite protoplasm in general, viz., mechanical, thermic, electrical, chemical (including the quality of the blood), and nervous. The effects of two of these stimuli, acting simultaneously at different portions of the intestine, are shown in the accompanying photographs (Fig. 1845).

1. *Mechanical Stimuli.*—Scratching, pinching, pricking, etc., will excite a local contraction if the irritation be mild and applied directly to the surface of the intestine ; or if the irritation be stronger, a peristaltic wave which travels usually toward the anus. The presence in the intestine of certain articles of food, but more especially of waste matter, such as berry-seeds, the cellulose structure of oatmeal, green-corn, etc., acts as a strong stimulus to peristalsis. The same is true of any rough foreign bodies accidentally swallowed, such as bits of clam-shell, of chicken-bone, pins, etc. The mere presence of bulky food-stuffs in the small intestine, or of bulky fæces in the large intestine, excites peristalsis.

In chronic constipation, especially in neurasthenic, anæmic, or marasmic cases, the mechanical stimulus of massage over the abdominal wall is often of very great service. This probably acts like blisters, poultices, etc., by reflex stimulation of the intestinal vaso-motor nerves, which alters the amount of arterial blood passing to the intestinal ganglia and muscles.

The amount of food contained in the intestine influences peristaltic activity. An empty intestine soon ceases to move ; but if filled with food or moderately distended by gases, peristalsis is resumed. An empty intestine is said to never exhibit spontaneous true peristalsis (Nothnagel), but pendulum movements have been observed (Braam-Hochgeest).

2. *Thermic Stimuli.*—Both heat and cold influence peristalsis, but in very varying degrees. Moderate warmth favors peristaltic waves, but excessive warmth tends to relax the intestinal wall. Similarly, moderate degrees of cold excite peristalsis, but cold in excess (below 19° C., Horwath) soon brings the intestine to rest, either in contraction or relaxation. We employ cold-water enemata to excite the peristalsis of the lower bowel ; and we apply hot fomentations over the abdomen when

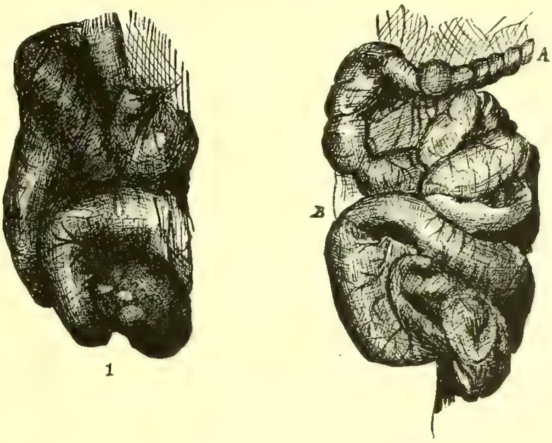

Fig. 1845.—Instantaneous Photographs of Peristalsis (Thompson). The loops in 1 and 2 are identical. In 1 they are seen at rest. In 2, at *B*, a strong peristaltic wave is seen passing downward, which has been excited by local application of potassium tartrate to the adjoining mesentery. In 2, at *A*, are seen strong contractions of the circular fibres, produced by the mechanical stimulus of pinching with a forceps. The contrast with the same loops in 1 is very marked.

there is colic, due perhaps to lack of peristalsis and distention of the intestine, or to excessive tonic contraction of the circular fibres at some part of the intestine. Exposure of the intestine to the air excites peristalsis. Cold water injected in the intestine checks peristalsis, but warm water increases it (Fick).

3. *Electrical stimuli* applied to the mesenteric nerves or the intestinal wall will excite contraction, local or general, according to the intensity. Induction shocks may be employed to reduce a hernia by exciting lively peristalsis. Electricity is occasionally employed over the abdominal wall for the relief of constipation.

4. *Chemical stimuli* are supposed to act in a great variety of ways, directly and indirectly, in promoting peristalsis. It is impossible to more than enumerate here the most important theories of their action. The reader is referred to articles upon the causes of constipation and the action of laxatives and cathartics.

Drugs may favor peristalsis or excite it :

(1) By exciting the intestinal muscle (*e.g.*, nicotin, muscarin, caffein).

(2) By exciting the terminal nerve-filaments in the intestinal wall, which cause contractile impulses to be reflected either from the intramural intestinal ganglia (see Art. Intestines, Anatomy of. Meissner's and Auerbach's Plexuses, vol. iv., p. 171) or from centres more remote.

(3) By affecting the blood-supply of the intestinal nerves and muscles.

(4) By improving the general bodily nutrition, and thereby improving the "tone" of the intestinal wall, *i.e.*, the readiness with which it responds to stimulation.

(5) By increasing the activity of glandular secretion, and especially the secretion of bile, which in turn is believed to excite peristalsis.

(6) By limiting absorption through the intestinal wall, and by controlling decomposition (*e.g.*, calomel).

Opium and morphine, in moderate doses, inhibit the nervous excitation of peristalsis, but the intestine remains contracted. Large doses are irritant and increase peristalsis (Brunton).

Belladonna diminishes the excitability of the plexus myentericus. Peptone injections promote peristalsis and cause the blood-vessels to become fuller (Brunton).

Salines increase the secretion of the intestinal glands, and at the same time their low diffusion hinders absorption (Hay). If water is withheld for two or three days before a concentrated saline is given, no catharsis results. After a salt is given, the blood, to replenish itself from loss of fluid through the intestinal vessels, takes up water from the tissues. If water at the same time be withheld, the blood becomes much more concentrated. Sodium or magnesium sulphate injected into the blood cause constipation by preventing transfusion into the intestine. As a result, the mucus and other contents of the intestine are dry, and are not easily moved along by peristalsis (Hay). When the intestinal contents are moved too rapidly but little water is absorbed, and hence the evacuations are fluid.

Salts of sodium produce peristaltic waves, which travel toward the pylorus. Salts of potassium produce localized sphincteric contraction, with little, if any, wave-movements when applied locally to the mesentery or intestinal wall (Nothnagel, Bardeleben). Nothnagel concludes from his experiments that potassium affects the musculature merely, while sodium irritates the ganglionic structures. Bardeleben finds that sodium resembles potassium more closely.

The activity of peristalsis is dependent upon the amount of O and CO_2 in the blood. Venous blood favors peristalsis. It increases, with dyspnœa, as soon as the vaso-constrictor centre is affected (Mayer, Basch). When the blood-vessels are greatly constricted, or empty, it ceases. Sometimes suffocation causes lessened peristalsis through inhibition by means of the higher nerve-centres.

When the aorta is compressed so that the intestinal blood becomes venous, peristalsis is greatly increased (Brunton). When the compression is removed, the peristalsis *increases* instead of diminishing. Compression of the vena porta or inferior vena cava yields a like result, although it is less marked.

When the intestines are first exposed in an animal after death they are at rest usually, but as the activity of the higher nerve-centres ceases, from lack of circulation, peristalsis is increased.

Many substances not usually employed therapeutically will cause active peristalsis when injected or locally applied, either inside or outside of the intestine. Such are, notably, nicotin and muscarin.

5. *Nervous Stimuli.*—The action of nerves upon peristalsis is both excitant and inhibitory. Irritation of the splanchnic plexus caused immediate inhibition of peristalsis (Pflüger) throughout the intestine, excepting in the lower colon and rectum. The irritation diminishes the calibre of the mesenteric vessels, and hence causes a temporary anæmia. The action seems therefore to be indirect. The inhibition is easily exhausted. If the circulation be already abnormal or has ceased, splanchnic irritation increases peristalsis (Braam-Hochgeest, Meyer, v. Basch). Electric or other irritation of the pneumogastric nerve increases the action of the small intestine. This effect is more marked if the splanchnic nerves are cut, and if the stomach and blood-vessels are full (Nothnagel). Conversely, severe blows over the abdomen have been known to stop the heart and cause instant death. Of the two intestinal plexuses, Auerbach's and Meissner's (see Art. Intestines, Anat. of, vol. iv., p. 171), Auerbach's is probably the more active in influencing peristalsis, while Meissner's is more active in exciting secretion, although both may be concerned with either function. It is through the former plexus that stimuli cause contractions when the intestine is severed from the mesentery and all external nerve-supply is cut off. If this centre is not stimulated, the movements stop. This condition is called aperistalsis. It occurs largely during sleep (Busch) and in intra-uterine life, in both of which states the blood is well supplied with oxygen (Brunton). If stimuli are applied in excess through the mesentery, violent evacuations take place, and there may be clonic contractions of the intestine at intervals. This condition is called dysperistalsis. It is caused by anæmia, or venous hyperæmia, the stimulus being either the want of O or the excess of CO_2, or both. Copious transfusion into the veins may congest the portal vein, and consequently the intestinal vessels, and cause peristalsis (Landois). On the approach of death there is frequently evacuation, caused by the loss of circulatory equilibrium or accumulation of CO_2.

Peristalsis is also excited by a great variety of nervous reflexes. This is, no doubt, due to the elaborate vascular and nerve-supply of the intestine, which brings it into close relationship with so many different organs. Extreme fright will sometimes excite immediate defecation. Sudden alterations in vascular pressure may do the same. It is argued by some that many cases of summer diarrhœa, which in adults are usually attributed to errors in diet, and which are often accompanied by a too lively peristalsis, are induced rather by sudden changes of temperature which chill the surface and alter the internal vascular pressure. A thorough knowledge of these reflexes is of great service in the treatment of simple diarrhœas and constipation.

The nervous impulses may as often cause inhibition of peristalsis. Habit has a great deal to do with regularity in the movement of the bowels. It is possible in many cases to train the rectum, so to speak, to operate at the same hour each day, and if the accustomed peristalsis which accompanies all the movements of defecation is deferred, in such cases, very great discomfort ensues. Cases of constipation (cited by Brunton) accompanying ovarian neuralgia have been cured by minute doses of morphine. The irritation conveyed from the ovary to the splanchnic plexus caused an inhibition of peristaltic movement. The morphine relieved the irritation. The inhibition was thus removed, and normal peristalsis was resumed. It is said that the mucous coat is capable of some degree of independent contraction, by the action of the muscularis mucosæ. It is believed by most observers (Engelmann, v. Brakel, Nothnagel, *et al.*) that the peristaltic waves travel by direct conduction from one muscle-fibre to the next, independently of nerves, as they are known to do in the heart and ureters. The waves may originate at any portion of the intestine, and usually a number may be observed simultaneously at more or less irregular intervals. The recovery of distention of the intestinal wall after a wave of contraction has passed along it may be due merely to its normal elasticity, or to active distention by expansion of intestinal gases after pressure upon them is removed. Individual waves do not travel the entire length of the intestine. They appear to cease at intervals and be replaced by new waves of greater intensity. As in all muscular contraction, there is always a latent period between the application of a stimulus and the resultant peristalsis. Continued or too violent stimulation soon fatigues the muscles so that their action is suspended, to be resumed again after a period of rest, provided the stimulation has not been too violent or too prolonged. This condition differs from dysperistalsis in that it is a true paresis from exhaustion. It may be caused by venous transfusion, which produces congestion of the portal, and consequently of the intestinal, system; by severe inflammation (inflammation at first increases peristalsis), by continued application of cold below 19° C. Meteorism accompanies the paresis.

The splanchnic is the sensory nerveof the intestine. When intestinal colic is very severe, most profound constitutional, vascular, cardiac, and nervous symptoms result. The heart's action may become very feeble, and the surface cold, pallid, and moist, and general convulsions may even occur (see Colic, Intestinal). The splanchnic is the vaso-motor nerve of the major portion of the intestine (see Intestines, Anat. of). That the stimulus to peristalsis is not purely due to vaso-motor action is proven by the fact that weak stimulation of the splanchnic nerve excites peristalsis before the calibre of the vessels has been affected (Braam-Hochgeest).

The effect of peristalsis is modified by the degree of fluidity or hardness of the intestinal contents. In enteric diseases, when too much mucus is secreted high up in the intestine it mixes with the food and keeps it semi-fluid. On the other hand, if the mucus is secreted low down it may coat over the hardened fæcal matter, so that the intestine in contracting glides over without propelling it. This is why acute intestinal catarrh in infants may sometimes be accompanied by constipation.

Antiperistalsis is a reversal of the peristaltic movement, so that the waves progress toward the pylorus and the intestinal contents are thus forced into the stomach. Under normal conditions this is said by Nothnagel and Landois not to occur, but Engelmann and others believe that it does exist normally. It occurs sometimes in cases of intestinal strangulation, intussusception, the violent irritation which may be caused by round-worms, with ileus, etc. The vomiting of intestinal contents in ileus is said to be due rather to pressure of the abdominal wall upon the empty intestine (Van Swieten, Nothnagel). It has recently been suggested that, as a treatment for intussusception, copious draughts of fluid be taken, which shall excite an antiperistalsis and relieve the intussusception by producing the opposite movement from that which caused it. It is caused by a violent contraction of a portion of the intestine, pushing several centimetres of the constricted part into a distended portion below. Intussusception seems to occur normally in some animals, like the rabbit. It may be produced more strongly by Faradization. In these cases it lasts only a few minutes (Nothnagel). The ileo-cæcal valve is generally supposed to check the passage of any of the contents of the large into the small intestine. The experiment of giving enemata by a force-pump to accomplish the same result has recently been successfully tried (see Illoway, Amer. Jour. Med. Sci., January, 1886, p. 168). The fæcal odor of stercoraceous ejecta is attributed to decomposition of food in the small intestine, not to fæcal matter.

It seems probable to the writer that a certain number of short peristaltic waves normally travel toward the pylorus—first, because such waves are easily excited by exceedingly mild stimuli; secondly, because such movement would more effectually mix the intestinal contents and promote digestion; and, thirdly, because in an intestine carefully guarded from external irritation one often sees a bubble of gas, confined between two constricted or occluded portions of intestine, move freely to and fro, like the bubble of an oscillating spirit-level. These antiperistaltic waves are less in frequency, force, and extent than the direct peristaltic waves. They may be produced by irritant enemata, such as concentrated solutions of $CuSO_4$, NaCl, KBr, etc. (Nothnagel). They do not follow a momentary constriction of the intestine.

The time occupied by food and fæces in traversing the intestine has often been measured, but the results vary greatly in different persons, and in the same person at different times. It is a matter of some importance in watching for pins, buttons, coins, or the like, which have been accidentally swallowed by children or adults. In a healthy adult the food remains from three to six hours, or longer, in the small intestine, and from twelve to twenty-four hours in the large intestine, where considerable water is absorbed and the contents, being of firmer consistency, move more slowly. The velocity of peristaltic waves varies in the different parts of the intestine. They are most rapid in the lower twenty centimetres of the ileum, which part is usually found empty; they are sluggish in the large intestine, and occur at long intervals only in the rectum. The duodenum and jejunum seem to maintain their peristalsis longer than other parts (Nothnagel).

Koch fed two hundred and fifty beads to a guinea-pig. In three hours half of them were still in the stomach, and the remaining half were mostly in the cæcum, while the small intestine was empty, showing that its peristalsis must have been very active.

Vella ligated an intestinal loop and made two fistulæ in it. A ball pushed in at one fistula was received at the other, and the time in traversing the distance between them was measured. As a result of these experiments the distance from mouth to anus, in the dog, was traversed in the estimated time of forty-five hours. The velocity of the ball was increased by electricity and by salt, and retarded by laudanum.

The large intestine is more sluggish, and its movements are less extensive than those of the small intestine. The longitudinal fibres act slowly and independently. When the surface of the large intestine is irritated by a needle, after a few seconds it is drawn into distinct ridges wherever the needle has touched. If the intestine be gently pricked at one point, a somewhat radiating contraction takes place from the centre of irritation. If the needle be drawn gently in parallel-lines, the appearance recorded by the photograph (Fig. 1846) results.

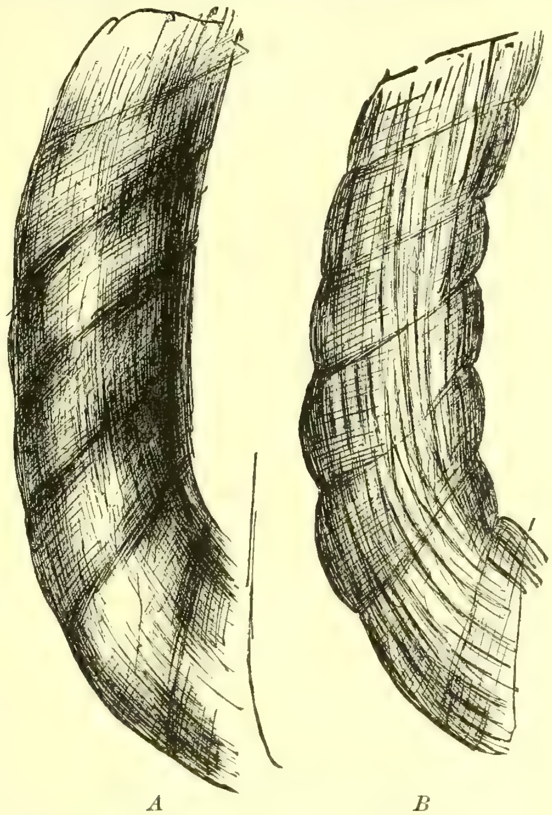

FIG. 1846.—Instantaneous Photographs of Peristalsis (Thompson). At *A* the large intestine is normal and smooth; at *B* the long fibres are puckered into ridges in the path of a needle drawn gently over the surface.

In those parts of the intestines of some animals (as the rabbit) which are more distinctly sacculated than in man, the separate sacculi are easily made to contract independently.

Peristalsis is more active, as a rule, in vegetable-feeders than in carnivora, for the nature of the diet gives greater bulk of fæcal matter. In persons with thin abdominal walls peristaltic movements may be felt, or even seen, if violent.

Defecation.—The fæces gradually accumulate in the sigmoid flexure and rectum above the internal sphincter, where they lie until sufficient pressure is brought to bear upon the sphincters of the rectum (see Intestines, Anatomy of), when for the first time their presence is felt. A nerve-centre (centrum anospinale, Budge) exists in the lumbar region of the cord—in rabbits between the sixth and seventh lumbar vertebræ, in dogs at the fifth (Masius). From this centre defecation is controlled. Defecation is accomplished by increased peristalsis of the rectum and other parts of the large intestine, assisted by voluntary pressure from the abdominal wall by closure of the glottis after a full inspiration, by retention of air in the lungs and fixation of the diaphragm. After the expulsion of the fæces the sphincter ani remains in a state of firm tonic contraction for about twenty minutes. After this it relaxes, and the elasticity of the parts around the anus keeps it closed without continued tonic sphincteric contraction (Landois), such as seems to exist at the neck of the bladder. The external sphincter can be contracted voluntarily, but if the rectal pressure becomes extreme the contraction will be suddenly overcome after reaching a certain limit. The voluntary contraction is aided by external rotation of the thighs and contraction of the glutei. Stimulation of the cerebral peduncles and of the cord below causes the external sphincter to contract. There seems also to be an inhibitory sphincteric centre which is excited by volition. Its excitation allows fæcal matter to pass through the anus without causing it to close reflexly (Landois). This centre is in the optic thalami (Masius) which communicate with the peduncles.

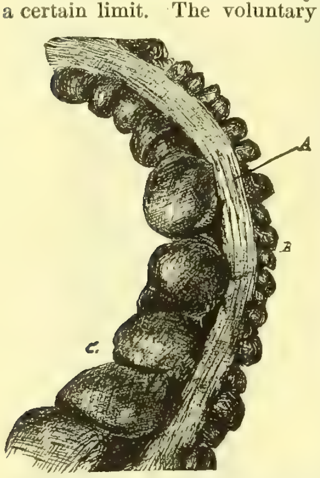

FIG. 1847.—Instantaneous Photograph of Peristalsis (Thompson). At *A* is shown a strong contraction of the longitudinal fibres, produced by mechanical irritation; at *B* the sacculi are greatly contracted; while at *C* they remain fully distended.

Short voluntary movements of the levator ani and external sphincter cause reflex stimulation of the plexus myentericus of the large intestine, and therefore accelerate defecation. The soft parts of the pelvic floor are forced downward in defecation, and the mucous membrane within the external sphincter is everted.

The levator ani pulls the anus upward over the protruding fæcal mass, and prevents distention of the pelvic fascia. Hyrtl says the fibres of the two levatores control the anus like the two cords of a tobacco-pouch. Between the evacuations of the anus, which in a healthy adult normally occur at least once in twenty-four hours, the rectum is empty. In cases of chronic constipation, especially in women, there may be no movement for several days, and not infrequently for two or three weeks. The rectum is then often found greatly distended by a mass of hard, dry fæcal matter, through the centre of which there is sometimes a channel for the occasional passage of fæces. Exceptionally, in apparently healthy individuals the rectum is evacuated only once in a week or two, and in other cases twice or thrice daily.

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William Gilman Thompson.

INTESTINE, ANATOMY OF. The intestine is that portion of the alimentary canal which extends from the pyloric orifice of the stomach, which opens into it, to the anus. It occupies a large part of the cavities of the abdomen and pelvis. It forms a long tube coiled in many loops, covered externally by a smooth coat derived from the peritoneum (peritoneum intestinale, p. viscerale), and lined within by mucous membrane and epithelium. Between these external and internal layers are arranged longitudinal and circular muscular fibres which, by a peculiar rhythmical contraction called peristalsis, propel the contents of the tube (see Intestinal Peristalsis).

The entire intestinal wall measures one millimetre in thickness upon the average, the muscular coat taking one-half. The intestine is principally supplied with blood from the cœliac and mesenteric branches of the abdominal aorta. Its blood is chiefly returned through branches of the vena porta, but in part through veins which empty into the vena cava inferior. The principal nerve-supply is derived from plexuses of the sympathetic system. The abundant lymphatics communicate with the thoracic duct. The intestine lies in contact, in some part of its course, with every organ in the abdomen and pelvis. It is naturally divided, by difference of calibre, into a large intestine (intestinum tenue) and a small intestine (intestinum crassum). The small intestine is further divided, by anatomical peculiarities, into the duodenum, jejunum, and ileum (Fig. 1848), and the large intestine is divided into the cæcum with its vermiform appendix, ascending, transverse, and descending colon, sigmoid flexure, and rectum (Fig. 1848). The portions of the intestine contained by the several regions of the abdomen are normally as follows: Right hypochondrium—part of duodenum, hepatic flexure of colon; left hypochondrium—splenic flexure of colon; umbilical region—transverse colon, lower part of duodenum, parts of jejunum and ileum; right lumbar region—ascending colon, parts of duodenum and jejunum; left lumbar—descending colon, part of jejunum; hypogastrium—part of ileum; right iliac region—cæcum, vermiform appendix, end

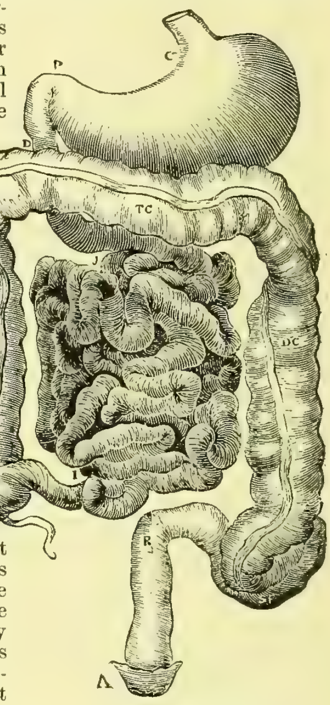

FIG. 1848.—The Intestine (Brinton). *C*, Cardiac; *P*, pyloric end of stomach; *D*, duodenum; *J*, jejunum; *I*, ileum; *CO*, cæcum and appendix; *AC*, ascending, *TC*, transverse, *DC*, descending colon; *SF*, sigmoid flexure; *R*, rectum; *A*, anus.

of ileum ; left iliac—sigmoid flexure of colon. The rectum lies in the pelvic cavity.

The intestine is at no point very firmly held as compared, for instance, with the œsophagus, but although the convolutions are capable of considerable gliding movement, their relative position, as above given, is very constant in different individuals and in the same individual. If displaced by any cause—tumors, ascitic fluid, etc.—the coils tend to return to their natural positions when the cause of displacement is removed, unless they have been bound in a new position by adhesions resulting from inflammation. The intestine is partly kept in position by vessels and nerves, and partly by modified folds of peritoneum known as mesenteries, which, more or less completely, embrace the coils. The mesenteries are divided into (1) the mesentery proper, which is attached over the spinal column and along the long axis of the jejunum and ileum, and (2) folds called the meso-cæcum, transverse and sigmoid meso-colon, and meso-rectum ; which latter are attached to the parts of the intestine indicated by their names. The line of attachment to the long axis of the intestine is termed the attached or mesenteric border. The opposite wall constitutes the free border. *The mesenteries* contain a very elaborate vascular system, nerve-vessels, and lymphatics, with numerous lymph-glands in connection with the latter, which are possibly to some extent connected with the elaboration of the blood (see article Mesentery). They are either applied directly to the intestine, or are attached to it by loose connective tissue.

THE SMALL INTESTINE measures about eight metres in length. Its average diameter is 2.5–3 ctm. Toward the pyloric end, in the duodenum, it is 3–4 ctm. in diameter, and it gradually decreases until near the lower end of the ileum, where it is two ctm. in diameter. It lies principally in the umbilical region, but it reaches outside of this upon all sides, occupying, when distended, the major part of the abdominal cavity. The coils are capable of considerable movement, gliding and rotatory, so that a given coil may at one time lie with its convexity toward the right, and at another be completely turned over toward the left. The advantages of this latitude of movement are obvious in preventing compression and strangulation by pressure from accumulated intestinal contents or from external causes.

The mesentery is attached over the left side of the spinal column, between the second lumbar vertebra and the sacro-iliac symphysis. It spreads out in a radiating manner to accommodate the length of the small intestine ; hence the farther a coil of intestine lies from the spinal column, the longer and freer is its portion of mesentery. The breadth of the mesentery varies between ten and fifteen centimetres. The small intestine is separated from the stomach by the pyloric sphincter, and from the large intestine by a valve, the ileo-cæcal valve, formed by an involution of its lining membrane (see below). It is greatly convoluted throughout its length (Fig. 1848). The folds or coils are termed ansæ, or gyri intestinales. Its divisions—the duodenum, jejunum, and ileum—are not clearly separate, but they present slight structural and functional differences presently to be defined. The coats of the small intestine are five : (1) an external tunica serosa ; (2) tunica muscularis ; (3) tunica submucosa ; (4) muscularis mucosæ ; (5) an internal tunica mucosa.

The tunica serosa is formed by the mesentery, which is derived from two layers of peritoneum. It envelops the entire small intestine with the exception of portions of the duodenum. It is smooth and lined on its free surface by squamous epithelium with projecting nuclei.

The tunica muscularis is three times as thick as the tunica serosa. It consists of (1) an external layer of longitudinal muscle-fibres and (2) an internal circular layer. A few spiral fibres are described by Verson as existing especially in the duodenum. The two layers are placed between the serous and submucous coats, and they are joined to each other by loose connective tissue. The fibres of each layer are about 0.225 mm. long and 0.005 mm. broad. The longitudinal layer is disposed about the entire wall, but it is best developed at the attached border. It is 0.1 thick. The circular layer is two or three times as thick as the longitudinal ; very rarely the proportion is reversed (Verson). Its fibres are grouped in small parallel bundles, with minute interstices between them. The longitudinal fibres are similarly grouped, but their bundles are broader and less thick than the circular bundles. The entire muscular coat becomes thinner toward the ileo-cæcal valve. The fibres are long, pale, non-striated, or involuntary. The action of both sets of fibres is to produce peristalsis (see Intestinal Peristalsis) and move the coils about.

The tunica submucosa (tunica nervosa, tunica fibrosa, tunica cellulosa) is formed of areolar tissue, which is

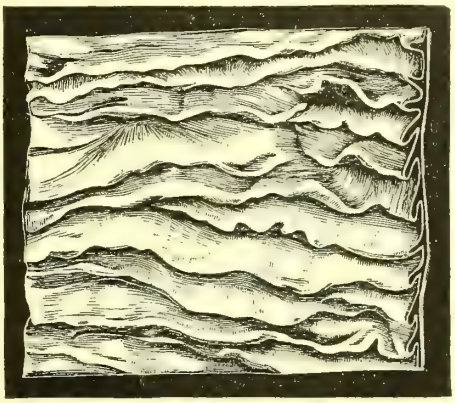

FIG. 1849.—Inner Surface of Small Intestine. Folds of mucous membrane. (Henle.)

composed of groups of interlacing fibrous bundles with some fine elastic fibres. It lies between the muscular coat and the muscularis mucosæ, being less firmly connected with the former. It forms a loose meshwork, in which the numerous blood-vessels and lymphatics divide and form plexuses before they enter the mucous membrane which it supports. It contains important nerve-structures (see below).

The muscularis mucosæ (Middeldorpf, Brücke) is a delicate layer of non-striated muscular fibres (external longitudinal, and internal circular) which lies immediately beneath the mucous coat and is intimately associated with it. This coat is less developed in man than in most animals.

The tunica mucosa, or villous coat, is studded with minute papillæ called villi. It is very red, owing to extreme vascularity, but toward the lower end of the small intes-

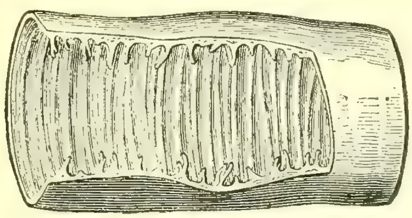

FIG. 1850.—Valvulæ Conniventes. (Brinton.) Portion of small intestine laid open.

tine it becomes thinner and paler. It consists of a layer of very fine, retiform connective tissue which contains blood-vessels, lymphatics, nerves, and many lymphoid corpuscles and branched cells. Embedded in this layer are numerous tubular glands. It is covered by a single layer of epithelial cells, principally columnar. The thickness of the muscularis mucosæ is 0.01 to 0.02 mm., that of the retiform layer is 0.1 mm., and that of the epithelial layer is 0.02 mm. (Henle). The mucous coat presents numerous folds (Fig. 1849), some of which may be smoothed out by distention, while others cannot be obliterated even by force. The latter are called valvulæ conniventes.

The valvulæ conniventes, or valves of Kerckring (Fig. 1850), are crescentic or circular folds formed by two layers of mucous membrane placed back to back, united by submucous tissue, but without fibres from the tunica musculosa. They are placed in a transverse or slightly oblique direction to the long axis of the intestine, and reach around one-half or two-thirds of its lumen. Some few are circular. They are rather closely set, with fairly regular intervals, and number between eight hundred and nine hundred. They are peculiar to the small intestine, and they are found from within a small distance of the pylorus (on its right side) to the ileo-cæcal valve. They are, however, most abundant in the duodenum and jejunum, and become both less numerous and shorter toward the pylorus and toward the ileum. On the average they are 6.0 to 7.0 mm. wide. Large and small ones often alternate, and they end with bifurcated extremities, or appear abruptly cut off. They are best developed about and below the entrance of the bile and pancreatic ducts into the duodenum. They increase the inner surface of the small intestine, so that it is estimated at 11,000 c.c.

The villi are found only in the small intestine (Fig. 1851). They are projections of the mucous coat into the intestinal lumen, which give it a sort of velvety appearance.

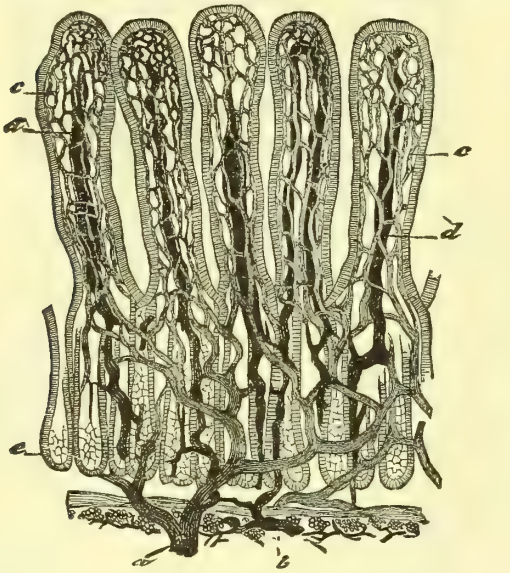

FIG. 1851.—Villi. (Cadiat.) Lacteals printed black, blood-vessels lighter. *a*, Artery; *b*, lymphatic; *c*, *c*, capillary plexuses at free end of villi; *d*, *d*, lacteals; *e*, Lieberkühn's glands.

They vary in shape, resembling cylinders or flattened cones, or they may appear leaf-like, or with club-shaped free extremities. They are usually independent, but two or three may be joined at their bases. They become smaller and less numerous in the ileum. Their number is variously estimated at from 4,000,000 (Krause) to 10,000,000 (Sappey). They are said to average twelve to the square millimetre where they are thickest. Their length averages 0.5 to 0.7 mm., and their diameter 0.06 to 0.18 mm. (Sappey). These measurements vary, as their shape alters with the amount of blood contained at different times. The villi consist of a stroma of wide-meshed, reticular connective tissue containing numerous lymph-cells, some of which exhibit considerable amœboid movement. In the centre of the villus is a lacteal vessel, or lymphatic (Fig. 1851, *d*, *d*), which runs parallel to the long axis of the villus and terminates at its free end in a closed, somehat enlarged, extremity, the ampulla. The other end of the lacteal communicates with a rich lymphatic plexus (Fig. 1851, *b*) which lies beneath the villus in the tunica submucosa. There is usually but a single lacteal for each villus, but some of the broader villi have two or even more in animals. During active intestinal digestion the lacteals appear white, distended with chyle (Fig. 1852). A single arterial twig enters each villus and runs by the side of the lacteal. Toward the end of the lacteal it divides into a capillary network, which becomes very fine and close about the ampulla. The blood from this plexus is returned by a single vein, which lies on the side of the villus opposite the artery. The larger vessels are somewhat twisted. The reticular connective tissue becomes denser toward the surface, and by some is said to form a distinct layer immediately beneath the basilar membrane of the epithelium. Verson takes exception to this statement, and fails to distinguish such a dense layer. Drasch says that the capillary plexus lies exclusively in this layer. The lacteal is surrounded by numerous lymphoid cells which join the branched cells found in the retiform tissue. The latter in turn join the flat cells of the basilar membrane of the epithelium. They are often forked about a connective-tissue corpuscle (Watney). The muscularis mucosæ sends from twelve to twenty non-striated muscular fibres into each villus. These fibres for the most part form two layers, one of which lies close to the central lacteal, the other in the parenchyma of the villus (Verson). These muscle-fibres anastomose with each other (His). They are exceedingly thin, and often not over 0.06 mm. long (Moleschott). Brücke, Kölliker, Henle, and others only describe longitudinal muscular fibres in the villi; but Moleschott, Wiegandt, and Donders maintain that muscle-fibres are seen running in circular or spiral directions. The function of the muscle-fibres is to retract the villus and compress the contents of the lacteal into the lymphatic plexus beneath the villus. Nerve-fibres are traced into the villi, but their termination is not decided.

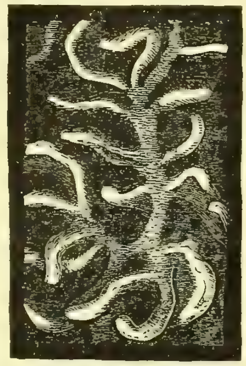

FIG. 1852.—Small Intestine. Inner surface during digestion, showing white lacteals distended with chyle. (Henle.)

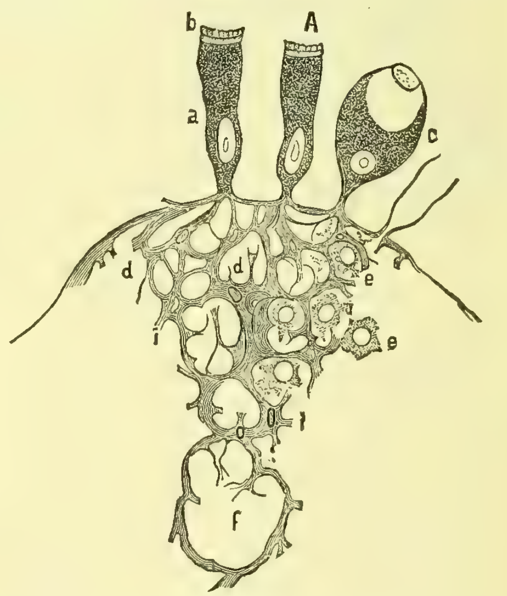

FIG. 1853.—Epithelium lining Intestine. *A*, Cylindrical; *C*, cup or goblet variety; *b*, striæ; *a*, nucleus; *i*, *i*, adenoid reticulum; *d*, *d*, spaces within the same containing lymphoid corpuscles; *e*, *e*, *f*, section of central lacteal. (Landois.)

The epithelium which covers the villi and lines the intestine is composed of two classes of cells (Fig. 1853):

1. Conical, cylindrical, or columnar cells, with bases directed outward so as to form a mosaic of a more or less hexagonal pattern and with pointed apices directed toward the basement membrane. These cells are granular, with clear oval nuclei (Fig. 1853, *a*). They are 0.02 mm. long. During digestion they swell somewhat and contain particles of fat, while their nuclei become less distinct. Their free ends present a peculiar striated appearance, due to differences in density (Fig. 1853, *b*). The striæ have been said by some to represent minute tubes through which chyle might pass (Kölliker, Fincke). Henle, Brettauer, Steinach have regarded them as solid rods. They form a distinct margin which is about one-tenth as thick as the length of the entire cell. 2. Cup-shaped or goblet-cells (Fig. 1853, *c*), which are embedded between the columnar cells and are far less numerous. They are not constantly found. They may be with or without nuclei. If nucleated, the nucleus is near the base of the cell, with its long axis perpendicular to that of the cell. The cells are attached to the basement membrane by pointed extremities. From their unattached bases cup-shaped projections, filled with clear fluid, reach to the surface. Their function is unknown. Some regard them as independent cells; others as degenerating cylindrical cells. They become swollen during digestion.

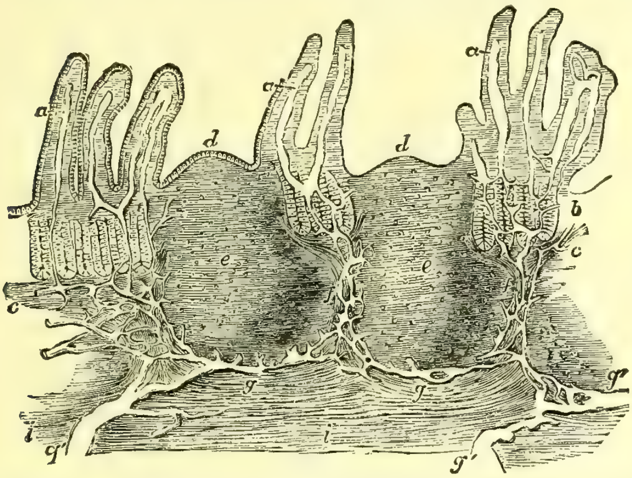

Fig. 1854.—Vertical Section of a Portion of a Peyer's Patch. (After Frey.) *a*, Villi with white lacteals in centre; *b*, follicles of Lieberkühn; *c. c*, muscularis mucosæ; *d*, *d*, cupola, or projecting part of the Peyer's follicles; *e*, *e*, central parts; *f*, *f*, reticulated lacteals between follicles, joined above by lacteals from villi; *g*, *g*, lymphatic plexus beneath follicles; *g'*, *g'*, *g'*, larger lacteals of submucous layer, *i*, *i*.

The function of the villi is the absorption of chyle.

Lieberkühn's crypts, or follicles (cryptæ minimæ, cryptæ mucosæ are the tubular glands (Fig. 1851, *e*) above alluded to, which are found throughout the small intestine and in a slightly modified form throughout the large intestine. They are very numerous and closely packed, the spaces between them being usually less than the diameter of the glands themselves. Their number is estimated at between forty and fifty millions (Sappey). They are tubular in shape; sometimes more or less bifurcated, more rarely divided into three. They open on the inner surface of the intestine, between the villi, by rounded orifices which are slightly narrower than the diameter of the tubes. The latter average 0.06 to 0.08 mm., and their depth averages 0.34 to 0.5 mm. (Verson). A few muscular fibres pass up between the crypts from the muscularis mucosæ (Kölliker, Brucke). The crypts are embedded in the tunica mucosa, and most of them reach to the muscularis mucosæ, upon which their closed extremities rest nearly perpendicularly. They are lined by the same varieties of cells which cover the villi. The cells rest upon a delicate, structureless membrana propria, and they are for the most part of flattened columnar form. They are surrounded by a narrow capillary and nerve-plexus (Drasch). They secrete a thin, watery, alkaline mucus—succus entericus. They are the smallest and most numerous glands of the intestine.

The solitary glands, folliculi sporades, are soft, rounded, white glandular structures, without ducts, which are found scattered at rather irregular intervals in the small intestine, sometimes coalesced, and also grouped together in bunches of ten to forty, usually twenty, which are called Peyer's patches (Fig. 1854). Similar solitary, ductless glands exist in the large intestine throughout, but especially in the cæcum.

The solitary glands push through the fibres of the muscularis mucosæ, and, raising the mucous coat, project a little into the lumen of the intestine. The projection is called the cupola. They lie upon the valvulæ conniventes as well as between them. They consist of dense retiform connective tissue, whose meshes contain abundant lymphoid corpuscles (Fig. 1856) and minute capillaries. Sometimes they join the surrounding lymphoid tissue, or hang into a lacteal sinus, but they are usually distinctly separated by a surrounding plexus of lymphatic vessels (Fig. 1856). The epithelial cells of the mucous membrane over these follicles often have lymphoid cells lying between them. They are covered by crypts, and often by a few villi.

Peyer's patches, or plaques (glandulæ agminatæ, g. sociæ, insulæ Peyeri—Peyer, 1677), are collections of lymphoid follicles (Figs. 1854 and 1855). The individual follicles in a plaque are a little smaller than when they occur as solitary glands, and they are not covered by villi. The crypts of Lieberkühn are arranged in circles about the margins of the individual glands. The plaques vary in number between ten and sixty. They are twice as abundant in youth as in adult life; less abundant, or absent, in old age. They average twenty in number. In shape they are usually oblong or oval (Fig. 1855); they may, however, be round or irregular. They occur opposite the attached border of the intestine, and their long axis is parallel to that of the intestine. The circular plaques occupy half the circumference of the intestine. The oval plaques average 3.3 ctm. in length (Böhm). They may be 7.20 ctm. long and 1.5 ctm. wide. The plaques are found scattered throughout the jejunum and ileum. Toward the ileo-cæcal valve they are more oval, larger, and more numerous. In the opposite direction they become rounder, smaller, and less numerous. They are exceptionally found in the lower end of the duodenum (Middledorpf). The follicles of the plaques do not always reach the surface. The lacteal plexuses are exceedingly abundant in the plaques (Fig. 1855), and beneath them the mucous and submucous coats are more closely united than elsewhere. The follicles are surrounded by capillary plexuses, from which very minute capillaries, not over 0.004 to 0.006 mm. in diameter (Toldt), converge and anastomose toward their centres (Kölliker). The venous radicles unite into large trunks. The solitary glands and plaques are generally supposed to belong to the lymphatic system, and to be concerned in the elaboration of the lymph from the chyle (Ziegler, Brücke, and others). The plaques are

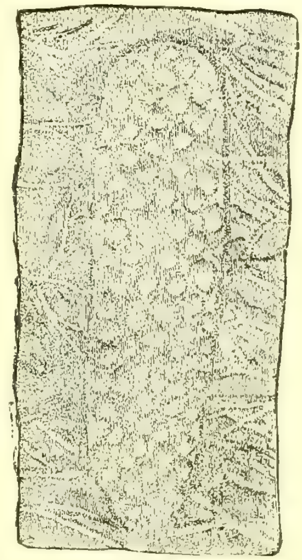

Fig. 1855.—Peyer's Patch. (Böhm.) Slightly enlarged.

the selected seat of ulceration in typhoid fever, and they, as well as the solitary follicles, are often involved in other diseases to a greater or less degree.

The arteries of the small intestine are derived from branches of the cœliac axis, and from the superior mesenteric artery. The duodenum is supplied by the pyloric and pancreatico-duodenal branches of the hepatic branch of the cœliac axis, and by the inferior pancreatico-duo-

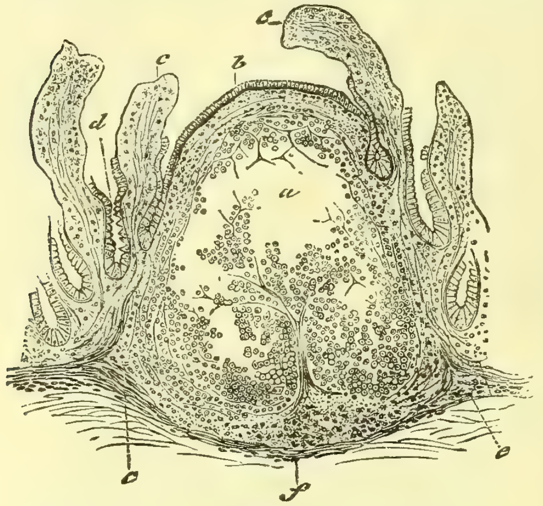

FIG. 1856.—*a*, Solitary follicle (Cadiat); *b*, epithelial covering; *c*, *c*, villi; *d*, follicles of Lieberkühn; *e*, *e*, muscularis mucosæ; *f*, submucous coat.

denal branch of the superior mesenteric artery. The superior mesenteric artery, after leaving the abdominal aorta, passes to the root of the mesentery and divides into some twenty branches, most of which form the arteriæ jejunales et ileæ. These branches form a series of three-arched plexuses, with frequent anastomoses in the mesentery; and finally, reaching the attached border of the intestine (ramuli intestinales), they encircle it somewhat obliquely, and meeting on the free border, anastomose again. The larger intestinal branches lie beneath the serous coat. They pierce the muscular coat, and form two series of oblong capillary meshes to accompany the longitudinal and circular fibres, respectively. They next ramify in a close network in the submucous coat, whence small branches pass to the valvulæ conniventes, villi, and glands. The small veins accompany the arteries, and correspond with them, but the larger veins unite to form branches of the vena mesenterica superior, which empties into the vena porta. Blood from the upper part of the duodenum is returned by the vena gastrica superior.

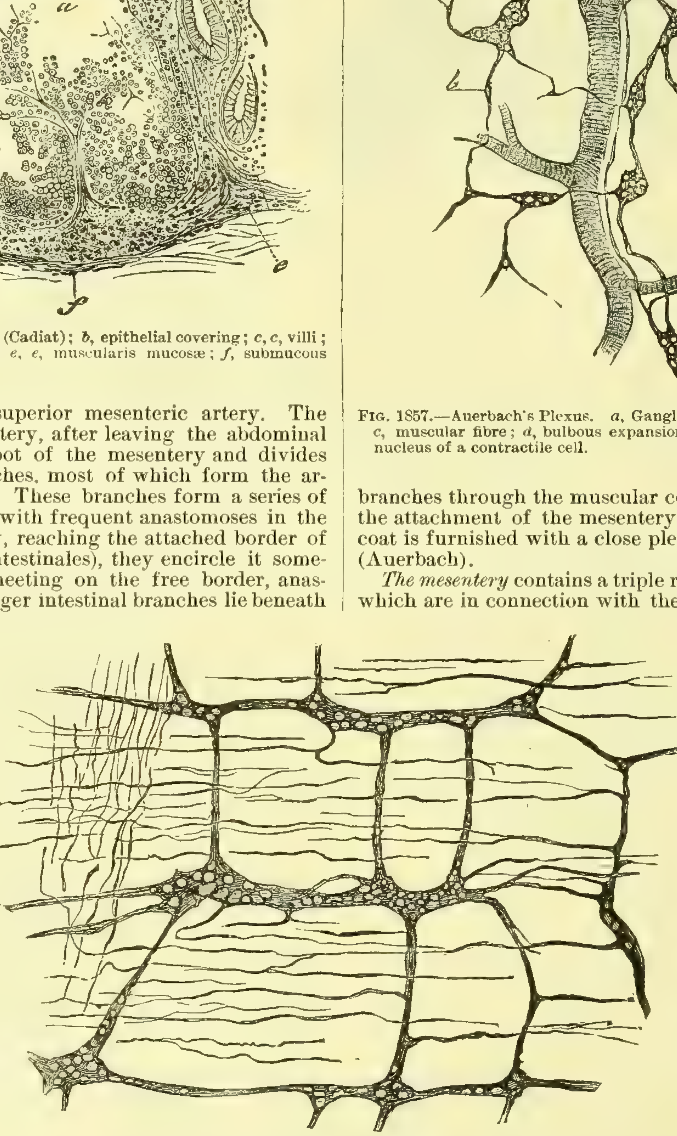

FIG. 1858.—Meissner's Plexus.

Hence all the blood of the small intestine is returned so as to pass through the liver. This is also true of most of the blood from the large intestine (see below).

The lymphatics of the small intestine, which are called lacteals (vasa lactea v. chylifera), lie in the mucous, submucous, and muscular coats. Those in the tunica mucosa form a rich plexus communicating with the central lacteals of the villi, and reach into the submucous coat where they form plexuses beneath and about the lymphoid follicles. The submucous plexus sends larger

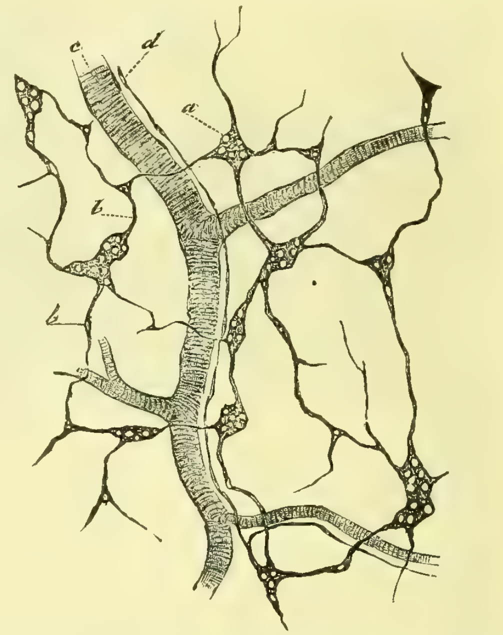

FIG. 1857.—Auerbach's Plexus. *a*, Ganglion-cell; *b*, *b*, nerve-branches; *c*, muscular fibre; *d*, bulbous expansion of nerve fibril opposite the nucleus of a contractile cell.

branches through the muscular coat. They then lie along the attachment of the mesentery. The entire muscular coat is furnished with a close plexus, called interlamellar (Auerbach).

The mesentery contains a triple row of mesenteric glands which are in connection with the lymphatics. Those of the first series are small and near the intestine; those of the second series are larger, as are those of the third which are near the root of the mesentery. The lymphatics of the mesentery finally form the truncus lymphaticus intestinum and ductus thoracicus.

The nerves of the small intestine are derived chiefly from the plexus mesentericus superior, formed by branches from the cœliac plexus, semilunar ganglion, and vagus. The duodenum also receives direct branches from the cœliac plexus and from the gastric plexus. There are also branches to the small intestine direct from the vagus, and from the anterior and posterior gastric plexuses. The nerves at first run with the superior mesenteric artery and its branches, but in the mesentery they leave them and run independently. They enter the intestinal wall and form a close

gangliated plexus, Auerbach's plexus, between the longitudinal and circular muscular layers, which completely surrounds the intestine. The ganglia are 0.4 mm. in diameter, and the nerve-fibres 0.002 to 0.004 mm. in diameter; they are all non-medullated.

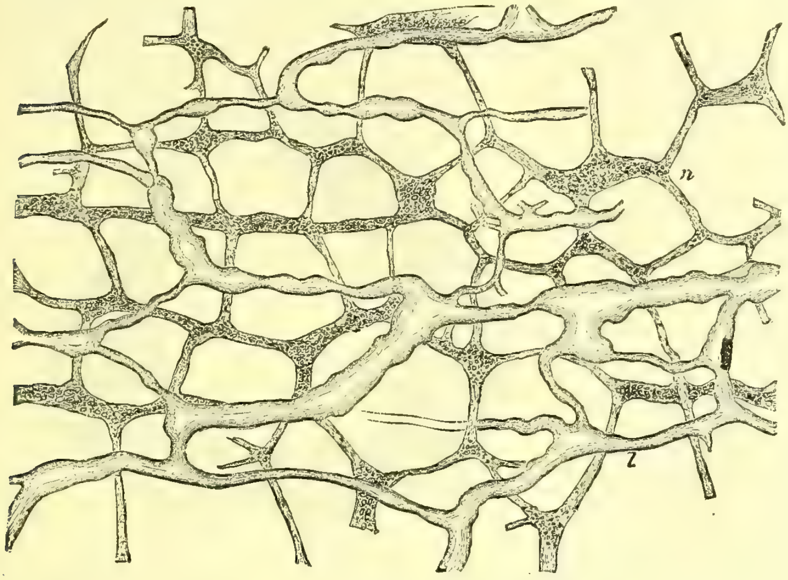

FIG. 1859.—Lymphatic Plexus (*l*) and Nervous Plexus (*n*) in the muscular coat of the intestine. (Auerbach.)

Auerbach's plexus, plexus myentericus, gives off fine branches which form lesser plexuses with polygonal meshes among the muscular fibres. At their nodes are numerous ganglion-cells, which are mostly multipolar. The nerve-fibres are pale, with a double contour; the majority pass to the circular muscle-fibres. Larger branches pass through the circular muscle-layer to the submucous coat, and form a second gangliated plexus, Meissner's plexus.

Meissner's plexus, plexus submucosus, contains finer fibrils than those of Auerbach's; they are pale, and form wide meshes. They contain ganglion-cells at the nodes, and these cells are also present in some of the thicker branches. From this plexus the fibres of the muscularis mucosæ are supplied. Some of the nerve-fibres penetrate the villi and take the direction of the branching cells contained in it, while others form very delicate anastomoses near the basement membrane of the epithelium. The final termination of the nerve-fibres is at present unknown.

The duodenum has certain relations and peculiarities of structure. Its name is derived from the fact that it is about as long as the breadth of twelve fingers. The duodenum is the widest and shortest division of the small intestine. Its length is eighteen to twenty centimetres, its average diameter 3 to 3.5 centimetres. It is less movable than some other parts of the intestine, and it lies farther back in the abdominal cavity, although very superficially placed at first. It lies principally in the epigastrium, where it forms a horseshoe curve, with the concavity directed toward the left, embracing the head of the pancreas. It is conveniently described in three parts: (1) A superior division, which is four to five centimetres long, lies on the right of the spinal column. It extends upward, backward, away from the pylorus, which empties into it, curves toward the neck of the gall-bladder on the right, where it bends at a right angle to form the second division. (2) The descending portion, which is seven centimetres long, lies almost perpendicularly. It is in contact with the right kidney; and it reaches across to the abdominal aorta, midway between the second and third lumbar vertebræ. It is only covered anteriorly by peritoneum, being joined by areolar tissue to the right kidney and vertebral column (Quain). Anteriorly it is crossed by the transverse colon and meso-colon. Some of the longitudinal fibres of its tunica muscularis pass between the lobules of the pancreatic gland on the left. The pancreatic and common bile-ducts together enter the duodenum near the junction of the descending and the third divisions (Fig. 1860). Occasionally a second lesser pancreatic duct enters a little lower (Fig. 1860). (3) The transverse portion, which is six to seven centimetres long, reaches to the commencement of the jejunum, where it forms a bend at almost a right angle—the flexura duodeno-jejunalis. It crosses the vena cava inferior and abdominal aorta. In front lie the superior mesenteric vessels. The left crus of the diaphragm and tissue surrounding the cœliac axis supply a band of tendinous muscular fibres to this division (Treitz, Hoffmann), which hold it practically immovable, even when the rest of the duodenum is dragged or pushed down by a heavy tumor or otherwise. The muscular coat of the duodenum is relatively thick.

The relations of the duodenum to neighboring vessels and organs are of great importance in connection with the frequency with which portions of it are involved by pyloric or hepatic carcinoma, catarrhal processes, ulcers consequent upon extensive abdominal burns, etc. It is occasionally excised in part for carcinoma, or incised to admit of forcible stretching of the pylorus for the dilatation of cicatricial tissue. For a more concise account of

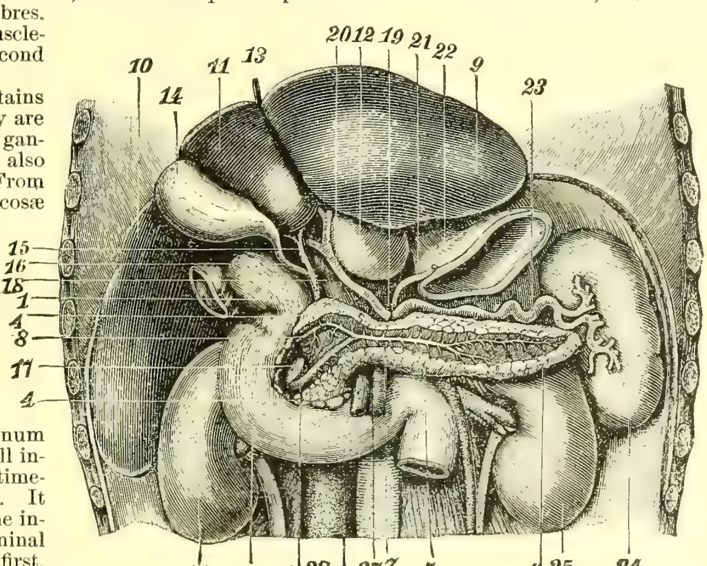

FIG. 1860.—Duodenum. (Brasch.) 1, Upper end of duodenum turned to right; 2, descending part; 3, lower end of duodenum; 4, head, 5, body, 6, extremity of pancreas; 7, main pancreatic duct; 8, lesser pancreatic ducts; 9, left lobe, 10, right lobe, 11, lobus quadratus, 12, lobus Spigelii of liver; 13, round ligament; 14, bladder; 15, 16, 17, bile-ducts; 18, vena porta; 19, arter. cœliaca; 20, arter. hepatica; 21, arter. gastrica super.; 22, pyloric end of stomach; 23, arter. splenica; 24, spleen; 25, left kidney; 26, right kidney; 27, upper mesenteric artery and vein; 28, vena cava infer.

these relations, the reader must be referred to works upon descriptive anatomy.

Brunner's glands. The duodenum presents a peculiarity of structure in the form of Brunner's glands. They are small, round, compound glands, grouped, as saccules or acini, about a common duct. There are five to ten acini for each gland, and their diameters are 0.07 to 0.14 mm. The saccules are structureless; they simply afford a membrana propria for the attachment of the flattened cylindrical epithelium which lines themselves and their common duct. These cells sometimes have beaked processes which overlie one another. These glands are thickest toward the pylorus, few, if any, occur at the lower end, and they are not found outside of the duodenum. They lie embedded in the submucous coat between the meshes of the capillaries and Meissner's plexus. Their slightly twisted ducts open freely upon the inner surface of the duodenum, and they secrete a fluid the function of which is poorly understood (see Intestines, Physiology of).

The jejunum (*jejunus*, empty) is that portion of the small intestine included between the duodenum and ileum.

The ileum (ειλειν, to twist) is the lowest division of the small intestine. It extends between the termination of the jejunum and the ileo-cæcal valve, which separates it from the first division of the large intestine, cæcum, into which it opens. The differences between the jejunum and the ileum are purely relative, and they are thus conveniently summarized by Quain:

The jejunum, as compared with the ileum, is wider, thicker, longer, heavier, more vascular, and more deeply colored; its villi and valvulæ conniventes are more numerous and better developed; its Peyer's plaques are smaller, fewer, and sometimes confined to the lower part.

A diverticulum is sometimes found at the lower part of the ileum. It is as wide as the ileum and 1.5 to 16 ctm. long, with its long axis at a right angle to that of the ileum. It is a relic of the embryonic tube which united the intestine with the umbilical vesicle in early embryonic life.

The ileo-cæcal valve (valvula Bauhini, v. Fallopii), or ileo-colic valve, separates the large and small intestine

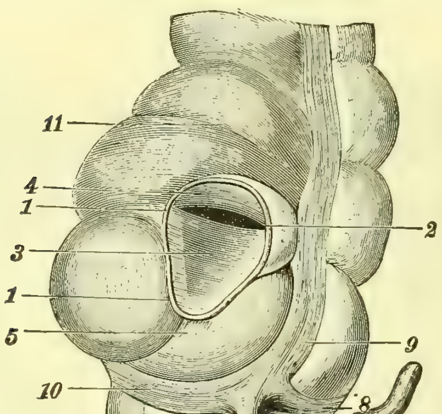

FIG. 1861.—The Cæcum. (Drasch.) 1, Transverse section of small intestine; 2, entrance into large intestine; 3, lower cusp of ileo-cæcal valve; 4, upper cusp; 5, muscle-band from small intestine to cæcum; 6, lower end of cæcum; 7, vermiform appendix; 8, posterior outer muscular band; 9, posterior inner do.; 10, anterior do.; 11, colon.

(Fig. 1861). It consists of an upper horizontal and a lower somewhat vertical fold of the tunica mucosa and musculosa. These folds are prolonged at the periphery, where they meet to form ridges or fræna (retinacula). The longitudinal muscular fibres become few and attenuated toward this valve on either side, and some of them curve in toward the circular layer (Verson). The surface of the valve which looks toward the ileum may have villi upon it, but the surface which presents toward the cæcum has no villi, although it has numerous crypts. There are some muscular fibres in the valve derived from the circular layer. The aperture of the valve is elongated, rounded at its anterior end, pointed posteriorly (Fig. 1861). The mechanism of the valve is to prevent reflux from the cæcum into the small intestine,

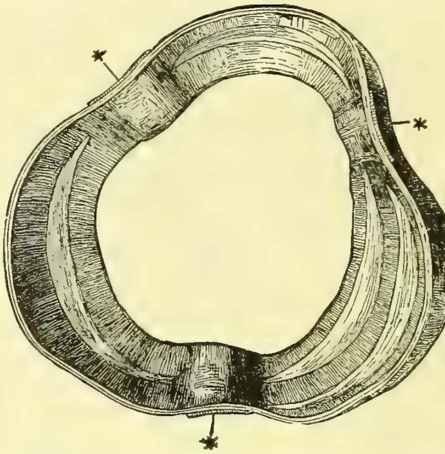

FIG. 1862.—Transverse Section of Colon. (Henle.) *, *, *, Ligamenta coli.

while the contents of the small intestine can freely pass into the large intestine. Distention of the cæcum stretches the fræna of the valve, which action closes the valve completely. It has been claimed that enemata have been injected from the anus beyond the ileo-cæcal valve. When this is the case, it is probable that force must be used sufficient to overcome the normal action of the valve.

THE LARGE INTESTINE differs from the small intestine chiefly in its greater calibre, irregular contour, bulging, curves, vermiform appendix, and the absence of villi, Peyer's plaques, and valvulæ conniventes. It is one and a half metre long, and it forms about one-sixth or one-seventh of the length of the entire intestinal canal. Like the small intestine, it has five coats. The tunica mucosa of the large intestine differs from that of the small intestine in that it is thicker, firmer, and paler. It is thrown into folds when empty, which are obliterated when it is full. The epithelium is like that of the small intestine. The muscularis mucosæ consists of thin, large fibres, which interlace freely, especially on the surface toward the lumen of the intestine. The follicles of Lieberkühn are longer and broader, more abundant, and more evenly disposed than in the small intestine, and at least half of them are bifurcated. There are numerous solitary glands which are covered by the mucous membrane. They are especially abundant in the cæcum and its appendix. These glands may, however, be wanting. When present, they are surrounded by wide lymph-sinuses lined by squamous epithelium (His). They are smaller than those of the small intestine.

The tunica musculosa resembles that of the small intestine, but in the cæcum and colon the longitudinal fibres are grouped into three long bands, or ligamenta coli. The posterior band lies over the attached border of the colon; the anterior band lies over the attachment of the great omentum (see Omentum); outside of the third or lateral band the majority of appendices epiploicæ are attached. These latter are numerous pediculated projections of the serous coat which contain fat. The three longitudinal muscular bands are considerably shorter than the portions of intestinal wall included between them, hence the latter are puckered into sacculi. If the bands are cut transversely, the sacculi are smoothed out to form a cylindrical wall. The external transverse depressions between the sacculi appear as ridges upon

Intestine.

the inner surface. In these ridges the circular muscular fibres are more abundant than over the sacculi themselves.

The nerves and lymphatics resemble in all respects those of the small intestine. The capillaries resemble somewhat those of the stomach (see article Stomach), but their arrangement does not materially differ from that of the small intestine.

The cæcum (*cæcus*, blind), intestinal cæcum, caput coli, is the first and shortest division of the large intestine (Fig. 1861). It is six to eight centimetres long and seven to eight centimetres wide, being the widest portion of the intestine. It lies in the right iliac fossa. Posteriorly it lies over the fascia iliaca dextra of the psoas major, and reaches to the anterior superior iliac spine. The ileum enters it obliquely near its union with the colon. It is the least movable part of the intestine. It is covered by peritoneum excepting posteriorly, where areolar tissue binds it over the fascia of the right iliac muscle. Sometimes it is almost entirely enveloped by peritoneum, the meso-cæcum, in which case it is less firmly attached.

The appendix vermiformis (processus v.) is a cul-de-sac two to fifteen centimetres long and one centimetre wide, directed upward, inward, and behind the cæcum (Fig. 1861). It arises from the fundus of the cæcum, into which it opens. Its closed end is often somewhat enlarged. It is not infrequently the site of inflammation, which may result in abscess or perforation, as a consequence of the impaction of sharp seeds or other foreign bodies. It is attached by a small mesentery. Its orifice is sometimes closed by a small valve made by a fold of mucous membrane.

The colon is the second and largest division of the large intestine. It is naturally divided into an ascending, transverse, and descending portion, and is continued by the sigmoid flexure at its lower end. The upper end is joined with the cæcum. Its wall is 1 to 1.5 mm. thick.

The arteries are the arteria mesenterica superior, which divides into the arteria colica dextra for the ascending colon, and the arteria colica media for the transverse colon; the arteria mesenterica inferior supplies the descending colon through the arteria colica sinistra. The veins of the colon empty into the vena mesenterica superior and inferior.

The nerves are derived from the plexus mesenterica superior and plexus solaris of the sympathetic for the right half of the colon, and from the plexus mesenterica inferior (derived from the plexus lumbo-aorticus) for the left half.

The ascending colon is relatively immovable. It starts from the cæcum, in the right iliac fossa, and extends almost vertically upward to the under surface of the liver, where it bends at a right angle, forming the flexura coli dextra (hepatica), at which point the transverse colon commences. It is wider than the latter. It is enveloped by peritoneum except posteriorly, where it is usually bound by areolar tissue to the fascia of the quadratus lumborum and anterior surface of the right kidney. In front and on the sides it is overlaid by coils of the ileum. It is sometimes attached by a short mesentery, the right meso-colon.

The transverse colon crosses from the right to the left hypochondrium (Fig. 1848). It sometimes, especially in women, lies as low as the umbilicus, or lower. In the latter case it descends obliquely to the midddle line, and then bends to form a loop, or "arch of the colon," with the concavity upward (Sappey). It is in contact above with the inferior surface of the liver, gall-bladder, lower end of the stomach, and lower end of the spleen. Below is the jejunum, and in front it is covered by the omentum. Behind lies the third division of the duodenum. The middle portion approaches the abdominal wall in front, but the extremities recede from it, and the left end is higher than the right. It is embraced by peritoneum, which posteriorly forms the transverse meso-colon.

The descending colon is continuous with the left extremity of the transverse colon, which forms with it a right angle—the splenic flexure (flexura coli sinistra, s. secunda, s. splenica) (Fig. 1848). At this flexure the peritoneum stretches across to the diaphragm at the level of the tenth or eleventh rib (Quain). This forms the costo-colic or pleuro-colic ligament. It has a crescentic border, and offers some support to the spleen as well (Haller). The descending colon terminates in the left iliac fossa, in the sigmoid flexure. It is invested by peritoneum excepting at the back, where it is attached by areolar tissue to the diaphragm, fascia of the quadratus lumborum, and left kidney. It is often overlaid by the jejunum.

The sigmoid flexure resembles somewhat the curve of a reversed S. It is the narrowest division of the colon; it occupies the left iliac fossa. It crosses the psoas muscle and joins the rectum. It is entirely surrounded by

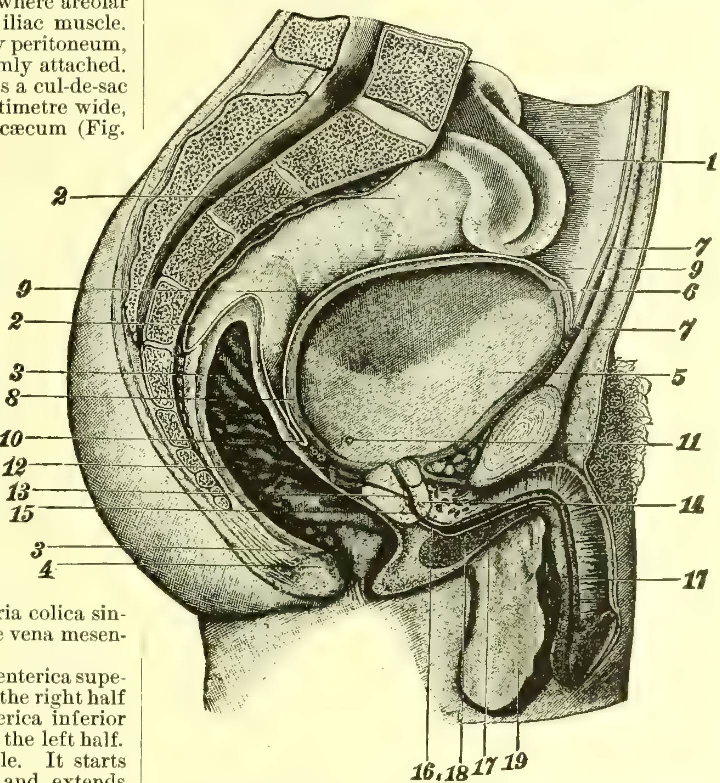

FIG. 1863.—The Rectum. (Drasch.) 1, Sigmoid flexure; 2, upper portion, 3, middle, 4, lower portion of rectum; 5, bladder; 6, fundus of bladder; 7, urachus; 8, base of bladder; 9, abdominal cavity; 10, Douglas' pouch; 11, left ureter; 12, vesicula seminalis; 13, posterior, 14, anterior portion of prostate; 15, prostatic part of urethra; 16, membranous urethra; 17, 18, penis; 19, testicle (left).

peritoneum, and is attached loosely by a meso-colon. It is in contact with the abdominal wall, when not overlaid by coils of the small intestine.

The rectum occupies the posterior part of the pelvic cavity, and extends from the left sacro-iliac articulation to the anus. It passes (1) obliquely from the sigmoid flexure downward and inward to the middle line, and (2) follows the curve of the sacrum and coccyx downward and forward, after which (3) it turns downward and backward to terminate in the anus. It is thus convenient to divide it into three portions for description. The first division ends at the centre of the third sacral vertebra, the second division ends at the tip of the coccyx, and the third at the anus. Its total length is eighteen to twenty-two centimetres. When empty it is scarcely larger than the small intestine, but it is capable of very considerable distention when filled with fæces, especially in women. In front of the middle portion are found in females the

cervix uteri and vagina; in males, the bladder, prostate gland, and vesiculæ seminales. In passing from the sigmoid flexure to the rectum, the anterior and external ligamenta coli unite and embrace the rectum in a uniform muscular layer (Sappey) which extends to the anus. Between them run other longitudinal fibres. There are no sacculi in the rectum. The upper part of the rectum is narrower than the sigmoid flexure; the lower portion just above the anus is considerably widened, especially in cases of chronic constipation. On the left side of the first division of the rectum are the left ureter and branches of the left internal iliac artery. A meso-rectum attaches this portion to the sacrum. The peritoneum over the rectum is quite thick. Toward the anus the rectum becomes less and less covered by peritoneum, which finally covers it anteriorly only, and then leaves it to be reflected to the bladder in the male, the uterus in the female, where it forms the recto-vesical or recto-vaginal pouch, excavatio Douglasii. After the peritoneum leaves the rectum it is bound by fatty areolar tissue to the coccyx and sacrum behind, and laterally to the contiguous muscles. This uncovered portion of the rectum touches the base of the bladder in front over a triangular area, on the sides of which it is in contact with the vesiculæ seminales, after which it passes beneath the prostate and turns down to the anus. After making this turn it is supported by the internal sphincter and levatores ani muscles (Hyrtl) and the triangular ligament of the urethra. The lower extremity of the rectum is surrounded by the sphincter ani externus muscle, which is one to two centimetres wide. In females the posterior vaginal wall and the rectum are firmly connected. Severe lacerations of the perineum tear through the posterior vaginal wall and perineum into the rectum. The muscular coat of the rectum is quite thick. The longitudinal fibres stop before reaching the anus. The circular fibres become more abundant toward the anus, and above it they form a band 0.6 ctm. thick and 3 ctm. high, known as the sphincter ani internus. This band may be felt upon digital examination. It is separated by fatty connective tissue from the striped muscle of the anus. The longitudinal fibres are paler than the circular, but both are more deeply colored toward the anus (Quain). The relations of the rectum to surrounding tissues and organs is of great practical importance, and for a more detailed account of them the reader must be referred to works upon descriptive anatomy. The rectum is often the seat of operation for polypi, prolapse, fissures, hæmorrhoids, carcinoma, etc., and it is very often used as a channel for digital examination of the prostate, bladder, uterus, etc. It may be the seat of dysenteric or other extensive ulceration. It may be explored for some distance by a speculum and incandescent electric light, and in rare cases, in an etherized subject, the hand and arm may be passed through it for some distance into the intestine to determine the site and nature of tumors—ovarian and the like. It is employed for evacuant and for nutrient enemata where the stomach fails, and it affords an available passage through which medication, in the form of suppositories or injections, can be applied for the relief of local or general affections. Rectal enemata of iced water are employed for the reduction of fever in some cases.

The rectum presents numerous folds upon its inner surface, most of which become obliterated when it is distended. Toward the anus the folds become longitudinal, where they form from five to eight columns called columnæ Morgagni; but higher up they take any direction, for the most part transverse or oblique. The columnæ are 7–14 mm. high, and they widen out toward the anus. Three of the oblique folds are especially prominent, the lowest one being opposite to the prostate gland (Houston). The middle of these crescentic folds is the only one which is constant (Hoffmann, Lamier). This is called the sphincter ani tertius (Hoffmann). It lies above the internal sphincter. Muscular fibres are said to enter the folds. The rectum is lined by mucous membrane which resembles that of the rest of the intestine, but toward the anus it contains fewer cells and vessels and more fibrous elements. It contains solitary glands, which appear depressed owing to the greater prominence of the crypts. These glands end near the columnæ Morgagni, where they are replaced by sebaceous glands. The crypts of the rectum are 0.07 mm. in diameter and 0.7 mm. deep. A few papillæ are found in the first division of the rectum, which are 0.2 mm. in diameter and 0.05 high.

The arteries of the rectum are the superior hæmorrhoidal from the inferior mesenteric, the middle hæmorrhoidal from the internal (or external) iliac, and the inferior hæmorrhoidal from the pudic. At the upper or first portion of the rectum the arteries penetrate the muscular layer and form plexuses in the tunica submucosa. At the second and third divisions the arteries, instead of forming a plexus, pass toward the anus parallel to the long axis of the rectum, communicating only occasionally until when, just within the anus, they join by large transverse branches (Quain). The veins follow the arteries and form a complicated hæmorrhoidal plexus. They return their blood in part through the vena cava inferior, by way of the internal iliac, and in part (from the upper half of the rectum) to the liver by way of the inferior mesenteric vein and vena porta.

The lymphatic vessels of the rectum are exceedingly numerous. Their arrangement is analogous to that in the intestine elsewhere.

The nerves are derived from the sacral (cerebro-spinal) plexus, and from the inferior mesenteric and hypogastric (sympathetic) plexuses.

The anus is a stellate orifice, capable of considerable dilatation, bounded within by mucous membrane, and without by the skin, which unites with the mucous membrane. When stretched by passing fæces the periphery of the anus becomes round. The loosely puckered skin about the anus contains numerous papillæ, sebaceous glands, and hairs.

The muscles of the anus are (1) the sphincter ani internus, above described; (2) the sphincter ani externus; and (3) the levatores ani.

The sphincter ani externus is thin, elliptical, 0.3 ctm. broad, and situated beneath the skin. Posteriorly it is attached to the tip and back of the coccyx by a small tendon, and, passing forward on either side of the anus, it blends at the central point of the perineum with the transverse and bulbo-cavernosus muscles.

The levatores ani arise anteriorly from the middle of the posterior surface of the pubes, and behind from the spine of the ischium and pelvic fascia between these two points. Some fibres, traced to the level of the obturator, pass downward and inward to the middle line of the pelvic floor. The posterior fasciculi are inserted on the side of the lower end of the coccyx. The adjoining fasciæ unite in the median raphé. The middle and greater part of the muscle is extended over the rectum between the two sphincters, with which it joins. The anterior bundles go between the rectum and genito-urinary passages, and unite beneath the bladder, prostate (or vagina), and adjoining part of the urethra.

The sphincters occlude the lower end of the rectum, and by their normal tension prevent evacuation of fæces except at proper intervals. The internal sphincter is wholly involuntary, and the external is partially so, but its contraction may be effected by the will. The levator ani (and coccygeus) elevates the lower part of the rectum, and inverts the anus after the eversion which results from defecation. Longitudinal muscle-fibres are described as running between the mucous membrane and internal sphincter (sustentator tunicæ mucosæ, Kohlrausch), but Henle says these are only the fibres belonging to the proper mucous coat. Ellis describes radiating fibres which pass from the submucous tissue inside of the sphincter ani to the subcutaneous tissue without.

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William Gilman Thompson.

INTESTINES, CONGENITAL MALFORMATIONS OF. The malformations of the intestines occasionally found existent at birth may be due either to arrest of development at an early period of intra-uterine life, or to disease (peritonitis) attacking the fœtus prior to birth. When due to the latter cause, the malformation consists in a narrowing or occlusion of some portion of the intestinal canal by constricting bands of plastic exudation. In such case the constriction may be found at any point of the intestines invested by the peritoneum. The symptoms of this condition are vomiting of meconium, straining, and the absence of fæcal evacuations. If the adventitious bands be of comparatively late formation, and be situated in the upper portion of the intestinal tract, there may be some meconium passed per anum, but true fæcal discharges will be absent. No treatment can be of any avail.

Of congenital malformations, strictly so called that is, deformities due to arrest or abnormality of fœtal development, there are many varieties. The most common of these are stricture and occlusion. Stricture may be due to a narrowing of the lumen of the gut by the presence of reduplications or folds in the mucous coat, or to the existence of an annular contraction at any point. The most common seats of obstruction from the first cause are in the neighborhood of the papilla duodenalis, or point of entrance of the pancreatic and common bile-ducts, and at about the union of the duodenum and jejunum. Stricture may also exist in the ileum at the point where the omphalo-mesenteric or vitelline duct joins the intestine, and in the sigmoid flexure, near its union with the rectum. In the two latter situations, however, there is more commonly a total obstruction, caused apparently by a twisting or knotting of the intestine. Sometimes there is a complete absence of the gut for a greater or less distance, or, in place of the canal, a simple cord may be found stretching between two normal portions of intestine. All these conditions are, of course, irremediable, and attempts to remove the trouble by operative measures are useless. The symptoms are the same as those due to obstruction from peritoneal bands.

The intestinal canal may be abnormally short or of undue length. An increase in length, when present, is found usually in the colon. A duplication of a portion of the intestine is sometimes seen, two tubes being found lying side by side. A not very uncommon malformation is the presence of a diverticulum in the ileum, due to a patency of the vitelline or omphalo-mesenteric duct which represents the primitive union of the yolk with the intestinal canal. This is sometimes called Meckel's diverticle. There may also be other diverticula in the ileum, the origin of which has not been satisfactorily explained. These are formed of the normal intestinal coverings, and may be the seat of inflammation or ulceration. A diverticulum is sometimes of considerable length, and may form adhesions by its tip to some other portion of the gut. Through the ring thus formed a loop of intestine may pass and, in later life, become strangulated. Other so-called false diverticula are sometimes found, more commonly in the colon, which consist in an opening or slit in the muscular coat through which the mucous lining projects. The vermiform appendix may vary greatly in length and diameter. In inversion of the viscera the relative positions of the different portions of the intestinal tract are also reversed, the cæcum being on the left and the sigmoid flexure on the right. In exstrophy of the bladder the intestine is not uncommonly defective, though complete eventration may exist without any abnormality in the formation of the intestines. These various malformations are not of common occurrence, and possess little or no clinical interest as they are beyond the reach of therapeutic measures.

Congenital malformations of the anus and rectum are, however, much more important than the conditions previously considered, since they may often be corrected by surgical measures. They may be divided into several classes: 1. Stricture, without complete occlusion, of the anus or rectum; a very common seat of this is at a point one and one-half or two inches above the anus, which marks the line of union of the rectal *cul-de-sac* with the cutaneous depression. 2. Occlusion due to a failure of the anus and rectum to unite, each terminating in a *cul-de-sac*, with an interval of from a few lines to several inches between them. 3. The anus is closed by a simple membrane or prolongation of the integument, the parts above being normal. 4. The anus is wanting entirely, the rectum ending in a blind extremity. 5. The anus is absent, and the rectum opens into the bladder, urethra, or vagina. 6. Both rectum and anus are wanting, but the bowel opens in some abnormal situation, such as the abdomen, chest, or back. Many of these conditions are amenable to surgical interference, and are not all necessarily fatal, as are the occlusive malformations of the intraperitoneal portion of the intestinal canal. For illustrations of the more common congenital malformations of the lower bowel, and for directions concerning treatment, the reader is referred to the article on Diseases of the Anus and Rectum, in vol. i. of this HANDBOOK. *T. L. S.*

INTESTINES: ENTERECTOMY. This term is applied to an operation which has for its object the excision and complete removal of a portion of the small intestine. The operation is completed either by stitching the cut ends of the bowels in the abdominal wound and forming an artificial anus, or by suturing the ends together so as to obtain union and preserve the integrity of the intestinal canal. The suturing of the bowel (enterorrhaphy) is usually, but not necessarily, implied when this operation is spoken of. The operation of enterectomy was first successfully performed by Ramdohr, in 1727, on a soldier from whom he removed two feet of intestine which had become gangrenous in a strangulated inguinal hernia. From that date up to 1846 the operation was performed 11 times, with the result of 7 complete cures, 1 recovery with an artificial anus, and 3 deaths. It was not performed again until 1873, when it was revived by Lücke (*Philadelphia Medical News*, March 15, 1884). In a review of this subject by MM. Bouilly and Assaky,[1] in 1883, the results are given of 65 enterectomies which had been performed in the preceding ten years (from 1873 to 1883). In 36 cases the operation was performed for gangrenous intestine. The results were 16 complete recoveries, 1 recovery with fistula, and 1 with artificial anus. In the other 29 cases the operation was performed for the cure of artificial anus. Of these, 17 recovered completely, 1 failed, and 11 died. Since the latter date (1883) the operation has been performed a number of times, and it has now an established place in surgery. Within the last century, too, a great many resection experiments have been performed upon the lower animals (especially upon dogs), both in Europe and America, the results of which have been generally very successful. Much has been learned from these experiments as to the difficulties and dangers of the operation, the process of repair in the intestine, and the ultimate effect upon the bowel and upon the general health of the animal. The results may be summarized as follows:

1. When failure occurred, it could generally be traced to an error or oversight in the details of the operation, or to some other preventable cause.
2. Very considerable portions of bowel could be removed with impunity.
3. After recovery no ill effects were observed, either locally or in the general health and nutrition of the animal.
4. When death occurred, it was generally due to peri-

tonitis, from the escape of fæcal matters or gases into the peritoneal cavity.

These conclusions seem to be justified by the recorded cases of enterectomy performed upon the human subject, and by the results of punctured and incised wounds of the abdomen. Thus Koeberlé, of Strasburg, successfully removed six and a half feet of the small intestine from a patient suffering from a series of strictures in the gut. It is well known, also, that punctured and small incised wounds of the abdomen in which the intestines are wounded are extremely dangerous, from the escape of fæcal matter into the peritoneum. Up to the present time enterectomy has been performed in the great majority of cases for the removal of gangrenous bowel, due to strangulation from some of its many causes, as hernia, intussusception, volvulus, etc. It may also be performed for irreducible intussusception, stricture, circular ulcer, epithelioma or other neoplasm, fæcal fistulæ, gunshot wounds or other injury to a segment of the bowel, and, in short, for obstruction from any cause which exists within the bowel itself and which cannot be cured by the simpler operation of enterotomy. The operation is *per se* a simple one, and if carefully performed, with strict attention to cleanliness and antiseptic precautions, the result will depend much more upon the disease for which it is undertaken than upon the operation itself; *e.g.*, in an acute obstruction which has lasted for a considerable time there is usually a degree of collapse which renders any operative measure very dangerous. It is impossible, therefore, to draw any conclusions from statistics of this operation without classifying the cases according to the disease for which it was performed and the condition of the patient at the time of operation. Its advantages over enterotomy are obvious. The latter is only a palliative operation. It may relieve, but can never cure; and if performed in the upper portion of the small intestine, it interferes seriously with nutrition. Again, when the intestine has become gangrenous from strangulation, the surgeon has no alternative but to remove it; and when cancer or sarcoma exists in the bowel and is confined to it, it would be folly to be satisfied with merely giving relief to the obstruction and to leave the disease to develop and destroy the patient. Again, in irreducible intussusception, enterectomy is probably, in most cases, the safer operation of the two, as there is great danger of the strangulated bowel sloughing and giving way in the peritoneal cavity, even after the obstruction has been relieved. Finally, the existence of an artificial anus is always a serious inconvenience—so serious as to be sufficient in itself to justify the undertaking of an operation of some danger and difficulty for its obliteration.

Enterectomy is performed in the following manner: Except in cases of hernia in which this operation is indicated, the abdomen is opened by an incision in any part, but preferably in the middle line. By making the incision in the linea alba, just below the umbilicus, no important structures are wounded, the bleeding is very slight and easily controlled, the wound can be enlarged very easily in any direction, and the hand of the operator can be introduced in the most favorable position to explore, if necessary, the whole abdominal cavity. Moreover, any portion of the jejunum or ileum can be withdrawn through a wound in this situation, and when the operation is completed the wound is easily closed and unites firmly, leaving no hernial protrusion. In inguinal or femoral hernia, when the sac is opened and the bowel discovered to be gangrenous, the constriction should be relieved and the bowel gently withdrawn, if possible, and enterectomy performed. In this case an abdominal incision will be unnecessary. If the obstruction can be definitely diagnosed in any special area of the abdomen, the incision may be made directly over it. In most cases, however, the median incision will be found to offer the greatest advantages. When all bleeding from the parietal wound has been arrested, the hand of the operator should be introduced, and the cavity carefully explored. If there is complete or nearly complete obstruction, the bowel below the obstruction will be collapsed, and will generally be found in the pelvic region. The obstructed portion should then be withdrawn through the abdominal wound, and the subsequent steps of the operation performed outside of the abdomen entirely. The wound itself should be covered with a warm, flat sponge, and its edges held together by an assistant, to prevent the entrance of blood or other foreign substances into the peritoneal cavity. The branches of the mesenteric artery leading to the part to be removed should now be ligatured by passing fine catgut ligatures round each branch with an aneurism-needle. The point at which the ligatures are applied will depend upon the size and shape of the piece of mesentery which it is intended to remove. Except in cases where it is necessary to remove a great length of bowel, it is better to excise a triangular piece of the mesentery, so that the edges may be stitched together after the ends of the bowel have been united. In this case the central artery should be ligated at some distance from the bowel, and those on either side at gradually decreasing distances until the outer ones are ligatured quite close to it. When several feet of intestine are removed, as in Koeberlé's case, it is, of course, impossible to excise the mesentery in this way. In any case, the objects to be kept in view are to secure against hæmorrhage into the peritoneum, to interfere with the blood-supply of the intestine as little as possible, and at the same time to dispose of the mesentery in such a way as to prevent future trouble from the entanglement of coils of intestine in loop-holes, cicatricial bands, etc. By ligaturing the vessels before excising the bowel the operation becomes almost a bloodless one. The intestine must now be occluded at points beyond the part to be excised. This can be most satisfactorily done by the fingers of an assistant. Some surgeons apply ligatures of silk, catgut, or india-rubber for this purpose, and clamps have been devised by Mr. Treves, of London, and Mr. Bishop, of Manchester. The application of either ligature or clamp is objectionable from the pressure exercised by it on the delicate tissues of the bowel, and which cannot be regulated with the same degree of nicety as with the fingers. The ligature is especially dangerous, as it will very readily cut through the muscular coat of the bowel just as it does in an artery. It has been objected that the fingers of an assistant tire during the operation, but, if they do, he can easily be relieved for a short time. The advantages of occluding the bowel in this way are, in addition to greater safety, that the assistant can control the bowel and allow it to empty itself if considered advisable, and can approximate and adjust the ends according to the directions of the operator. The bowel should now be cut across with scissors, care being taken to cut through healthy intestine, well free of the disease on either side, and, with a portion of the mesentery attached to it (triangular or otherwise as previously decided upon), removed. It is usually better to cut the bowel transversely, but if there is a great difference in the diameter of the two ends to be approximated, from distention of the upper and collapse of the lower, it may be advisable to cut them diagonally, or to resort to some other device to facilitate their adjustment. At this point the little artery which forms the terminal arch of the vasa intestini tenuis, and which runs longitudinally in the mesenteric attachment of the bowel, should be ligatured, and if the upper portion of the bowel is distended, it should be allowed to partially empty itself. In this way the obstruction is immediately relieved, and the tension to which the line of suture will be exposed on its return to the abdomen is greatly lessened. When cut across, the contraction of the muscular coat of the bowel causes a considerable narrowing just above the incision, and great eversion of the mucous membrane, as shown in the accompanying figure (Fig. 1864). This muscular retraction and eversion of mucous membrane makes it extremely difficult, if not impossible, to secure accurate coaptation of the serous and muscular coats of the bowel and inversion of the mucous lining.

On this account a great many plans have been devised to overcome the difficulty, and a great number of sutures have been described for the union of the ends of the resected intestine (*vide* Enterorrhaphy). The Czerny-Lem-

bert and Gussenbauer's sutures, however, have found most favor with the profession of late years, and have been very generally recommended and adopted. By these methods an inner row of sutures unites the mucous membrane, and an outer row brings the serous surfaces in contact with each other. The ends of the intestine, having been carefully cleansed with an antiseptic solution, should be sutured by whichever method has been selected, and with attention to the following details: The first suture should be introduced at the mesenteric attachment of the bowel, the next directly opposite on the free margin, then one midway between these two on either side, and so on, so that puckering or stretching may be avoided. As many sutures as possible should be applied, so as to prevent the escape of gas or fæcal matter from the bowel for the first few hours. From thirty to forty or more are required, according to the circumference of the bowel. In a very short time, however, swelling occurs around the sutures, and plastic lymph is effused, which effectually prevents extravasation. The ends of the bowel having been united, the mesentery should be attached by a few fine catgut sutures. The loop of bowel and its mesentery outside the abdomen should then be carefully cleansed by a soft, warm sponge, and the whole returned to the peritoneal cavity. The abdominal wound should now be closed with silk sutures, an antiseptic dressing applied, and the operation is complete. Some surgeons recommend that when the diseased portion has been excised the ends should be stitched in the wound and an artificial anus formed, and the operation completed by resecting the ends of the

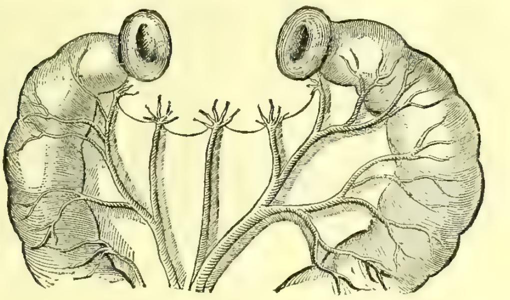

FIG. 1864.—From Address by Dr. Charles F. Parkes, Philadelphia Medical News, Vol. I., 1884.

bowel again and suturing them together at a subsequent operation, when the patient has recovered from the disease for which the excision was originally performed (*vide* Intestinal Obstruction, Treves). They argue in favor of this method, that patients suffering from obstruction are not in a condition to be subjected to a long and tedious operation, that the relief of the obstruction is of first importance, and that this can only be satisfactorily accomplished by allowing the bowel to empty itself gradually; and that, when obstruction has lasted for a considerable time, there is danger of the cut edges of the distended bowel sloughing. There can be no doubt but that these are valid reasons, and that it is very desirable to shorten the operation as much as possible, but there are also serious objections to this method. The bowel may, and ought to, be allowed to relieve itself sufficiently to overcome the hyperdistention which exists; but it should also allow some of its contents to pass into the distal portion to prevent further contraction and shrinkage of that part of the bowel, and if a sufficient number of sutures have been introduced, there is little fear of extravasation.

The time saved by stitching the ends of the intestine into the abdominal wound instead of uniting them can be very little, for this part of the operation must be very carefully performed to prevent the escape of liquid fæcal matter into the abdomen during or after the operation. Again, the experience of Koeberlé's case, already mentioned, and of many experimental resections, shows that it matters little how much of the intestine is removed, as far as the immediate effects are concerned, and therefore all diseased bowel, or bowel in a doubtful condition, should be removed. If this be done and the intestine be gently handled during the operation, avoiding clamps and ligatures, there will be little, if any, danger of sloughing at the line of suture. It is also conceded that, in any case where the obstruction is high up in the jejunum, the bowel should be united at the primary operation. Finally, subjecting the patient to a second intraperitoneal operation is always a serious matter, and surely should be avoided if possible. The safer rule to adopt is probably to suture the bowel immediately, and complete the operation, unless there is reason to fear that the patient's powers are failing, in which case it should be concluded as quickly as possible consistent with immediate safety. More experience is wanted before a definite rule can be laid down. At present no single operator has had sufficient experience to speak with authority on this point, and until the subject can be discussed from the standpoint of such experience a final decision cannot be arrived at. *James Bell.*

[1] Revue de Chirurgie. May and July, 1883.

INTESTINES: ENTERORRHAPHY. It is now a generally accepted principle in surgery that all wounds of the intestine, whether occurring accidentally or in the course of operative measures employed by the surgeon, should be closed by suture, except of course in cases where it is considered desirable to establish an artificial anus. The object to be attained is the closure of the wound in such a way as to prevent fæcal extravasation at the time, and to approximate and retain the edges of the wound in the manner best adapted to secure firm and good union without subsequent interference with the functions of the bowel. As early as the thirteenth century this subject received the attention of the leading minds in the profession, and has continued to do so up to the present time. Three principal methods of suturing wounds of the intestine have been adopted at different periods—the method of direct union, the method of invagination, and the method of approximating serous surfaces. Many modifications and combinations of these methods have been practised and their results brought before the profession, so that as many as thirty or forty different sutures have been described and are known by the names of the surgeons who introduced them. (For a full and historical account of this subject, the reader is referred to the "Medical and Surgical History of the War of the Rebellion," Part Second, Surgical Volume.)

FIRST METHOD.—Method of direct union. This plan, known as the method of the "four masters," * was practised by them and their contemporaries about the middle of the thirteenth century, and consisted in the attempt to unite the cut surfaces of the wounded intestine by suture over a firm cylinder placed within its cavity for support. They (the four masters) used segments of the trachea of an animal for this purpose; others used segments of dried intestine; others, again, cannulæ of wood or cardboard, or cylinders of wax or gelatine; and among their followers metallic rings or ferrules were also used for the same purpose. These were introduced in some of the modifications of this plan not only to give support to the wound, but the sutures were fixed to them in such a way that they were drawn into the intestine and expelled per anum with them. Modifications of this plan are still practised.

SECOND METHOD.—Method of invagination. This method was introduced by Ramdohr, who is credited with the first successful case of enterectomy in the human subject in 1727. There are so many objections, however, to this method that it is now obsolete. The chief objections to it are as follows:

1. It is undesirable to approximate a serous and a mucous surface, as union cannot readily occur between them.
2. It is often extremely difficult in operating to determine the upper from the lower end of the bowel.
3. It is with great difficulty that one portion of the bowel can be invaginated within the other.

* Four celebrated monks who practised surgery in Paris in the thirteenth century.

4. The difficulty in securing invagination unnecessarily prolongs the operation, and causes considerable bruising of the intestine and separation of the mesentery, which is the source of its blood-supply.

THIRD METHOD.—Method of approximation of serous surfaces, known as Lembert's method. This plan, modified in many ways, is the one most frequently employed by surgeons of the present day.

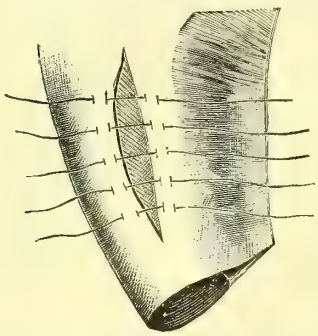

FIG. 1865.—Lembert's Suture. (From "Surgical History of the Rebellion.")

For partial wounds of the intestines of moderate extent either the simple interrupted suture or the original Lembert suture (Fig. 1865) answers every purpose, and is to be preferred to any other. For extensive wounds or transverse wounds involving the greater part or the whole of the circumference of the intestine, as in resection operations, the modifications of the Lembert suture, known as the Czerny-Lembert and Gussenbauer's sutures, are generally employed. (Another modification of the Lembert suture was described by Mr. E. S. Bishop, of Manchester, in a paper on Enterorrhapy, read before the surgical section of the British Medical Association in Cardiff in 1885.)

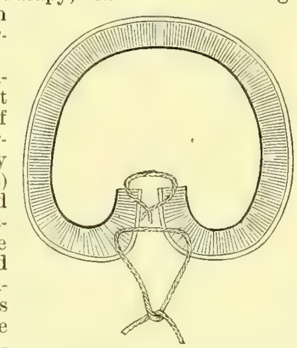

FIG. 1866.—Czerny-Lembert Suture. (From sketch.)

By the former the mucous surfaces are brought together by an inner row of sutures, and the serous surfaces by an outer row; by the latter (Gussenbauer's) the same result is secured by a single suture. Objections to these methods are that they are tedious and complicated, and by the inversion of the divided ends of the bowel a considerable degree of occlusion is temporarily produced. The continuous suture, either in the form of the seamstress' or the glover's suture, has been and is occasionally employed. It is not to be recommended, however, as in either form it produces a puckered and uneven suture, and if drawn sufficiently tight to secure close apposition of the divided ends, it is likely to produce a degree of constriction of the bowel. The simple interrupted suture has not been extensively employed in operations upon the human subject. It is impossible to unite by this suture the cut edges of the serous and muscular coats without including the everted mucous membrane. It has been recommended to pass the needle through the whole thickness of the bowel, and then pare away the mucous membrane. This is objectionable, as it is difficult of performance and leaves the bowel united by the serous coat alone. If, however, the needle be passed through all three coats of the bowel, entering about one-sixteenth to one-twelfth of an inch from the edge of the serous coat, and the suture drawn moderately tight, it will either displace the mucous membrane inward or cut through it. If interrupted sutures are introduced in this way very close together, around the whole circumference of the bowel, it will be found that the mucous lining which was greatly everted is now almos tentirely displaced into the interior of the intestine, and that the cut surfaces of the serous and muscular layers are in fairly accurate apposition. The objection urged against this suture is that primary union cannot occur in it on account of the mucous membrane interposed between the sutures, if not actually included in them. The observations of Mr. Travers and Professor Gross have shown, however, that the union of wounds of the intestine, whether left to the unaided efforts of nature or brought together by suture, is always effected by adhesive inflammation and the effusion of plastic lymph, and that it is probable that primary union of intestinal wounds never occurs. Dr. Otis ("Medical and Surgical History of the War of the Rebellion") concludes "that, whatever tissues are brought in contact, reunion takes place through plastic exudation, and the stitches that will prevent fæcal effusion long enough for adhesions to form will prove the best." What, then, can be better than the simple interrupted suture inserted in this way? It is simpler, more easily and quickly introduced, and less liable to yield than any other, while the redundant mucous membrane, closely applied along the line of suture in the interior of the intestine, would seem to be the best safeguard against immediate fæcal extravasation. Nor does the evidence in its favor rest on theoretical grounds alone. In a great many experimental resections performed upon the lower animals, by different operators, the use of this suture has been followed by as great if not a greater percentage of recoveries than any other, while the union secured was most satisfactory. Fig. 1868, from a photograph, shows the line of union in two pieces of intestine taken from dogs three months after operation. Both the mucous (*b*, *b*) and the serous (*a*, *a*) surfaces of the pieces are shown.

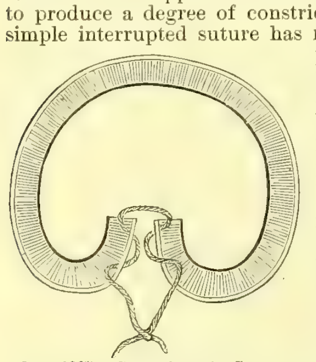

FIG. 1867.—Gussenbauer's Suture. (From sketch.)

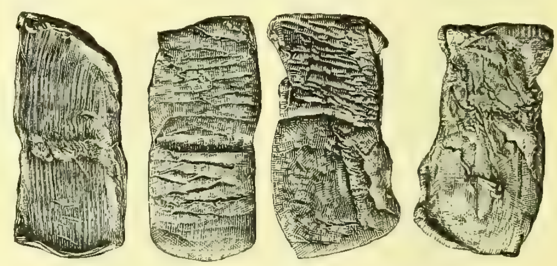

FIG. 1868.*

Professor Gross quotes five successful cases in the human subject where this suture was used. He has also shown, by a series of experiments, that all sutures applied to the intestine tend to find their way into its cavity, and that interrupted sutures do so much more rapidly than uninterrupted ones. It would seem, therefore, that while this suture has been allowed to fall into disuse on account of the impossibility of disposing of the extended mucous membrane, and accurately coaptating the cut edges of serous and muscular coats so as to secure primary union, other complicated and ingenious devices which have been resorted to have failed to produce better results. I believe that this suture will undoubtedly be more generally employed in the future than it has been of late years. The needle used in enterorrhaphy should be a fine, round sewing-needle, either straight or curved, and the suture should be of fine-spun silk. Catgut and other animal sutures cannot be depended upon, as when absorption begins in them the loop slackens and the edges of the wound may be drawn apart and allow of fæcal effusion. Some surgeons still recommend the introduction of cylindrical supports into the intestine to facilitate the application of the sutures. Mr. Treves advises the use

* The specimens from which these photographs were taken had been in spirit for three years, and are much shrunken.

of a rubber bag, which is introduced and inflated *in situ*, and collapsed and withdrawn when the line of suture is nearly completed. Others advise the use of cylinders of cocoa-butter, gelatine, etc.

It was formerly recommended that the intestine at the point of suture should be fixed to the abdominal wound, so that in case of fæcal extravasation the patient might recover with an artificial anus, or, the bowel being within easy reach of the surgeon, the accident might be remedied. Experience has shown, however, that it is far safer to cut the sutures off close to the intestine and return it to the abdominal cavity. The equable pressure and the freedom of peristalsis which is thus allowed seem to favor the rapid union of the wounded surfaces.

James Bell.

INTESTINES: ENTEROTOMY. This operation, which is usually performed for the *relief* of obstruction or for the removal of a foreign body, consists in cutting through the abdominal parietes, withdrawing a loop of the small intestine into the wound, and making an incision into it. It is the analogue of colotomy, but owing to the anatomical relations of the small intestine the peritoneum must be opened. If the operation be performed for the removal of a foreign body, the incision into the bowel may be closed by suture, the part returned to the abdomen, and the external wound closed. Usually, however, it is necessary to stitch the edges of the incised bowel to the skin wound and establish an artificial anus for a time. This artificial anus may subsequently be cured by an enterectomy.

Enterotomy was first proposed by Nélaton, and has been known as Nélaton's operation. His rule was to open the peritoneum in the groin by an incision a little above and parallel to Poupart's ligament, and external to the epigastric artery. The right groin was selected by preference, as it was found that in this situation the lower part of the ileum was usually reached. If performed for the relief of obstruction, the first distended loop of bowel which could be reached was brought down, carefully stitched to the edges of the abdominal wound, and opened. If the site of the obstruction can be diagnosed, the abdomen may be opened immediately over it, or in the middle line, or at any other part. Enterotomy may be performed for the relief of any of the forms of obstruction; but its effects are only palliative, and it is not to be recommended as a primary operation except for the removal of a foreign body, and possibly for syphilitic or dysenteric ulceration of the cæcum or colon, when the condition can be diagnosed with a sufficient degree of accuracy. In acute obstruction from hernia, intussusception, or volvulus, it is more dangerous than an exploratory laparotomy, by which the obstruction may be relieved or the part resected, for the reason that, although the relief to the obstruction may be satisfactory, there is every probability that the inflammatory process already established at the site of the obstruction will go on and end in gangrene and fæcal extravasation. In cancer or other neoplasm of the intestine the disease is left untouched, and will surely progress to a fatal issue. In chronic conditions, such as stricture, kinking of the bowel, etc., laparotomy should be performed and an accurate diagnosis made; and if it is found necessary to open the bowel, enterectomy is a far preferable operation. In short, as a primary operation, enterotomy must be looked upon at the present day, and in the light of recent and great advances in the surgery of the peritoneal cavity and its contents, as a most unsurgical proceeding. In certain cases, when a laparotomy has been performed, and enterectomy is found to be impossible or extremely difficult and dangerous from any cause, such as infiltration of neighboring organs with malignant disease or the matting together of the coils of intestine by peritonitis, enterotomy may offer the greatest hope of relief and the prolongation of life. *James Bell.*

INTESTINES, INFLAMMATION OF. Synonyms.—Enteritis, Mucous enteritis, Intestinal catarrh, Enteric catarrh, Endo-enteritis, Acute diarrhœa, Chronic diarrhœa; Fr., Entérite; Ger., Darmentzündung.

History and Differentiation.—Surgeon J. J. Woodward, U.S.A., in the "Medical and Surgical History of the War," Part Second, Medical Volume, gives an exceedingly interesting and wellnigh exhaustive *résumé* of prevalent definitions and theories concerning inflammatory affections of the bowels and peritoneum, from the earliest history of medicine. Hippocrates described intestinal obstruction under the name of εἰλεὸς. Even as late as the time of Boerhaave (1785), mucous enteritis, enteritis from obstruction, dysentery, and peritonitis failed of differentiation and recognition as separate, individual affections; and in description their distinct symptoms were commingled, in apparently inextricable confusion, under the single head of inflammation of the intestines. Cullen, in his "First Lines of the Practice of Physic" (1783), admits two varieties of enteritis, the phlegmonic and the erythematic, but in his chapter on enteritis treats only of the phlegmonic form, and his description applies chiefly to peritonitis. I quote his entire representation:

"The inflammation of the intestine, like that of the stomach, may be either phlegmonic or erythematic; but on the subject of the latter I have nothing to add to what has been said in the last chapter (on gastritis), and shall here therefore treat of the phlegmonic inflammation only.

"This inflammation may be known to be present by a fixed pain of the abdomen, attended with pyrexia, costiveness, and vomiting. Practical writers mention the pain in this case as felt in different parts of the abdomen, according to the different seat of the inflammation; and so, indeed, it sometimes happens; but very often the pain extends over the whole belly, and is felt more especially about the navel.

"The enteritis and gastritis arise from the like causes; but the former, more readily than the latter, proceeds from cold applied to the lower extremities or to the belly itself. The enteritis has also its own peculiar causes, as supervening upon the spasmodic colic, incarcerated hernia, and volvulus.

"Inflammations of the intestines have the same terminations as those of the stomach, and in both cases the several tendencies are to be discovered by the same symptoms.

"What might be mentioned with respect to the suppuration or gangrene occurring in the enteritis may be sufficiently understood from what has been said on the same subject with respect to the gastritis."

It is interesting to compare such a description of enteritis with one of to-day. Pinel, Rostan, Andral, and many later writers have restricted the term enteritis to inflammation of the small intestine. Woodward states that the opinion was prevalent among medical officers at the commencement of the War of the Rebellion, and is still entertained by many American physicians, "that the small intestine is the part of the alimentary canal particularly concerned in acute diarrhœa (intestinal catarrh), the large intestine in dysentery." This opinion he pronounces "a purely scholastic error."

The clinical statistics of the war, as classified and recorded by Dr. Woodward, seem fully to justify his conclusions: (1) that in acute enteric catarrh the inflammation is not limited to the small intestine, but involves the cæcum and upper colon quite as constantly as the ileum; (2) that in dysentery the descending colon and rectum are the parts essentially and chiefly involved. Thus, under the head of acute diarrhœa, which term he uses as synonymous with the acute intestinal catarrh of many late writers, he says: "Its lesions, whether it be mild or severe, are most generally seated in the cæcum and colon; but more or less extensive tracts of the small intestine, especially of the ileum, are often involved also." He makes tenesmus, when prominent in any case of acute alvine flux, a pathognomonic symptom of dysentery, and holds that tenesmus arises "whenever the inflammation of the intestine, upon which it depends, affects the descending colon and rectum with sufficient intensity to make the expulsive efforts painful."

Definition.—Enteritis is inflammation of the intestines; often of a continuous segment, more or less exten-

sive, embracing portions of both large and small intestine; usually commencing in the mucous membrane, often limited to it and the submucous connective tissue, sometimes invading successively all the layers.

It is not, however, intended to include dysentery, a well-recognized, separate affection, whose essential anatomical seat is the descending colon and rectum, and which is characterized by tenesmus, tormina, and peculiar stools. Neither is it intended to include the peculiar affection of the alimentary canal common in little children in hot weather, and popularly known as "summer complaint." This also is generally accorded a separate consideration, apart from enteritis.

Division and Classification.—Inflammation of the intestines will be here considered under three heads, viz.: (I.) Catarrhal enteritis, or Intestinal catarrh; (II.) Croupous or pseudo-membranous enteritis; (III.) Phlegmonous enteritis. The first will be presented *in extenso;* while the second and third will be considered briefly and in outline, mainly for the purpose of differentiation and distinction.

I. Intestinal Catarrh.—At the outset I would acknowledge my special indebtedness to Woodward's "Medical History of the War" (supra), which, with its superb illustrations, actual reproductions from nature by the aid of modern photographic art, its carefully reached conclusions from such a mass of original material, its complete *résumé* of anatomical and histological knowledge upon this subject, is a perfect magazine of information; and also to Cruveilhier's magnificent work, "Anatomie Pathologique du Corps Humain," with its wealth of cases and its unequalled colored plates.

Anatomy and Histology.—The mildest form of enteric catarrh is characterized by an increased secretion of mucus rich in cellular elements, the inflammation being confined to the mucous layer of the intestine. The ileum, cæcum, and colon are the parts of the intestine most frequently involved. Hyperæmia of the mucous membrane is the first step in the process. Reddish discolorations of the surface are observed, usually in patches varying from a few inches to several feet. An arborescent appearance is sometimes observed, when a portion of the gut is held between the eye and the light, due to distention of the capillaries and small vessels with blood. The lymphoid cells enlarge, their protoplasm granulates, and their nuclei become indistinct. At first there is dryness of the mucous membrane; but hypersecretion soon occurs, and the mucous membrane is coated with glairy mucus, sometimes colorless, sometimes of a yellowish, reddish-brown, or greenish hue, from admixture of blood or bile in varying proportions. Sometimes it has a creamy or muco-purulent consistency, especially in the more intense forms of inflammation. A plush-like or velvety appearance is given to the surface by the swelling of the epithelia and tumefaction of the villi. Desquamation of the epithelia occurs. When the process does not advance beyond the stage of hyperæmia, it is probable that the redness and congestion may subside and, in cases fatal from other causes, leave no post-mortem evidence of the catarrhal inflammation. It is probable that the vessels may contract sufficiently during the death-agony to expel the greater part of the contained blood.

In the severer forms of inflammation there is more intense hyperæmia, and the secretion is more abundant and becomes more puriform in character. There is a large infiltration of lymphoid corpuscles into the adenoid tissue of the mucous membrane, pushing aside the closely packed follicles of Lieberkühn. Thickening of the mucous membrane occurs. There is also infiltration and hyperplasia of the submucous connective tissue, and lymphoid corpuscles accumulate, especially around the periphery of the small veins and in the serous canals of the connective tissue. An acute œdema is developed. Desquamation takes place to a greater extent, and abrasions of the surface are produced. Softening of the mucous membrane occurs; its epithelial layer can be easily scraped off. It is sometimes difficult, if not impossible, at autopsies, to distinguish between softening of post-mortem origin and that which has resulted from inflammation. In the latter case some other inflammatory lesions should be associated with the softening, such as the peculiar cellular infiltration, swelling of glands, etc. Amyloid degeneration of the mucous membrane, and of its arterioles and capillaries, sometimes takes place, and may be shown by the peculiar color-reaction of iodine. The solitary glands in the reddened areas are enlarged, becoming usually of the size of a pin-head, with a circlet of increased vascularity. The agminated glands are also thickened and elevated. In the large intestine they are usually sessile, while in the ileum they may project above the surface of the mucous membrane like tiny polypi.

The color varies from bright red to mahogany-red, brown, slate-color, or green, the latter shades being most fully developed in chronic inflammations. The walls of the capillaries give way, and blood is extravasated. Ecchymotic spots are seen. Pigmentation of the mucous membrane occurs in ashen, slate-colored, greenish, or blackish hues, the pigment being probably formed out of the coloring matter of the bile, or by transformation of the hæmoglobin of the red corpuscles into hæmatoidin or other substances. The pigment is most often deposited in the apices of the closed follicles. When the solitary follicles are the seat of the deposit, small black points appear on small rounded elevations studding the mucous membrane. When the follicles of Peyer's patches are pigmented, the peculiar "shaven-beard" appearance is produced which was found by Woodward to have been present in so many of his cases, and is so admirably shown in some of his chromo-lithographic plates. Diffuse pigmentation of the mucous membrane also occurs, the deposit being chiefly in the apices of the villi in the small intestine and thickly studding the surface of the mucous membrane of the large, so as in both cases to give the effect of a diffused coloration to the affected patches. The diffuse form of pigmentation is more common in the large, and the follicular in the small, intestine.

Catarrhal ulcers are common, and appear in two forms—the follicular and the non-follicular. Both forms, in their fullest and most typical development, are found most often in the large intestine, and in connection with chronic enteritis, but they also occur in the ileum, and in the course of acute inflammations. The follicular ulcer first appears as a minute, sharply defined, punch-hole-like opening, circular or oval in form, in the apex of an enlarged solitary follicle; or one or more of the individual follicles of an agminated gland may be affected. The involved follicle is completely destroyed in the process, and the ulcer extends by burrowing under the mucous membrane. The surface opening becomes gradually larger as the nutrition of the mucous membrane is cut off by the burrowing process underneath it, but always maintains the abrupt, overhanging character which distinguishes it from the bevelled margin of the diphtheritic ulcer. Extensive and irregularly shaped excavations may result from the coalescence of adjacent ulcers.

The non-follicular catarrhal ulcer of the intestine occurs in the mucous membrane intervening between the individual follicles as a superficial erosion of the surface, usually of small, occasionally of large, extent. It may gradually invade the submucous and other layers of the intestinal wall. When of large extent, it very closely resembles the bevel-edged ulcer which results from diphtheritic sloughs. Associated with the catarrhal ulcers there is often extensive thickening and induration of the intestinal walls. In the worst cases, especially of chronic inflammation of the large intestine, the walls of the colon are found much thickened, with narrowing of its calibre. It gives a hard feel when compressed between the thumb and fingers, and shows, on section, the submucosa greatly increased in thickness and often in a state of amyloid degeneration. Dilatation of the bowel is often found just above the points of stenosis. Catarrhal ulcers may go on to perforation or may cicatrize, with more or less of resultant stenosis of the intestine.

Occasionally peculiar colloid cysts, one-fourth to one-tenth of an inch in diameter, are found, especially when the colon is the seat of the inflammation, and are believed to result from degeneration and dilatation of the follicles of

Lieberkühn. These are more common in dysentery than in intestinal catarrh. Gangrene and sloughing occur in intestinal catarrh, but are less common and extensive than in malignant dysentery and in enteritis from obstruction.

Narrowing of the calibre of the intestine occurs in connection with ulcers, either by induced thickening of the walls or by cicatricial contractions. It is also found from morbid contraction of the muscular coat of the bowel in intense and suddenly fatal attacks, and associated with hypertrophy of the muscularis in cases of long duration. Dilatations of the intestine are also met with, due to paresis of the muscularis, admitting of extreme distention by gaseous and fæcal accumulations, and leading to suspensions of the peristaltic movements.

In acute diarrhœas of armies, according to Woodward, lesions of the large intestine are more pronounced in the cæcum and descending colon than in the intermediate tract, and when the ileum and large intestine are both involved the lesions are apt to be more advanced in the latter, as though commencing there.

The peritoneal coat of the intestine in catarrhal enteritis is usually nearly or quite normal. It is sometimes hyperæmic, and sometimes shows a thin coating of opaque, yellow lymph. The intestinal canal after death is usually found to contain a considerable amount of liquid, sometimes of a greenish, reddish, or blackish hue, from additions of altered blood or bile, and often of a peculiarly offensive, septic odor. Articles of undigested food and undissolved medicines, in powder or pill form, are often present. Elements of broken-down tissue, and bacteria of different varieties and in immense numbers, are present, and may be recognized by microscopical inspection.

The lesions of chronic enteritis cannot be sharply separated from those of the acute form. They are most often found, and in most marked degree of development, in the lower ileum and colon. The change of color is very noticeable. The bright-red colors of acute enteritis are replaced in the chronic by the mahogany-red, brown, ash-color, slate-color, green, and blackish shades, and by various neutral tints. Black, bluish, and brownish deposits of pigment are seen in the closed follicles, and in scattered patches of the mucous membranes, both of the large and small intestine, and in the apices of the villi, especially of the ileum. The epithelial layer is found in the various stages of fatty degeneration. The walls of the intestine show very marked changes in chronic catarrh, being hypertrophied, indurated, occasionally softened, and sometimes atrophied in limited areas. Narrowings of calibre are common and sometimes very considerable, these narrowings being not so much dependent upon cicatricial contractions as upon thickening and induration of the mucosa and submucosa. The most common seats of these stenoses are the sigmoid flexure and the rectum. Accumulation of lymphoid cells in the reticulum of the mucous membrane, and in the submucous connective tissue, is a marked histological feature. Atrophy of the parenchymatous elements, with increase of the fibrous tissue, is a constant result. The transverse folds are swollen and heavy. Both the solitary and agminated glands show marked hypertrophy, and are raised above the level of the mucous membrane. Ulcers, especially those in the apices of the solitary glands, are common and deep, and extensive cicatrices of fibrous tissue, not recovered with an epithelial layer, are found. Sometimes little patches of mucous membrane are seen, like islands, elevated above the level of the cicatricial tissue, marking points at which a number of ulcers had coalesced and healed, nearly surrounding small areas of normal mucous membrane. A honey-combed appearance is sometimes produced by the extensive burrowings of ulcers. The mucous membrane is puckered around the scars. The condition of thickened walls in a state of amyloid degeneration is almost peculiar to chronic inflammation. Granular and tiny polypoid growths are developed in connection with the process of ulcer-healing. The jelly-like cysts above mentioned are more common in chronic enteritis. Pseudo-membranous patches of greenish-yellow hue are found.

Lesions of other organs are met with in acute and chronic enteritis, whose association with them seems to be something more than casual. The connected mesenteric glands are frequently enlarged and softened. Gastric catarrh is very frequently present. When the duodenum is the seat of inflammation, the biliary ducts are often invaded by extension, and the calibre of the ducts, or of their orifices, is sometimes narrowed. Rarely abscesses, usually multiple when present, are formed in the liver. The blood suffers loss of its albumen and corpuscles. General peritonitis may occur from perforation of an ulcer. The kidneys may be large and pale. The soft, flabby heart, heart-clots, pneumonic consolidations, cerebral hyperæmia, and other lesions often met with in protracted inflammatory processes, may be present.

Etiology.—On account of its delicate structure and exposed situation, the intestinal mucous membrane is particularly liable to attacks of inflammation. Leube calls attention to four anatomical points as related to this peculiar liability: (1) The capillary network of the projecting villi of the small intestine is only covered in by the thin epithelial layer; (2) the venous radicles of the capillary plexuses surrounding the tubular glands of the mucous membrane increase rapidly in volume, and are much more scattered than the ascending arterial twigs, and hence the return blood-flow through them is more or less obstructed; (3) while the arteries, in their passage through the muscularis of the intestine, are surrounded by quite a strong sheath of connective tissue, the venous twigs pierce the muscular coat in an exposed condition, so that every muscular contraction interferes somewhat with the return blood-flow; (4) the intestinal mucous membrane is one of the regions of the body where the passage of blood-cells through the walls of the vessels takes place with special facility, the chyle-vessels of the mesentery always containing red corpuscles during digestion ("Ziemssen's Cyc.," vol. vii., p. 363).

In this disease, as in others, it is impossible to draw a sharp line between predisposing and exciting causes. I shall, however, in enumerating, mention first those conditions, or circumstances, which render the occurrence of enteritis more likely, and then those which seem to act more directly to determine an attack.

1. Climate and Seasons. Inflammation of the bowels is more common in hot climates, and in the summer months, and especially when the atmosphere is damp and the alternations of temperature from day to night are considerable and abrupt.

2. Age. The period of the first dentition is characterized by a very marked tendency to irritation and inflammation of the gastro-intestinal mucous membrane. The entire period of childhood shows a similar predisposition, though in less degree after the second summer. The United States Census of 1870 shows that almost exactly three-fourths (761 out of every 1,000) of all the deaths from enteritis, dysentery, and diarrhœa, were in children under ten years of age.

3. Debility, with its impaired power of resistance against morbid influences in general, must be mentioned among the causes of enteritis. Hence must be included all influences which impair the vital energies; especially unsanitary conditions, such as want of out-of-door exercise, confinement in close rooms, the breathing of air poisoned with emanations from privies, sewers, or other foul places, insufficient food or sleep, etc.

4. Hyperæmia of the capillaries and veins of the intestines, resulting from either portal, pulmonary, or cardiac obstruction.

5. Previous attacks of inflammation of the bowels leave the mucous membrane weakened and predisposed to renewed attacks.

6. Temperament and Idiosyncrasy. Individual bodies, as well as minds, have their own peculiarities and proclivities. Some, on taking cold, will suffer habitually from enteric catarrh, while others, instead, will be afflicted with nasal or pulmonary trouble. The inherited tuberculous diathesis must also be mentioned, since tuberculous ulcers about the ileum, cæcum, and colon underlie so many fatal cases of chronic enteritis.

7. Various general diseases have enteric catarrh often associated with them, either as concomitant or sequel. Thus, notably, the eruptive fevers, typhoid fever, consumption, Bright's disease, pyæmia, and scurvy.

8. Among causes favoring the occurrence of enteritis must be mentioned, as probable factors, epidemic and endemic influences, morbid conditions of the vaso-motor and other nerve-centres, and emotional influences.

9. Prominent among the direct exciting causes of enteric catarrh stands exposure to cold. Chilling of the surface of the body, especially when moist with perspiration, often promptly induces a hyperæmia of the intestinal mucous membrane which proves to be the first stage of enteritis. The blood is driven out of the capillaries of the skin, and those of the enteric mucous membrane become overloaded. It is not necessary here to discuss the explanation. The fact is admitted. Exposure to drafts of air through open windows and doors, sitting or lying on damp rocks or ground, and the imprudent leaving-off of flannels worn next to the skin, are common methods of exposure.

10. Irritant ingesta constitute a class of causes of prime importance. Food may act either as a mechanical irritant, or through the acids and gases set free in imperfectly performed digestion. It may be excessive in quantity or of improper quality, or it may disagree with the stomach or bowels from idiosyncrasy of the individual. The writer recalls instances of individuals in whom lobsters, clams, and cheese, each and severally, constantly induced gastro-intestinal irritation or inflammation. Unripe fruit and vegetables, raw and underdone and too long kept meats, are unsuitable. Besides possible acid and septic elements, bacterial and other germ-elements capable of producing this and other diseases may be thus introduced into the alimentary canal. Drastic purgatives, such as croton-oil and elaterium, may be taken to the extent of inducing severe intestinal inflammation. Aloes, long and largely used, often induces local inflammation of the rectum. The most intense and destructive gastro-intestinal inflammations are produced by the swallowing of caustic and corrosive poisons, such as arsenic and corrosive sublimate.

Hard foreign substances swallowed, such as cherry-stones, plum-stones, the seeds of oranges and lemons, fish-bones, pins and needles, are often very mischievous, not so much by the injury done to the surface of the mucous membrane in passing over it, but chiefly by becoming impacted in the folds of the mucous membrane at one of the flexures, or lodged in the cæcum or its appendix, or in the rectum, or, if pointed, by penetrating the intestinal wall at some point. The writer remembers seeing removed at an autopsy a half-thimbleful of shot which had become lodged in the appendix cæci, and had induced at last a fatal inflammation. The man was a sportsman, and had swallowed the shot with the game.

11. Impacted fæces, intestinal worms, collections of pus discharged into the bowel by perforation, pressure from tumors, as a retroflexed uterus, fibroid nodes and tuberculous ulcers of the intestinal walls, may induce enteritis. Alcohol may cause gastro-enteric catarrh directly, if taken strong enough or in large enough quantity. Taken habitually, especially in the form of distilled liquors, it may cause cirrhosis of the liver, and, secondarily, hyperæmia and inflammation of the intestines. An excessive flow of acrid bile should probably be mentioned among the causes of this affection, but it must be borne in mind that catarrh of the duodenum may also stimulate the liver to excessive and morbid secretion. Extensive burns of the skin may be followed by inflammation and ulceration of the duodenum.

Incarcerations, intussusceptions, and twists of the intestine are more likely to induce the phlegmonous form of enteritis. Inflammation of the bowels may occur by extension from adjacent parts, as the stomach, biliary passages, and peritoneum; or it may be the result of direct contusion or penetrating wounds. Hard and irritating substances have been pushed up into the rectum by wanton, revengeful, and insane persons.

Clinical Varieties.—It will be convenient to describe intestinal catarrh under the following several varieties, viz.:

1. Diffuse intestinal catarrh.
2. Ileo-colitis.
3. Duodenitis.
4. Typhlitis and perityphlitis: (*a*) typhlitis; (*b*) appendicitis; (*c*) perityphlitic abscess.
5. Proctitis and periproctitis.

1. Diffuse Intestinal Catarrh. Uniform inflammation of the entire tract of the intestinal canal is probably never met with. The nearest approach to this occurs, perhaps, in some cases of measles, scarlet fever, and cholera. Extensive irritation, with œdematous infiltration of the mucous membrane, is also found in connection with the occasional profuse, eliminative diarrhœas of chronic Bright's disease. The symptoms of diffuse intestinal catarrh as seen in such association are those which make up the distinct groups which separately characterize the above well-defined local varieties, in varying combinations and degrees of development, superadded to those of the primary disease upon which the intestinal catarrh has been engrafted.

2. Ileo-colitis. Synonyms: Catarrh of the ileum and colon, acute and chronic diarrhœa, follicular enteritis.

Ileo-colitis, by reason of its frequency of occurrence, the large extent of intestine and the number and variety of glands involved, and from the fact that portions both of the large and small intestine are included, may appropriately be styled *the typical variety of intestinal catarrh.*

Special Points—anatomical, physiological, and etiological. Inflammation of the colon, and especially of its descending portion, alone, or in connection with the rectum, is wellnigh peculiar to dysentery. In the ileo-colitic variety of intestinal catarrh, the extent of intestinal surface involved is greater than in either of the other varieties. The entire ileum and colon, with the intervening cæcum, may be included. Besides the glands of Lieberkühn and the solitary follicles, which are of wider distribution, we find in the ileum, chiefly at its lower part, the agminated glands, or Peyer's patches, some fifty or sixty in number. They probably exercise an important function in the elaboration of the chyle. They are the seat of peculiar thickenings and ulcerations in ileo-colitis, as also in typhoid fever. While the ileum is more concerned than the colon in the elaboration and absorption of the chyle, the colon has largely to do with the conversion of the chyme into fæcal matter. The fluid chyme becomes here more and more inspissated, quasi-putrefactive processes are established, and the indol is produced which gives to the alvine evacuations the peculiar fæcal odor. The occurrence of diarrhœa indicates, either that the contents of the colon have been hurried through it by hyperperistalsis so that insufficient time has been allowed for the normal drying process to be accomplished by the absorbents, that large liquid exudation or transudation has occurred, or that the absorbent power of the colon has been impaired. The colon is the portion of the intestine most frequently affected by inflammation. This may be largely accounted for by the longer retention of its contents, their drier and more fæcal character, and the presence of the gases developed in the process of the quasi-putrefactive changes alluded to above. Exposure to cold and damp, the sudden suppression of perspiration, and irritating contents of the bowel are the most common exciting causes. Infancy predisposes, and may so far modify the results as to produce the so-called "summer complaint" of children.

Symptoms. Ileo-colitis presents itself both as an acute and as a chronic disease. The acute affection shows many grades of severity, proportionate to the extent of intestine involved and the intensity of the inflammatory process, the symptoms varying accordingly. There are mild cases, in which resolution is reached in a few days, and intense choleriform attacks, happily rare, which attain to a fatal result within a single day or two. In mild cases the invasion is usually abrupt, with chilliness, a general sense of malaise, and feverishness. The tongue has a thin whitish coat, or red tip and edges, rather than the red, dry, and smooth tongue of the severer cases. Py-

rexia is not always present, but, as a rule, it is proportionate to the extent and intensity of the inflammatory process. A sudden rise of temperature in the course of an attack would point to some complication arising, or to some extension of the inflammation to new areas. The head and nervous system are generally only slightly affected; but the aged may become speedily exhausted, and sink into stupor and coma, while children may present twitchings or convulsions.

Diarrhœa is the most characteristic and important symptom, and is occasionally attended with nausea or slight vomiting. The liquid stools consist chiefly of transuded blood-serum; desquamated epithelia, mucus, and bile, variously altered; pancreatic and intestinal juices; fæcal matter in liquid form, with occasional scybalous masses, sometimes coated with mucus, the amount of fæcal matter being greatest at the beginning; indigested food, or its waste element; blood coloring the liquid stools, or poured out upon them, usually in small amount, from capillary extravasation; or, rarely, in large amount from deep ulceration; or, occasionally, in soft, small coagula, but never in the black, powdered, coffee-ground form common in gastric and duodenal hæmorrhage; mucous or pseudo-membranous patches, or casts, rarely; minute tissue-sloughs, emigrant white corpuscles, and numerous bacteria, recognizable by the microscope. Sometimes medicines, unaltered, in form of pills, or powders, or oils, are seen. The stools vary in number from two or three to twenty or thirty, or more, per diem. They are much more copious than those of dysentery, often averaging three or four ounces. The total amount per diem is considerable, not infrequently reaching the weight of five or six pounds, while instances are on record in which a total weight of forty pounds has been attained. The color is variously changed from the normal brown. It is often of a yellowish-brown, or pale yellow. In mucous and purulent fluxes there is but little color, and in the choleraic variety the true "rice-water" stools are seen. Yellow, greenish, and blackish hues may be communicated by bile hurried down by hyperperistalsis, without normal decomposition or discoloration, while clay-like and chalky shades result from retention and suppression of the bile. A pale hue also results from an exclusive diet of milk, and lumps of casein and coagulated albumen may appear. Blackish hues follow the administration of iron and bismuth, and sulphate of copper may cause a greenish-black shade. The stools of children are more readily modified in these ways than those of adults. The natural fæcal odor is modified or lost; the stools are apt to take on a sour, sickening smell, and at last, in the worst cases, may become fetid and exceedingly offensive, like the smell of the macerating-tub in a dissecting-room. Toward the last the odor has sometimes a cadaveric quality. In old people the stools are apt to be thin, yellowish, frothy, and offensive. In severe and protracted cases the stomach becomes greatly disordered, nausea and vomiting are troublesome, and the breath becomes sour, offensive, and at last even fetid.

Abdominal pain is a quite constant symptom. It generally centres about the umbilicus, and is often felt in the sides and upper part of the abdomen, along the course of the colon. It is colicky and griping in character, sometimes partaking slightly of the peculiar tenesmus-quality which belongs to dysentery. The pain often precedes, and is more or less completely relieved by, an evacuation.

The paroxysms of pain which precede the stools extend, in exceptional cases, to the genital organs and down the thighs, and are intense enough to cause faintness, pallor, and clammy sweat.

Tenderness on pressure is usually present, either diffused over a large surface of the abdomen or limited to the sigmoid flexure, the cæcum, or some other point.

Tympanites is a common symptom. Considerable enlargement of the abdomen occurs in cases in which, the muscular coats of the intestine having become weakened or paralyzed by the inflammation, great distention of the gut, with thinning of the walls, has taken place. Borborygmi are frequent and loud, great temporary relief sometimes resulting from the belching of wind or its ejection per anum. The catarrhal secretions seem to act as a ferment, and induce flatulence. The gas may be held chiefly in the small intestine, and induce central abdominal swelling; or may be located below the ileo-cæcal valve, in which case the course of the colon along the sides and across the upper part of the abdomen can be easily outlined by percussion.

Course and termination of acute intestinal catarrh: In mild cases improvement may commence in the course of two or three days. The slight pyrexia subsides, the tongue cleans, the diarrhœa and other symptoms diminish, and easy convalescence is established. Even in these cases, however, relapse is easy from slight indiscretions of diet or mild exposures, and, after repeated relapses, it becomes easy for the acute to lapse into the chronic form.

In the severer cases, the lesions being deeper and more extensive, the course is often prolonged to three, four, five, or six weeks. The invasion is apt to be less abrupt. Prodromes are common, such as gastro-intestinal irritation, general malaise, and weakness. There is more pyrexia. The strength is rapidly lost, and emaciation occurs quickly. The diarrhœa increases. The stools become purulent, ill-smelling, slimy, grumous, and bloody. Pain, tenderness, and meteorism increase. The tongue becomes dry, shiny-red, or brown; the face anxious, cold, clammy, and purplish; and the pulse small, weak, and rapid. Hiccough occurs, and cannot be relieved. The patient lies on his back, sometimes with largely distended abdomen and knees drawn up. Death may occur from asthenia, septicæmia, or perforative peritonitis. Slow and tedious convalescence may occur, or, after repeated relapses, the disease may assume the chronic form.

In the most severe forms, such as the choleriform seizures of little children, such as occur to travellers in tropical climes, and such as sometimes exist coincidently with gastritis when corrosive poisons have been swallowed, collapse and death may take place within twenty-four hours.

The Chronic Form.—This presents itself in many different grades of severity. In the mildest there are no constant, continuous symptoms, but there is a permanent, perhaps life-long, irritability of the intestinal mucous membrane. Its normal power of resistance is diminished, so that it cannot bear the contact of the chyme and fæcal matter passing over it. There is also slight impairment of functional power. Attacks of diarrhœa are easily induced. Flatulence is induced by the slightest error of diet. In these cases there is probably no permanent lesion which could be recognized post mortem in such persons dying by accident.

In other mild cases symptoms of intestinal indigestion are constantly present. The patient is annoyed with flatulence, meteorism, rumblings, and abdominal discomfort. Dyspnœa results from consequent crowding-up of the diaphragm, and flutterings and palpitation of the heart may be present. Nausea and eructations are sometimes observed. Diarrhœa is steadily present, or may alternate with constipation. The loose stools are marked by the presence of mucus, and the scybalous masses are often wrapped in a coat of mucus. The stools are apt to come soon after rising, or speedily after meals. There is some habitual depression of spirits, some loss of weight and color, and a slight impairment of activity and strength. In these cases, could the intestine be examined, it would probably present some of the lesser inflammatory lesions, without glandular ulceration or other of the most serious lesions.

The severe form is associated with the more serious and extensive anatomical lesions, such as thickenings, softenings, atrophy, and abrasions of the mucous membrane, hypertrophy of the submucous connective tissue, glandular swellings, deep ulcerations, indurations, and amyloid degenerations of the walls, and narrowings of the calibre, of the intestine. There is usually little or no fever. The tongue may have a thin whitish coat, but is oftener red, shiny, and glazed, and may have a brownish stripe in the centre. The characteristic diarrhœa is typically developed. Emaciation, anæmia, and debility are

progressive and become extreme. The peculiar depression of spirits is fully manifested, and all activity and energy, and all mental as well as bodily force, become greatly impaired. The course of the disease is not continuous, but is made up of a succession of exacerbations and relapses.

Recovery from chronic enteritis may take place after many months of suffering, but often the recovery is incomplete. Narrowings of the intestine may be found, most frequently in the region of the sigmoid flexure. At best there is apt to be a marked tendency to the recurrence of diarrhœa, or a persistent constipation, with permanent impairment of the power of intestinal digestion. Caseation of intestinal and mesenteric glands, constituting one of the forms of abdominal phthisis, chronic feebleness, and paralysis are among the most common sequels.

In fatal cases, emaciation, anæmia, and debility become extremely developed, and are attended with great gloominess of mind. Fever of hectic type is common. Aphthous sores appear in the mouth and throat. The pulse becomes very small, frequent, and feeble. The stools become frequent and thin, and partake of a cadaveric odor. Death finally takes place by asthenia, marasmus, septicæmia, perforative peritonitis, serous cerebral effusion, or some intercurrent affection.

3. Duodenitis. Synonym: Duodenal catarrh.

Special Points of anatomy, physiology, and etiology. The mucous membrane of the duodenum is continuous with that of the stomach, and the function of the upper portion of the duodenum, above the point at which the bile and pancreatic juice are poured into it, probably resembles quite as much that of the stomach as that of the rest of the small intestine. The special function of the bile and pancreatic juice is to convert the starches into grape-sugar, and to emulsionize the fats. But we must remember that the albuminates, coming out from the stomach, probably undergo further elaboration after meeting the bile and the pancreatic and intestinal juices, and that the absorption of all the classes of alimentary principles is probably carried on to an important extent in the small intestine. The limitation of the glands of Brunner to the duodenum, and chiefly to its upper portion, must also be mentioned. In duodenitis the inflammatory process is pretty constantly most intense around the openings of the common duct and of the pancreatic duct, at about the middle of the perpendicular portion of the duodenum. The most important special causes of duodenitis are: (1) the extension into the duodenum of an acute gastric catarrh, such as may follow a debauch, in which case there would be a history of gastric symptoms preceding the appearance of the duodenal; (2) irritant ingesta passing out from the stomach, excess of saccharine, starchy, and fatty food, acrid bile or gall-stones discharged from the ductus communis; and (3) extensive burns of the skin, and equivalent cutaneous irritations.

Symptoms and Course. The special symptoms of duodenitis are not always sufficient for absolute diagnosis. Still they include a good deal that is distinctive.

With mild pyrexia, pain and tenderness may be present. The pain is well-defined, and is deep-seated in the right hypochondrium, usually limited to the region of the vertical portion of the duodenum, and aggravated by pressure; or it may be only developed by pressure; or it may extend transversely into the umbilical region. The pain is not, as a rule, very great, but in some cases severe paroxysms occur, neuralgic in character, and in which the hepatic plexus of nerves (hepatalgia) seems to be involved. In other cases the pain seems to be due to flatulent distention, gas being produced in connection with the disordered digestion or morbid secretion.

Biliary derangements may arise. Probably, in health, the passage of the chyme over the orifice of the ductus choledochus is a stimulant, leading to the outpouring of bile into the bowel. In duodenitis it is likely that the liver may sometimes become so irritated that acrid bile may be secreted and discharged into the bowel. The inflammation may invade the biliary passages by simple extension from the bowel and derange secretion; or, by inducing tumefaction of the mucous membrane lining the biliary passages, and so obstructing the escape of the bile, it may lead to jaundice. The bile may also back up into the stomach, and induce nausea and vomiting.

Constipation, instead of diarrhœa, is the rule in this form of enteritis. Exceptionally, however, bilious stools, as well as bilious vomiting, may be found. In case of closure of the orifices of the pancreatic duct, fat, in globular form, may be seen in the stools.

Jaundice, when present, does not usually appear earlier than the third or fourth day, and the yellowness, commencing in the conjunctivæ, gradually invades the entire skin. The coated tongue, the fetid breath, the peculiar pasty, slate-colored or dirty-white, ill-smelling stools, the characteristic urine ("saffron-tea urine"), and the headache, dulness, and depression of spirits are present.

If starchy, saccharine, and fatty foods are largely used, local discomfort, flatulence, and other symptoms of duodenal indigestion are very likely to appear two or three hours after their ingestion. If the inflammation is severe, narrowing of the duodenum may result from cicatrization of ulcers or infiltration of the intestinal wall.

Acute duodenitis usually lasts from one to three weeks, and terminates in recovery, with slow convalescence, or, especially when complicated with malaria, it may lapse into the chronic form. In chronic duodenitis the same symptoms may exist, with little or no fever and diminished intensity, and may last for months. Permanent stenosis of the gut is more likely to result from chronic duodenitis.

4. Typhlitis and Perityphlitis. Inflammation in and about the cæcum presents itself in three clinical varieties, viz.: (1) the body of the cæcum is the primary and essential seat of the inflammation, the appendix being invaded, if at all, only secondarily, by simple extension of inflammation along a continuous mucous membrane; (2) the vermiform appendix is the primary and essential seat, the body often escaping altogether, and the common, if not constant, cause is the lodgment of some hard foreign body in the appendix; (3) the inflammation early invades the post-cæcal connective tissue, and produces a burrowing abscess there.

Special Points of anatomy, physiology, and etiology. The usually fixed position of the cæcum in the right iliac fossa, restricting the amount of its peristaltic action; its deep transverse sacculi, affording such opportunity for the lodgment of hard fæcal and foreign bodies; the arrangement of the ileo-cæcal valve, preventing relief to the distended cæcum by backward crowding of its contents; the vertical direction of the ascending colon, along which the contents of the cæcum must be moved onward; the existence of the vermiform appendix, so admirably adapted to the catching and retention of small foreign bodies; and the immediate relation of the back of the cæcum, without intervening peritoneum, to the post-cæcal connective tissue, are all anatomical circumstances favoring the occurrence of local inflammation. The vermiform appendix is a blind diverticulum of the cæcum, round, tapering, and hollow, and usually about four inches in length, its general direction being upward and backward, behind the body of the cæcum. Its walls contain but a small amount of muscular tissue, so that solid contents are not easily extruded into the cæcal cavity. It is commonly filled with viscid mucus. It is subject to great variations in size, shape, and situation. Occasionally it is absent. Post-mortem lesions of it, of various sorts, are often found in persons who have died from other diseases. Taft, as the result of three hundred autopsies, found evidence of past or present inflammation in every third person between the ages of twenty and seventy; and actual, existing ulceration in one out of twenty of all cases examined. Ulceration and stricture of this part are specially common in connection with tuberculosis, dysentery, and typhoid fever. So frequent is the lodgment in it of foreign bodies which set up inflammations which result fatally that it has been termed "the death-trap" of the intestines. In cases of inflammation in and about the cæcum which terminate fatally,

the appendix is by far the most common seat of the fatal lesion. Meigs and Pepper, in their "Diseases of Children," say there is no case on record of acute typhlitis proving fatal in which the post mortem did not show perforation of the cæcum or appendix. In the great majority of cases the appendix is the seat of primary perforation. The most common causes of primary severe inflammation in and about the cæcum are (1) the lodgment of small, hard substances in the appendix; (2) neglected fæcal impaction of the cæcum; and (3) catarrhal and tuberculous ulcers advancing to perforation (*vide* section on etiology of intestinal catarrh, *supra*).

(*a*) Typhlitis. The term is here limited to cases in which the inflammation is located primarily and essentially in the body of the cæcum. The simplest and mildest form of typhlitis is the simple catarrhal, which occurs without fæcal impaction and does not end in ulceration. A somewhat severer form is the typhlitis stercoralis, in which the catarrhal inflammation is associated with neglected constipation and fæca limpaction. The worst form is ulcerative typhlitis. The ulcer which gives character and danger to this form of the disease may be of catarrhal, mechanical, or tuberculous origin.

The general symptoms are those of ileo-colitis, already described. The fever, when present, is of irregular type and range. The invasion may be sudden or insidious. There may be a history of constipation, or of alternate constipation and diarrhœa, of intestinal indigestion, of biliousness, or of vague discomfort in the bowels, or of general depression, or the local characteristic symptoms may abruptly appear. The diarrhœa so characteristic of the more diffused forms of intestinal catarrh is not common. The tendency is rather to constipation. Obstruction of the bowels sometimes is present. The most distinctive symptoms are pain, tenderness, and fulness, or well-defined tumor, all located in the right iliac region. The degree of development of the pain and tenderness varies greatly. Sometimes they are intense. In cases of catarrhal typhlitis without fæcal accumulation there is at first only a sense of vague fulness, then gradually the outline of the cæcum, enlarged by inflammatory thickening of its walls, becomes distinct. In cases of typhlitis with impaction there is generally a large tumor from the beginning, its lower part having the rounded outline of the cæcum, with a sausage-shaped vertical prolongation sometimes added, representing the ascending colon, also distended with hardened fæces. There may be a painful sense of pressure, and the pain may be diffused, especially down into the thighs, the bladder, and genital organs. The decubitus may be peculiar, the right side of the trunk being curved and the right thigh flexed, to take off pressure from the tender region.

In the ulcerative form of typhlitis, perforation of the walls of the cæcum may occur. In this case one of two separate groups of symptoms may be present, according as the opening is made into the post-cæcal connective tissue or into the peritoneal cavity. In the former event, which is the more common one when the ulcer is in the posterior wall of the cæcum, the symptoms of perityphlitis are superadded; while in the latter the symptoms of perforative peritonitis appear, and are usually followed by sudden collapse and speedy death. In cases of typhlitis complicated with intractable impaction, there would be added the group of symptoms belonging to intestinal obstruction, but, happily, the associated impaction is generally promptly relieved by treatment. Typhlitis without perforation or persistent impaction almost invariably ends in resolution.

In mild cases of acute typhlitis without perforation, subsidence of the symptoms may be expected in a few days, with a speedy convalescence. In other cases a subacute course is run—the acute symptoms subside, the tenderness and pain notably diminishing; but the enlarged cæcum only slowly undergoes reduction; the local symptoms do not wholly disappear; the normal digestive power remains impaired; the patient remains debilitated, and it is not till after a series of weeks that complete recovery takes place.

Chronic typhlitis is rarely found existing alone. It is much oftener met with as part of a chronic ileo-colitis, (chronic diarrhœa) in soldiers who have served in hot and malarial regions. In persons who have suffered from repeated attacks of acute typhlitis there is apt to remain a predisposition to its recurrence, a diminished power of resistance against its ordinary causes. The symptoms of chronic typhlitis are those of intestinal indigestion, especially slight local tenderness and pain, and an occasional consciousness that the fæcal and gaseous contents of the intestine are passing the region of the ileo-cæcal valve. In case of resultant stenosis of the ileo-cæcal orifice, there may be habitual relative fulness of the small, and emptiness of the large, intestine, showing itself by distention of the central region of the abdomen and flatness of its sides.

(*b*) Appendicitis. This term is applied to inflammation of the vermiform appendix, primary and essential. It usually, if not invariably, results from the lodgment in it of some small, hard substance, often a small enterolith. It is relatively more common in early life. The symptoms of appendicitis, pure and simple, are probably very slight, and not easily recognizable. Probably slight pain, tenderness on deep pressure, confined to a very small area in the right iliac region, and slight nervous disturbance, may exist. These symptoms may become more marked when the serous layer of the appendix becomes involved. No fulness can be detected, and there is no recognizable tumor. These symptoms are so vague and inconsiderable that anxiety is not aroused on the part of the patient or friends, and the doctor is not apt to be sent for until perforation of the appendix and the escape of the contained small, hard substance into the peritoneal cavity. The perforation is probably often determined by some effort, as of walking, or lifting, or even turning over in bed. It is usually attended with pain, nervous shock, and often momentary faintness. The pain and tenderness in the right iliac region may now become marked and intense, fever arises or increases, and all the general and local symptoms of perforative peritonitis are speedily developed. The peritonitis becomes quickly general. No recognizable tumor is to be found. It is often plain, however, that the peritonitis commenced in the right iliac region, and this fact, in the absence of all evidence of traumatic origin, and no other explanation being apparent, renders it extremely probable that perforation of the appendix has occurred. As an exceptional thing, and very rarely, the peritonitis following the perforation is circumscribed instead of general. Limiting adhesions quickly form around the point of perforation, local suppuration takes place, and an abscess is formed—the rarest variety, perhaps, of perityphlitic abscess. Cases of appendicitis are met with in which the symptoms are so vague, not only before but also after the occurrence of perforation, as to justify the application of the term latent. Such an one recently occurred in the Maine General Hospital. The patient was one of the resident assistant physicians. On Friday morning he assisted the writer in his daily round at the hospital, and afterward in a clinical lecture, two and a half hours being spent in the work. He seemed as well as usual. That afternoon he complained of pain in the bowels, and was a little feverish; temperature, 101° F. On Saturday morning the writer found him with temperature of 102.5° F., a slightly and uniformly swollen abdomen, coated tongue, etc. He complained of pain in the bowels, centring around the umbilicus. Tenderness on pressure was present, but not markedly greater in the right iliac region than elsewhere. "I *think*," he said, "there may be rather more tenderness in the right side than in the left, but I am not sure." In sixty hours from his first complaint he was dead. The autopsy showed an intensely inflamed appendix, without involvement of the body of the cæcum; perforation, with extrusion into the peritoneal sac of a small, hard enterolith. Incipient gangrene appeared about the margin of the perforation. General peritonitis had occurred. Two weeks before the attack he said to the writer: "I don't feel quite well; I suspect I'm bilious." Two or three days later he reported himself relieved. He also told a medical associate, on the afternoon of the attack, that

while assisting at the clinical lecture that forenoon he had experienced a momentary faintness and nausea. "I did not know, for a minute, but I should have to give up, but it passed off." The competence and carefulness of statement of the witness in this case add great weight to his testimony as to subjective symptoms. The moment of faintness and nausea probably marked the moment of the perforation, and the slight intestinal indigestion and not-quite-well feeling two weeks before were the only prodromes. A late popular writer on practice makes pain and tenderness felt "as low down as Poupart's ligament, and not in the cæcum," a distinctive sign of appendicitis as compared with typhlitis. Such a sign cannot be relied upon. The appendix is, as a rule, turned upward and located behind the cæcum, and tenderness in it would be developed by pressure over the cæcum.

(*c*) Perityphlitic abscess. Synonyms: Perityphlitis, paratyphlitis. Perityphlitis is an inflammation of the tissues around the cæcum, chiefly of the connective tissue upon which it rests in the iliac fossa. It tends directly and constantly to suppuration and the formation of the so-called post-cæcal, or perityphlitic, abscess. The most common cause is ulceration and perforation of the posterior wall of the cæcum, allowing the escape of fæcal matter. The vermiform appendix located behind the cæcum, between it and the fossa, is very frequently the seat of the primary, inflammatory, and perforative process. External injury and other general agencies, enumerated under the head of causes of enteric catarrh, may sometimes induce it. It is possible that the pressure of an impacted cæcum, without perforation, may in rare instances produce it. So pus from other abscesses—psoas, perinephritic, etc.—or from empyema, burrowing along the post-peritoneal connective tissue into the iliac fossa, may induce suppuration there. It is said to be relatively more common in adult life.

Perityphlitis is even more insidious in its development than typhlitis. Sometimes it comes up slowly, as the result of some old and forgotten injury, only general symptoms, such as debility and loss of color, preceding the evidences of deep swelling. Intestinal derangements are much less prominent than in typhlitis. Owing to pressure upon the vessels, nerves, and muscles of the right iliac fossa, pain is often severe in the thigh and hip of the same side. Sensations of numbness and tingling may be felt in the same regions. There is a tendency to incline the trunk to the right, and to place the right leg in a flexed position, to take off pressure from the tender point. Thrombosis of the iliac and connected veins may occur. The femoral vein may be involved, giving the appearance of milk-leg. Dysuria, priapism, and retraction of the testicle may be present. Local soreness, tenderness, and sense of throbbing occur, and there is the gradual, often obscure, development of a tumor from deep down behind the cæcum. A sense of tension as well as throbbing accompanies the process of suppuration, and, especially in the more severe cases, fever is present. The pus may burrow up to the crest of the ileum, down into the pelvis, along upon the psoas and iliacus muscles, along the inguinal canal toward the scrotum, upward toward the thorax, and rarely in other directions. The most common point of discharge is the right iliac region near the crest of the ileum. It may open into the rectum, the cæcum at the point of the primary ulceration, into the bladder, in the groin, at the upper part of the thigh, in the buttocks near the head of the femur, into the peritoneal sac, or at other possible points. The abscess may heal after discharge at some favorable point; or, after extensive burrowings, the sinuses, especially when much fæcal matter enters them, may remain patulous and prove occasions of great discomfort to the patient, and gradual failure of health through tedious months. Death occurs from general peritonitis, from pyæmia, and, in chronic cases with fæcal fistulæ, from exhaustion. In the most acute cases death may occur, usually from peritonitis, by the end of a week. In cases of favorable discharge, either natural or by operation, a favorable crisis may be reached in about the same time. Termination in acute peritonitis is said to be more common in children, while protracted suppuration, with formation of extensive sinuses, is more common in adults. The affection is peculiarly liable to relapse and recurrence.

5. Proctitis and Periproctitis. Proctitis is an inflammation of the lining mucous membrane of the rectum. Periproctitis is an inflammation, usually suppurative, of the perirectal connective tissue.

(*a*) Proctitis. Synonym: Catarrh of the rectum. It may occur as part of a dysentery, or diffuse enteric catarrh. It also occurs as an independent affection. The rectum is the natural receptacle of fæcal matter ready for evacuation. It easily affords lodgment, also, for hard substances which have been ingested, or formed within the body. In rare cases sharp or irritant substances are introduced per anum. It is therefore a portion of the intestine specially liable to scratching, distention, and puncture. Inflammation of the rectum may arise by extension from inflamed piles. It is often caused by sitting upon the cold ground when the body is heated, and by the abuse of aloetic purgatives (*vide* section on etiology of intestinal catarrh, *supra*). Idiopathic proctitis is usually caused by irritation from matters contained within the bowel. It is more likely to affect nervous and debilitated persons. Insane persons are specially liable to it, unless closely watched so as to secure regular movements of the bowels.

The most common clinical variety, perhaps, is that from fæcal impaction in the aged, or in younger women in whom the contractile power of the rectum has been impaired by repeated and hard labor. A hard fæcal mass forms in the rectum, sometimes completely filling it and extending up into the colon. The local symptoms are tenesmus, with its burning heat, and straining, and most distressing spasm of the sphincter ani. Complete obstruction of the bowels does not usually result, but thin, watery stools make their way around the mass. These evacuations, even when copious, do not afford relief. The patient is most painfully conscious of something remaining behind and keeping up the trouble. No relief can come while the impacted mass remains in the rectum. Later the stools become scanty and frequent, and take on the peculiar "blood-and-slime" character of the evacuations of dysentery. Seen for the first time at this stage, the affection is liable to be mistaken for dysentery, and lives of aged persons are sacrificed to this error of diagnosis. The irritation extends to adjacent organs, and strangury and uterine pains are added. The pain radiates from the anus to the hips and back. General symptoms are also marked. The patient is nervous, restless, and despondent. There is heat, anorexia, indigestion, and sometimes vomiting. The appearance of the anus is sometimes peculiar. As a result of spasmodic contraction of the sphincter, a nipple-shaped protrusion of the anus takes place, and the introduction of the finger is rendered difficult. In other cases, portions of the mucous membrane, or small hæmorrhoids, are crowded out, and gripped by the spasmodic sphincter in a most painful embrace. If the impacted mass is left unrecognized in the rectum, the strength and nervous power soon become exhausted, and gangrene and sloughing take place, or peritonitis occurs, or septicæmia, and the patient sinks speedily away. If the nature of the case is early recognized and the offending mass removed from the rectum, immediate relief is afforded and prompt recovery secured. In all cases of mechanical origin, the offending substance—fæcal mass, fish-bone, seed, stones, or whatever it may be—must first be removed before relief can come.

Proctitis sometimes takes on a chronic form. The symptoms are less intense, but of longer duration. Chronic constipation, scybalous stools, the scybala being coated with mucus, painful evacuations, a persistent sense of discomfort about the rectum, with dyspeptic and nervous phenomena, and depression of spirits characterize it.

(*b*) Periproctitis. Synonym: Perirectal abscess. Periproctitis is inflammation of the connective tissue around the rectum; it is generally suppurative, and results in abscess.

By reason of its great vascularity, and the relation of

the hæmorrhoidal veins to both the portal and the systemic systems, its large amount of loose connective tissue, its singular liability to injury from within or from without, the ischio-rectal fossa is specially prone to suppurative inflammation. While referring the reader to the section on general etiology, it may be well to say here that pressure, scratching, and punctures from sharp and rough substances contained within the rectum, and perforating ulcers of its mucous membrane are, perhaps, the most frequent causes of perirectal abscess. Sitting on cold, damp ground, external violence, and the unskilful handling of instruments in the rectum, bladder, and vagina are also common causes. The burrowing of pus from post-peritoneal abscesses, formed higher up in the pelvis or in the abdomen, is more apt to lead to chronic than to acute periproctitis. A scrofulous or tuberculous diathesis predisposes strongly to this affection. The distinctive symptoms of acute periproctitic abscess are pain, continuous, throbbing, and increased by the effort of defecation, a painful sense of pressure, and, at last, a local point of tenderness, superficial, dusky redness, and pointing. The acute abscesses do not burrow so extensively and destructively as the chronic. The local symptoms are accompanied with febrile and constitutional disturbance, sometimes strongly marked. Spontaneous discharge often takes place within a week, and when penetration or perforation of the rectum has coexisted, either as a primary or secondary lesion, fistula in ano results. The point of discharge is usually in pretty close proximity to the anus. The chronic form of perirectal abscess may last for months. Extensive and destructive burrowings occur. There may be little or no pyrexia, but vague hectic symptoms, cold, clammy sweatings, and rapid loss of strength and color are noticed. The local pain may be very slight. Instead of the distinct pointing of the acute abscess in the vicinity of the anus, there is a comparatively painless, vague, flat, œdematous, boggy enlargement. Fistula in ano often results, with sinuses burrowing extensively and in different directions.

Diagnosis.—An early question to be raised in connection with intestinal catarrh is, Is it idiopathic or symptomatic ? Is it the essential disease, or only an accompaniment of some other, as cancer, or ulcer of the intestine, or measles ? If we find the coexistence of catarrh with the distinctive group of symptoms belonging to some other disease, a careful consideration of the history of the individual case, and a knowledge of the ordinary behavior and associations of both diseases, will enable us to determine whether the catarrh is an outgrowth and consequence of the other disease, or whether the combination is a mere coincidence. Diffuse intestinal catarrh, involving the whole, or nearly the whole, intestinal tract, is usually symptomatic. Is the catarrh high up or low down in the intestine ? The higher up, the less frequent the diarrhœa, the more frequent the vomiting ; if hæmorrhage occur, the more coffee-ground is it in character. If low down in the intestine, tenesmus, scanty stools of bloody slime, scybala enwrapped in mucus and fresh-colored blood are likely to be present. In the former case the gaseous distention, the pain, and the tenderness are central ; in the latter, more along the sides and across the top of the abdomen.

The distinctive local symptoms of ileo-colitis are pain, tenderness, and meteorism in both the central and the lateral regions of the abdomen—the former chiefly when ileitis predominates, and the latter when colitis is the more extensive ; and the peculiar stools—liquid, often yellowish or greenish-yellow and copious, consisting of altered elements of the blood, the secretions of the mucous tissues, and of undigested food. Tormina are present, but there is no tenesmus unless the descending colon or rectum be also invaded. In chronic colitis there are often scybalous masses thickly coated with mucus.

In duodenitis the distinctive symptoms are grouped as follows : The pain and tenderness are in the right hypochondriac region, below the margin of the ribs. Constipation is the rule instead of diarrhœa. Gastric symptoms are relatively prominent, bile is often vomited, and there is frequently a history of well-marked gastric catarrh preceding the duodenitis. Biliary derangements and jaundice are frequently present. If the pancreatic duct is closed by inflammation, fatty globules may appear in the stools. If blood is present in the stools, it may be in blackish, broken-up clots, more or less resembling coffee-grounds.

Typhlitis is characterized by pain and tenderness in the right iliac region and the presence of a tumor. In simple catarrhal typhlitis the tumor, located in the right iliac fossa, is of moderate size, soft, and having the outline of the cæcum. It consists of the cæcum enlarged by the inflammatory process. In typhlitis stercoralis the tumor is large, hard, and often nodulated from the first. It consists of the cæcum, whose form is still maintained, distended and impacted with hardened fæces. Added to this there is often a vertical, sausage-shaped mass, representing the impacted ascending colon. The so-called "pressure-symptoms," especially in the upper thigh and groin, are more marked in typhlitis stercoralis. In the differentiation of typhlitis from appendicitis, the great difference of fatality must be borne in mind, the former being generally recovered from, while the latter is very generally fatal.

Appendicitis, also, is marked by pain and tenderness in the left iliac fossa. They are more deeply seated than in typhlitis, and, as a rule, there is no noticeable tumor. Very exceptionally, after perforation, only local peritonitis results, limiting adhesions are formed, and one of the varieties of perityphlitic abscess is produced, giving a well-formed tumor. The unobtrusive and vague symptoms of appendicitis, before the stage of perforation, are generally overlooked. Frequently the physician is not called till perforation has occurred and peritonitis has commenced. Loomis holds, as a matter of theory, that by the careful examination of a patient, previously anæsthetized, with the index-finger of the right hand in the rectum and the left hand pressing into the right iliac fossa, evidence may be obtained to establish the diagnosis in the early stage, and so aid in determining the question of laparotomy. When general perforative peritonitis has already occurred, a history may sometimes be obtained of a preceding appendicitis, or of a slight shock, with momentary faintness and nausea marking the moment of perforation. Oftener, the simple fact may be observed, or ascertained, that the peritonitis began in the right iliac fossa. Oftener still, the conclusion has to be reached by a process of exclusive, rather than inclusive, reasoning. In the absence of all evidence of the pre-existence of latent typhoid fever, or tuberculosis, or other affection likely to be attended with abdominal ulceration, the probability becomes very strong of a perforating ulcer about the caput coli, and, this point being reached, the fact of the far greater frequency of ulcer of the appendix than ulcer of the cæcum almost compels the diagnosis of perforation of the appendix.

Perityphlitis is even more insidious in its invasion. It is usually, when not traumatic, engrafted upon a typhlitis, or appendicitis, its occurrence being marked by a chill. There are pain, tenderness, and throbbing deep down in the iliac fossa, and the presence of the tumor. The relative prominence of the pressure-symptoms, the relative slightness of the intestinal derangements, the pointing of the abscess usually in the iliac fossa, the occasional burrowing of the pus to such distant points of discharge, the resulting fistulæ, and the more frequent occurrence of the disease in adults, are the chief distinctive features upon which to base a diagnosis.

In the diagnosis of proctitis, great advantage, especially in chronic cases, is derived from direct exploration by the finger and with the speculum. All doubt may frequently be cleared up in this way. Pain in the bowel low down, pressure-symptoms in the other pelvic organs when impaction exists, tenesmus, strangury, and dysenteric stools constitute the most distinctive symptoms.

Periproctitis is distinguished by a throbbing, boring pain in the region of the lower pelvis and the fundament, and by painful defecation. There may be a history of previous proctitis, or of an abscess of the pelvis or abdomen, with burrowings. There is great tenderness

on sitting down. The pain gets lower and lower, and external bulging and pointing occur; or, in chronic cases especially, there is a vague, diffused, boggy feel, with purplish discoloration of the skin.

The questions of diagnosis in intestinal catarrh largely relate to the distinction of the different varieties among themselves. The question might exceptionally arise of the differentiation of ileo-colitis from laten typhoid fever; but the history of the case, and the presence or absence of the distinctive non-enteric symptoms of typhoid fever, would nearly always remove doubt. There might be a question between simple typhlitis and ileo-cæcal intussusception; but the greater suddenness of the attack, the intensity of the symptoms, the frequent, bloody, mucoid stools of the latter, and, possibly, the throwing-off of the separated portion of the bowel, would soon clear it up. An impacted cæcum might possibly be confounded for a time with a small ovarian tumor, a misplaced kidney, or any tubercular or cancerous mass occurring in that region; but, aside from other methods of distinction, the prompt unloading of the impacted fæces ought to remove all doubt.

Prognosis.—In acute intestinal catarrh, the prognosis varies greatly with the severity of the attack, the seat and extent of inflammation, the age and vigor of the patient, and the external conditions. Mild attacks in previously healthy adults are usually recovered from in a few days. In the case of little children a guarded prognosis must always be made, especially in the hottest seasons. The dangers are chiefly from liability to exhaustion and collapse, and perforation of the intestine. Diffuse, general intestinal catarrh occurring, as it does, almost wholly in temperate climes, as a complication of other diseases, may sometimes add enough to the primary disease to turn the scale unfavorably. In the severe forms of ileo-colitis, a large tract of intestine being involved, death may occur in a few days by collapse, perforation, or septicæmia. Much danger is involved in it, but when both intrinsic and conditional circumstances are favorable, recovery, with slow convalescence, may be hoped for; without these, death or lapse into the chronic form must be feared. The most fatal of all the varieties is perforative appendicitis, death often occurring in two or three days. Simple typhlitis and typhlitis with impaction are usually recovered from. The prognosis in perityphlitic abscess is serious, but with proper treatment much hope may be entertained of recovery. When extensive fæcal fistulæ are formed, a chronic course may be run, with gradual wearing out of the patient. Proctitis from impaction, in the aged, if neglected, proves speedily fatal. Perirectal abscess is usually recovered from with surgical assistance. Duodenitis is liable to leave the openings of the ductus communis and the pancreatic duct more or less obstructed.

Chronic intestinal catarrh, or chronic diarrhœa with deep ulcers, and others of the more serious lesions of the disease tend strongly to death at last, from failure of nutrition and gradual exhaustion, or from some complicating disease.

Either extreme of age, feebleness, extremely hot weather, impure air, unwholesome food, unsuitable clothing, polluted drinking-water, and damp houses are especially unfavorable circumstances. Exhaustion, frequent thin, bloody, putrescent stools, extensive hæmorrhage, great abdominal distention, the occurrence of peritonitis, septicæmia, or collapse, and extreme emaciation and debility, are unfavorable indications.

Treatment.—In entering upon the subject of treatment of intestinal catarrh, a few general considerations should receive brief notice. Rest in bed is a measure of great importance, and should be rigidly enforced in all acute cases. The gentle support of the abdomen by a thin flannel roller-bandage, evenly applied, or a broad band, closely fitted and secured by a sufficient number of safety-pins, is valuable. Opium is the sheet-anchor of medicinal treatment. It relieves pain, allays tenderness, reduces the abnormal peristalsis, quiets irritability, restrains hypersecretion, and exercises an anti-inflammatory influence. The influence of diet is hardly less marked than that of opium. It should receive constant and watchful care. There is an objection to the general use of medicine in the form of pills, inasmuch as, being hurried through the intestinal canal by the hyperperistalsis and the abundant transudation and secretion, they are liable to pass off undissolved. Diarrhœa, the great symptom of intestinal catarrh, sometimes occurs as an eliminative act, as in the profuse fluxes of Bright's disease, relieving the system of urea. Occurring sometimes in the later stages of the eruptive fevers, it seems to afford relief to the system. Sometimes it marks the favorable crisis of typhoid fever. In such cases its conservative character should be recognized, and it should not be abruptly checked.

Diffuse intestinal catarrh, involving the intestinal tract pretty generally, being most often met with as a complication of general diseases, must often be considered and treated from the special point of view of such relationship and association. Its treatment, *per se*, consists of a judicious blending of the special methods of the different local varieties of intestinal catarrh, as described below.

Ileo-colitis being the most extensive and typical form of intestinal catarrh, its treatment will require the most extended and detailed statement. Several preliminary questions should be raised. (*a*) Does the appearance or history of the case suggest the idea of hard or irritating substances in the alimentary canal, such as stones, seeds, indigestible or unwholesome food, or poisons, so as to call for special initial evacuative measures? (*b*) Is it eliminative, and so to be let alone? (*c*) Is it the direct result of overheating of the body, so as to require special initial cooling remedies, such as cold spongings and ice-bags? (*d*) Is it a result of surface-chilling and driving of blood to the intestinal mucous membrane, and so calling for a hypodermic injection of pilocarpine, or some other derivative, to the skin? (*e*) Is there any malarial element indicating the use of quinine?

In the mildest cases a day's abstinence from food may be all that is needed; or a simple laxative of rhubarb or salts, followed by a few drops of tinct. opii deod., or a few doses of Squibb's tinct. opii co., may be needed.

In the severer cases, with marked fever, cold sponging of the abdomen and temples, kept up for hours, if need be, till the heat is reduced, or a warm bath, gradually reduced to cold, or drop-doses of tinct. aconiti rad., every hour at first, or quinine in antipyretic doses, are indicated. The preliminary laxative should be given, and often, when the liver is sluggish, it may be advantageously preceded the night before by a few grains of calomel, or ten or twelve grains of blue mass combined with a little opium. After satisfactory operations, opium should be administered in just sufficient doses to measurably relieve pain and restrain diarrhœa. Morphia, gr. $\frac{1}{4}$, with atropin, gr. $\frac{1}{150}$, given by hypodermic injection, for the first dose, and followed every three to six hours by a dose half or two-thirds as large, will often be enough; the deodorized tincture of opium, in equivalent doses, or starch and laudanum rectal injections may be used. Should it become desirable on account of retained irritant secretions or scybalous masses, the saline laxative may be repeated, or castor-oil, with two or three drops of oil of turpentine and five to ten of deodorized tincture of opium, may be given. By such measures relief is usually obtained in from two to eight days.

In cases of persistent diarrhœa various astringents are resorted to. The subnitrate of bismuth is useful in doses of from five to twenty grains, and especially so in the case of children, in proportionate doses; sometimes given in chalk-mixture, with sodium bicarbonate added. Of the vegetable astringents, the most popular are gallic acid, krameria, kino, catechu, log-wood, and blackberry-root. They are often given in the form of fluid extract, and combined with chalk-mixture. Theoretically, the first named ought to substantially represent the remedial value of the whole class. Of the mineral astringents, those most used are acetate of lead, nitrate of silver, the sulphates of zinc, iron, and copper, and tincture of the chloride, and solution of the persulphate, of iron. Acetate of lead, with opium, is more used than the others, which find their chief use in the chronic forms of the disease.

They are generally given in small doses and in combination with opium, to which, probably, the greater part of the improvement made is due. The mineral acids, especially the diluted sulphuric and muriatic, are much used, with small doses of opium, in profuse, severe diarrhœas. Besides their astringent effects, they tend to diminish excessive fermentation. In cases of sour, fermentative changes, bisulphite of sodium, tincture of iodine, and carbolic acid, one drop each, creosote-water, the sulpho-carbolate of sodium, and salicylate of sodium, combined with powdered extract of licorice, are used. They are also believed by some, even in the small doses in which they are commonly administered, to exercise germicidal power. The corrosive chloride of mercury is recommended by Ringer for clayey, pasty, or dysenteric stools, one grain being dissolved in ten ounces of water and administered in teaspoonful doses often repeated. Calomel, in small doses, and the gray mercurial powder are given with opium or Dover's powder, especially when the stools are chalky or clayey.

For flatulence, gaseous eructations, and meteorism, bismuth subnitrate or carbonate, zinc oxide, alkalies, sodium bisulphite, and aromatic spirits of ammonia and other aromatics are given. There is advantage, in tendency to great abdominal distention, in the application of a flannel or rubber roller-bandage. Sometimes the application of the ice-bag to the abdomen is helpful. In cases of intestinal hæmorrhage, acetate of lead, ergot, and gallic acid are given, and ice-bags and ice-water enemata are used. Arsenic is recommended by Bartholow for the "chopped-spinach" stools; Fowler's solution, one drop, with two or three of deodorized tincture of opium, is the preparation most used.

In duodenitis, besides the regulation of diet and local measures externally (both which see below), and opium in just sufficient amount to moderate pain, the constipation may need attention. The salines in small doses, especially phosphate of sodium in drachm doses, four times a day, may be used. For the relief of jaundice, usually due to obstruction of the duct-orifice, treatment must be addressed to the bowel rather than the liver. Bartholow thinks the saline laxatives relieve hyperæmia of the intestinal mucous membrane by inducing watery transudation; the theory is rejected by others, who hold that the salines themselves first produce hyperæmia, and afterward watery evacuation.

In the treatment of typhlitis and appendicitis, the general rule may be laid down that opium must be freely used, while active purgation is prohibited. In the case of simple catarrhal typhlitis, with small, soft tumors in the right iliac fossa, having the outlines of the cæcum, opium should be given in doses sufficient to relieve pain, control hyperperistalsis, and keep the bowels quiet. This may be kept up for a number of days, till the heat and tenderness subside, till a spontaneous movement of the bowels occurs, as it often does, or till urgent need of an operation is felt. Then a simple enema, a spoonful of castor-oil, with a few drops of tincture of opium, or a saline laxative, in small doses often repeated, may be given. If there be much heat and tenderness, a few leeches may be applied early and fomentations used. Later, or in case of less heat and tenderness, blisters or iodine may be applied. Sometimes the ice-bag gives more relief.

In typhlitis stercoralis, with a large, hard, nodulated tumor in the right iliac region, having the outline of the distended cæcum, with, perhaps, a sausage-shaped vertical addition representing the impacted ascending colon, when fever and local pain and tenderness have been first removed, free irrigation of the large intestine may be cautiously tried, a soft rectal tube being passed up through the sigmoid flexure, if necessary; and the simple laxatives mentioned above are to be made use of. No harsh catharsis must be resorted to.

Appendicitis, being usually due to the lodgment within the appendix of some hard substance, is characterized by a strong tendency to perforation and general peritonitis. If, happily, the usually vague symptoms of appendicitis, pure and simple, are early noticed, such as local pain, tenderness on deep pressure over a very limited spot in the right iliac fossa, without distinct recognizable tumor, the treatment of simple catarrhal typhlitis, as above detailed, may be promptly and vigorously applied. If, notwithstanding this, the trouble continues, and if signs of developing peritonitis appear, especially if immediately preceded by slight sensation of shock, with momentary faintness and nausea, then morphine should be given in heroic doses, after the plan of Professor Alonzo Clark. He would push it to the production of "the drug symptoms," viz.: "subsidence or marked diminution of the pain; some or considerable tendency to sleep; contraction of the pupils; reduction of the breathing to twelve respirations in the minute; in the favorable cases, a considerable reduction in the frequency of the pulse; a gentle perspiration; an itchy state of the skin, or oftener of the nose; absolute inactivity of the bowels, and, after a time, a subsidence of the tumor and tenderness in them; some suffusion of the eyes." At the present day great attention is attracted to the results of surgical interference, and many of the most able and accomplished physicians favor the immediate and early performance of laparotomy, for the purpose of finding and removing any hard substance extruded from the perforated appendix into the peritoneal cavity, where its presence usually determines a general and fatal peritonitis. Cases of favorable results following laparotomy are being rapidly multiplied.

In perityphlitic abscess the same general plan may be pursued, but there is no objection to the use of laxatives, if indicated. If suspicion is aroused as to the real nature of the case, if any appearance of a soft tumor coming up from low down in the iliac fossa, or, particularly, if any sign of fluctuation or pointing appear, immediate exploration should be made with the aspirator-needle, and evacuation of the pus accomplished. Dr. John Homans (in the New York *Medical Record* of May 1, 1886) reports an interesting case. The patient was a boy of eleven, with acute inflammation located in the right iliac fossa. No exploration was made with the aspirator-needle because there was "no pointing and no dull place in which to pass a needle." But both himself and Dr. Green "having decided not to wait for the autopsy," he dissected down through the locality of the greatest tenderness, near the anterior superior spinous process of the ileum. Two ounces of "rotten-egg" pus welled up and escaped; slight discharge continued for two weeks through the rubber tube inserted, and healing by granulation and recovery followed.

In proctitis, especially in the cases of aged persons, and women after hard labors, the rectum should be explored by the finger to determine the fact of impaction, and hard fæcal matter, too large to pass the anus, should be mechanically broken up and removed. By the finger, the bougie, and the anal speculum, the presence of ulcers, strictures, fissures, and foreign bodies may be discovered, and subjected to proper medical or surgical treatment. In acute cases, besides the general treatment of dysentery, irrigations of warm or cold water, starch or laudanum injections, mild astringent solutions, and soothing suppositories, may be used. In chronic cases, nitrate of silver, sulphates of zinc and copper, and other astringents and alteratives are resorted to.

In case of perirectal abscess, poulticing and free evacuation are called for; resulting fistulæ should receive suitable surgical attention; and the general health usually needs to be built up.

In chronic intestinal catarrh great attention must be paid to the general condition of the patient, which must be built up in every possible way. Habits, occupation, exposures, hygiene, diet, and personal and family history, must be taken into account. A feeble heart, Bright's disease, a syphilitic or tubercular taint, or some constitutional weakness may be present, and furnish a clue to treatment. Change of scene, rest, and travel may afford relief. Various natural waters, drank and used as baths, and visits to Carlsbad, Kissingen, Saratoga, Hot Springs of Arkansas, and Virginia, have proved of great value.

If constipation, with scybalous, mucus-coated masses in the stools, be present, laxative mineral waters, strych-

nine and belladonna granules, or granules of aloin, may be used. Cold-water injections or irrigations are often useful. Some of the mineral astringents, as nitrate of silver, sulphates of zinc, iron, or copper, and alum, may be added, in weak solution, in some cases. Arsenic, tincture of iron, diluted sulphuric acid, corrosive chloride of mercury, turpentine, and copaiba are often used in small and divided doses. Cod-liver oil, quinine, quassia, gentian, and other tonics, may be needed. Opium should be used with great caution in chronic catarrh, lest to all the miseries of the disease there be superadded the greater horrors of the opium habit.

External applications are frequently made to the abdomen, such as leeches over the most tender points in intense inflammation ; poultices ; fomentations, simple and anodyne ; hot dry applications, as of hops in a flannel bag ; sinapisms ; ice-bags ; hot-water bags ; turpentine stupes ; iodine paint ; anodyne and stimulant liniments ; roller-bandages of flannel or rubber, and strips of adhesive plaster.

Diet.—As a rule, in intestinal catarrh the work of digestion should be mainly thrown upon the stomach, such articles of food being chosen as may undergo solution and absorption in the stomach, such as milk, skim-milk, buttermilk, eggs, animal broths, beef-tea, rare beefsteak, game, and oysters, raw or roasted ; while the starches and fats should be withheld, or very sparingly used. Peaches, grape-juice, celery, tomatoes, and raw cabbage, are frequently acceptable. But theory must not override observation in individual cases. The intestinal digestion is not destroyed, but impaired, and when desired by the patient, gruels, aerated bread, stale or toasted, and other simple farinaceous articles, may be tried. Lime-water, Apollinaris water, bits of pounded ice, and kumyss may be used as indicated.

Prophylaxis.—On the approach of hot weather much may be done by way of prevention, so much better than cure. Laxatives should be avoided. Great care should be bestowed upon the diet. Simple, wholesome, nutritious food should be selected. Unripe and overripe fruit should be avoided. Flannels of appropriate thickness should be worn next the skin, and all chilling of the surface of the skin, especially when moist with perspiration, should be sedulously guarded against. Removal from cities to the country or seashore is desirable. The great danger of polluted drinking-water, and of foul emanations from privies and cesspools in and around crowded summer hotels and boarding-houses, should be borne in mind, and due discrimination exercised. The thorough boiling of questionable water before drinking it is a precaution of great value. The importance of maintaining the best hygienic circumstances, individual and incidental, needs only a suggestion.

II. Pseudo-membranous Enteritis. — Synonyms : Chronic exudative enteritis ; diarrhœa tubularis ; mucous diarrhœa ; colique glaireuse ; tubular exudative casts of the intestines.

Definition. — A chronic, non-febrile affection, chiefly met with in nervous, debilitated women ; attended with a peculiar condition, more or less extensive, of the intestinal mucous membrane, with marked disturbance of the digestive and nervous functions and depression of spirits ; frequently with associated uterine, ovarian, or vesical disorder ; and characterized by the discharge, per anum, of a peculiar membranous exudate, composed chiefly of mucin, in the form of shreds, ribbon-like bands, or complete tubular casts of the intestine.

The disease will be presented here only briefly and in outline, mainly with a view to definition and differentiation from intestinal catarrh. Croupous enteritis, as above defined, is a disease, *per se*, of well-marked individuality. The name is also used in connection with the development of membranous shreds and patches in the alimentary canal, as a complication or casual accompaniment of other diseases, as diphtheria, dysentery, the exanthems, Bright's disease, pyæmia, and puerperal fever. In these cases the exudate consists largely of fibrine, and should be counted as a part or accident of the primary disease.

Pseudo-membranous enteritis is obstinately persistent in its course, and consists of a series of paroxysms and intermissions. The paroxysms recur at irregular intervals of weeks or months, and continue for longer or shorter periods, the membranous exudate being present in all, or nearly all, the stools ; they are often preceded, or attended, with increased dyspeptic and nervous phenomena—nausea, vomiting, or pyrosis, and abdominal pain, tenderness, tormina, and tenesmus ; the pain often extending to the womb and bladder, and down the thighs ; derangements of sensation, both general and special, occur ; the paroxysms are usually followed by marked relief of both local and general symptoms.

The health, however, is by no means perfect in the intermissions ; the stomach is apt to remain irritable ; both gastric and intestinal digestion are imperfectly performed, and the bowels may be constipated, or alternately constipated and loose ; the nervous system remains weak and irritable, hysterical and neuralgic manifestations are common, and impairment of the health is usually slowly progressive.

The large intestine is the seat of the trouble oftener than the small, but frequently a portion of each is involved. While the individuality of the disease is marked, and its recognition easy, the pathology is by no means clear. It can hardly be considered a simple croupous inflammation, for the membrane is not composed chiefly of fibrine, but of mucin. Is it an affection of the muciparous glands of the intestine? As Da Costa asks : " Is not the true trouble in the nervous system, in the nerves presiding over secretion and nutrition in the abdominal viscera ? " The disease seems to have little tendency to directly destroy life, but it is very persistent and difficult of cure. It favors the occurrence of other diseases by lowering the tone of the system, and diminishing its power of resistance. It also tends to intractable dyspepsia, melancholy, general nervous disorder, extreme weakness, and marasmus.

The treatment demands patience and courage on the part of both doctor and patient. The best hygienic conditions must be established, the diet must be carefully arranged, and a judicious course of tonic medicines may be adopted. Opium is usually required in the paroxysms. Hypodermic injections of morphine and atropin may be used. The final expulsion of the exudate is hastened and facilitated by copious enemata of hot water through the long rubber tube. In the intervals weak solutions of carbolic acid, iodine, nitrate of silver, or sulphates of zinc or copper, may, in the same way, be brought into contact with the local diseased surface. Besides the general tonics, turpentine and copaiba, arsenic and corrosive sublimate, and other alteratives, are sometimes administered with advantage.

III. Phlegmonous Enteritis.—Synonym : Enteritis from obstruction.

Phlegmonous enteritis being seen most commonly and typically in association with intussusception, internal strangulation, and other forms of intestinal obstruction, will be elsewhere considered in connection with that affection. *Israel T. Dana.*

INTESTINES, NEOPLASMS OF. Fibroma, Myoma, and Myo-fibroma (for histological anatomy of these and other intestinal new-growths, see article on Growths, Pathological) are found growing from the muscular coat, and are composed of fibrous and muscular tissue in varying proportion. They may occlude the ducts entering the intestine, or, being grasped by peristalsis, they may be drawn into its lumen, carrying with them the parts to which they are attached, thus causing an intussusception.

Adenoma.—Glandular polypi are rare in the small intestine, but common in the rectum (see vol. i., p. 284, under Diseases of the Anus and Rectum).

Enchondroma is a very rare intestinal neoplasm, being generally the result of secondary changes in a glandular tumor.

Lipoma.—Of this only a few cases are recorded. These have usually been attached high up in the large intestine Owing to traction the pedicle is often long, and may con-

tain peritoneum. They are liable to cause invagination, and, the pedicle giving way under the tension, they may then be passed *per anum*. A thick, tough capsule envelops these tumors, and the fat composing them, undergoing inflammatory changes, becomes hard and dark-red in color. Sometimes, also, it breaks down, forming a cavity full of liquid fat.

Hypertrophy of the appendiculæ epiploïcæ produces fatty tumors, which in some cases twist away from their attachment, and wander free in the peritoneum.

Lymphoma and Lymphadenoma are found in leukæmia. Beginning in the solitary follicles and patches of Peyer, they may extend diffusely to the mucosa, and may ulcerate. They are found with especial frequency in the ileum near the ileo-cæcal valve, and usually accompany other leucocythæmic neoplasms of the lymph-glands, spleen, bones, peritoneum, etc.

Cysts.—Besides cysts formed by degeneration of chyle-ducts, there have been observed dermoid cysts of the rectum, containing hair, teeth, and in one case brain-matter. Cysts of the small intestine, besides those above indicated, are very uncommon.*

Gumma.—A few cases have been reported by Verneuil, Esmarch, Mollière, Bartels, Zappula, and Zeissl. It occurs as a thickening of the rectal submucous tissue, tumor-masses forming here and there, and may cause stricture, the rectum being metamorphosed into a hard, thick cylinder. This infiltration may ulcerate, diarrhœa and cachexia ensuing.

Angioma.—Causes producing portal congestion determine the appearance of venous varices in the small and large intestine (see article on Hæmorrhoids, vol. i., pp. 270–272). Arterio-capillary nævi of the rectum also occur, and have been a source of alarming and even fatal hæmorrhage.

Sarcoma is a very rare form of intestinal growth, occurring usually in the rectum. Dr. Bessel-Hagen, however, reports (Virchow's *Archiv*, Bd. xcix., Heft i.) a case of sarcoma of the small intestine. A boy, after an injury, developed an abdominal tumor, became marasmic, and died in four months. The autopsy revealed a small, round-celled sarcoma, as large as a fist, springing from the submucous tissue of the jejunum, and accompanied by numerous secondary deposits.

Carcinoma is the usual form of neoplasm affecting the intestine. It may occur in any part of the tube, but is vastly more common in the large than in the small segment, its occurrence in the former being estimated to be four times as frequent as in the latter (excluding rectal cancers). According to Leichtenstern (Ziemssen's "Cyclopædia," vol. vii., p. 636), the proportionate frequency of cancer in the different regions is as follows: Rectum, 80 per cent.; colon, 11.5 per cent.; cæcum (including the ileo-cæcal valve and vermiform appendix), 4.2 per cent.; small intestine, 4.3 per cent. It is thus apparent that cancer becomes gradually more common as the lower extremity of the intestinal tube is neared.

In the intestines, as in other structures, cancer is a disease of middle or advanced life, and, though occurring as a pathological curiosity even in youth, it is rarely seen before forty-five. With the exception of those spreading to the intestine from organs immediately contiguous, and those set up by metastases from distant points, these cancers are primary in their origin, and there is much in favor of the view that they are caused by the irritation of passing fæcal contents.

In the bowel, as in the stomach, cancerous neoplasms may assume one of the several types, scirrhous, encephaloid, colloid, and cylindrical-celled epithelioma. They usually involve all of the intestinal coats, sometimes spreading diffusely, more often girdling a circumscribed portion of the tube, affecting sooner or later all its coats, and presenting a tumor notably hard and uneven to the touch. Such a tumor grows mostly at the expense of the lumen of the gut, which, owing to this fact and to the cicatricial contraction taking place in the annular neoplasm, suffers great diminution, and offers an obstacle to the passage of its contents. Great masses accumulate above the point of obstruction, distending their receptacle and forming a large tumor. Indeed, fæcal impaction figures more prominently under palpation than the original growth, whose real dimensions can be determined only after dissipation of the former by cathartics and enemata. Ulceration and disintegration of the cancer-elements may finally reopen a passage, or, adhesions having formed and perforation occurred between the tumor and adjacent healthy intestine, some other of the hollow viscera, or the abdominal parietes, relief may be afforded to the symptoms dependent upon obstruction.

The symptoms of cancer of the bowel vary within quite wide limits, according as it is situated at either extremity of the intestinal tract or at some intermediate point. If cancer affect the duodenum, the symptoms closely resemble those of cancer of the pylorus. The usual pain, vomiting of matters possibly stained with blood, and a tumor indistinguishable from, and, in fact, often continuous with, a pyloric growth are present. Unless one or more of the glandular ducts emptying into the duodenum are blocked, and obstructive jaundice or fatty stools, due to shutting off the pancreatic juice, occur; or unless blood appear exclusively in the dejections, and never in the vomited matters, we have no means of differentiating the one from the other.

Cancer of the rectum produces a congeries of symptoms perfectly characteristic, and which have been discussed under other heads (see vol. i., Diseases of Anus and Rectum).

It is when situated at some point intervening between these *termini* that intestinal cancer produces its usual and peculiar effects. Vague disturbances of the health, a little pain, digestive derangements, possibly a little blood in the passages (a matter which often escapes unobserved) open the case. Unless the disease runs a rapid course, the general condition may suffer and cachexia develop in advance of the local symptoms. Sooner or later, however, abdominal pain is felt, the bowels move irregularly, the belly becomes distended, and a tumor is distinguished. This usually appears larger than it actually is, owing to the fæcal impaction adjoining it above. If the diseased bowel have not contracted adhesions with neighboring organs or the abdominal wall, the tumor is freely movable, and shifts its position, being felt now here, now there. Such a growth is tender to the touch, and causes more or less constant pain. Fæces, which under the efforts of the hypertrophied muscularis are forced through the strait, may be slim and ribbon-like in form, contain blood, pus, offensive ichor, and even cancerous masses. Severe hæmorrhages are rare, and occur chiefly with villous cancer. The irritation of the accumulation above the stricture sets up a catarrhal enteritis and diarrhœa, and the offending mass is thus flushed away, a period of constipation thereupon ensuing. These processes alternate for an indefinite time. At last, unless the increasing constriction is relieved by ulceration or sloughing of the new-growth, the obstipation becomes absolute, and then (though sometimes only after an amazingly long time) the symptoms of ileus develop; or else the distended gut ruptures into some adjacent and adherent viscus, or into the peritoneum. After the disease has lasted for a considerable period metastases may occur, and multiple tumors appear on the skin or in other internal organs.

The prognosis is usually bad. In a very few cases the ulcerative process has destroyed the disease as by cautery, the base thereupon cicatrizing. In others the growth has separated entire, and been passed per anum.*

* As an example of this rare growth and its successful treatment, the reader may refer to the case described in The Lancet, April 25, 1885, wherein Mr. Sydney Jones removed by abdominal section a cyst attached to the wall of the small intestine. It was as large as an orange, smooth, sessile, and had to be peeled from its attachment, and on section was found to be filled with a thick, yellow fluid, containing fat, molecular matter, and cholesterine.

* Such a case was reported to the Soc. Anatomique, July, 1883, by M. Dejerné for Dr. Gallard. The patient, a man, aged forty-five, had suffered from diarrhœa alternating with constipation, and presented a tumor in the hypogastrium. This latter disappeared suddenly, all the symptoms ceased, and a little later the tumor, which had been attached by a pedicle, appeared in the stool. It was a cylindrical-celled epithelioma.

These fortunate terminations are, however, too rare to alleviate the extreme gravity of the outlook, if the case be left to nature. The average duration of cases of intestinal cancer is said by Duchaussay to be eight months.

Until quite recently treatment was wholly expectant, and consisted in careful regulation of the diet, the prevention of fæcal impaction, and the subdual of pain by opiates. When the disease was situated in the colon, the establishment of an artificial anus in one or other loin was practised, with marked relief to suffering and temporary amelioration of the general condition. Of late, however, the extreme success attending antiseptic laparotomy and intestinal resection for penetrating abdominal wounds has emboldened operators to attempt the radical removal of the disease. This has been done in several ways, depending upon its situation. Some have opened the loin by the usual lumbo-colotomy method, and above the seat of disease, and after its extirpation through this opening have secured the upper portion of the gut and formed an artificial anus. Others have made their incision in the median line, have removed the cancerous mass, and reunited the severed ends of the intestine; or, in some cases, have closed the lower end and made an artificial anus. Other plans, such as removing a cancer of the colon through the rectum, opening and suturing the healthy gut above and below the stricture when the entire ablation of the neoplasm was found impracticable, have been tried or proposed.

Enterectomy and colectomy for cancer have been attended thus far by a mortality of fifty per cent. ("Int. Encyclop. of Surgery," vol. vi., p. 92). It cannot but be confidently hoped that as skill in abdominal surgery increases this operation-mortality may be cut down. Operations have as yet been too few to afford data whereon to estimate the frequency of return after radical removal.

Wm. S. Cheesman.

INTESTINES, WOUNDS OF. The influences that cause intestinal wounds may come from without the body, and be dependent on all the recognized forces that produce bodily injuries, or they may occur within the body, due to the presence of some foreign substance in the intestinal canal.

While the former influences are common, the latter are very infrequent. Each anatomical division of the intestinal tract is liable to injury; but those portions that are most extensive or most exposed are obviously in the greatest danger. For these reasons the ileum and the jejunum suffer most frequently, the colon occasionally, and the duodenum the least of all. The mobility of the intestines, due to their lax attachments and to the peculiar nature of their investing membrane, their elasticity, and the yielding nature of the tissues about them afford the greatest possible natural immunity from the effects of violence that is consistent with the proper performance of the functions of the human body. While in normally developed adults the divisions of the intestine present no decided variations from each other in their relations to the abdominal walls, yet Treves has shown it to be impossible to definitely localize any certain portion of the ileum or jejunum by external examination, because of the variations in the relations of the intestinal loops to each other and to the abdominal walls; and while these variations are not sufficiently well pronounced to constitute a deformity, still they are of such a character as to make impossible an accurate diagnosis of the part injured, or even of that existing in a hernial protrusion. In early extra-uterine life, during the development of the intestines and of the bony structures that give them attachment, their relation to each other and to the abdominal walls are constantly though slowly changing; in fact, these relative changes do not cease entirely until the body is quite well prepared for the performance of all its general and special functions. A time then exists, no doubt, when the relations of the abdominal contents to each other, and to the parts holding them in position, do present but trifling variations in every well-formed human organization. This happy state of things, however, is not of long duration in many persons. The pernicious influences common to the every-day life of both sexes soon disturb these harmonious relations, until finally, in many instances, little else than the abnormal contour of the abdominal wall or the protrusion of an escaped viscus can suggest the locations of the displaced organs. It is, therefore, manifestly true, in a large majority of instances, that scarcely more than a good surmise can be made of the anatomical location of an intestinal injury when caused by external violence. The colon, especially its vertical portions, has but a limited range of motion, and therefore it is poorly protected against traumatic influences. It has the exemption from injury, however, afforded by a comparatively limited area, by deep location, and by dense protecting structures.

Classification.—Wounds of the intestines are classified under the headings of incised, punctured, lacerated, contused, and gunshot.

This method of arrangement is not only simple, but possesses the additional merit of being well understood, by reason of its almost traditional association with wounds of the soft parts generally.

Causation.—The cause of an intestinal wound is commonly clearly indicated by the nature of the wound itself, although a single form of violence may produce a wound of multiform characteristics. All kinds of intestinal injuries can be attributed to some form of violence, either direct or indirect, coming from without or arising within the body. Violence is the direct or exciting cause of an intestinal wound, while the habits, occupation, idiosyncrasies, and surroundings of the patient are the indirect or predisposing causes. The direction of the force, together with its degree and the magnitude and character of the agent transmiting it, determine the extent, and largely, also, the number and variety, of the wounds inflicted. The direction of a wound of the intestine, as well as its size, exerts an important influence on its local physical phenomena.

Causation of Incised Wounds.—An incised wound may be caused by the cutting edge of a knife or other implement of a like character, or by the presence in the intestine of some movable, sharp body introduced from without, as a bit of oyster-shell or foreign substance of a similar nature. The latter causes are so rare that fatalities resulting from them are classed as strange. If the incised wound be long and longitudinal, the contraction of the circular fibres will cause it to gape and permit the easy escape of the intestinal contents. If the longitudinal cut be but a third of an inch in length, the contraction of the muscular fibres of the intestinal walls will diminish it about one-third, and the remaining portion of the opening will quite certainly be closed by the eversion of the mucous lining of the intestine without extravasation, provided the intestine be not loaded with fæcal matter at that point. While there is, without doubt, a direct relation between the size of the wound and the ability of the natural forces of the intestine to close it, still, these forces are too easily modified by accidental causes to be relied upon to the exclusion of medical and surgical means; and, moreover, this uncertainty of action and the probability of intestinal plenitude should admonish one to avoid, if possible, even puncturing the intestinal wall, unless the part wounded be visible at the time. It is of little practical utility to theorize on the form and size of the wound of an intestine, as modified by the direction of the incision in its walls, since these features cannot be determined in any particular case, unless the injured part be closely inspected, when the indications for treatment will be similar to those of other solutions of continuity of the intestinal structure. The late Professor S. D. Gross considered that an intestinal wound twelve millimetres in length, irrespective of its direction, is almost invariably followed by fæcal escape and fatal peritonitis.

Causation of Punctured Wounds.—This form, like the preceding, is caused by external traumatic influences, and by sharp-pointed foreign bodies that gain admission to the intestine along with the food or are accidentally swallowed. The common and mischievous habit of making the mouth a temporary receptacle for pins and needles is not infrequently followed by a sudden disappearance of

one or more of their number down the œsophagus; an occurrence soon forgotten, but often recalled by the advent of obscure abdominal pains that suggest the disquieting possibility of their relation to the previous accident. Pointed objects, with or without a cutting edge, may pierce the abdominal wall and the intestines. If a cutting edge be present, the injuries will resemble the incised more nearly than the punctured wounds. Punctured wounds of the rectum, sigmoid flexure, and even of the colon itself, have been caused by incautious or forcible introduction of instruments or of foreign bodies for various purposes. Minute punctures of the intestines with a fine trocar, pushed through the abdominal wall, are sometimes made for the relief of the extreme gaseous distention often associated with complete obstruction of the bowels.

Causation of Lacerated and Contused Wounds.—These forms commonly arise from external violence, and when thus caused both varieties may be well marked at the same situation. A considerable degree of external violence is required to cause a laceration or a severe contusion of the intestines, owing to their mobility and flexibility, and also to the nature of their investing tissues. Usually the agents that transmit the force have a blunt outline. The passage of the wheel of a loaded vehicle across the abdomen offers a fair and frequent illustration of the manner the violence is inflicted; also a blow from a clinched hand, or from the kick of a horse or a man, especially if the intestine be forced against the spinal column, or if the violence be received at a point where a dense fæcal impaction exists. The intestines may be bruised, and even lacerated, by imprudent manipulations when employed in the reduction of a hernial protrusion, either before or after the exposure of the contents of the sac. The incautious introduction of the hand or an instrument into the sigmoid flexure or colon has not infrequently caused a laceration of their structures. Contusions of the intestines, with and without lacerations, have been caused by the force employed in kneading the abdomen to overcome intestinal obstructions dependent on fæcal impaction. Rupture of a small intestine has arisen from the force exerted by a circumscribed collection of intestinal gas, which had been generated as a result of morbid conditions of an obstructive nature. The force of spent pieces of shells has caused laceration of the small intestine. The duodenum and jejunum suffer more frequently from these forms of injury than the remaining portions of the intestinal tract.

Gunshot Injury of the Intestines.—The variety of the injury indicates at once its causation. This form of intestinal injury, as of other portions of the body, is caused directly or indirectly by a missile or projectile propelled by the force of gunpowder or other explosive compounds. Gunshot wounds are essentially contused injuries; still, not infrequently, from the peculiarity of the missiles, they may possess the characteristics of incised and lacerated wounds. The frequency of gunshot wounds of the intestines, complicated, of course, with abdominal penetration, depends on the status of those who are exposed to the conditions causing them. In civil strife they are comparatively more frequent than in military conflicts, because in the latter the trunk is exposed as little as possible and the missiles fly high. In the former the attacks are more unexpected and less guarded against, the range is shorter, and the aim better. The percentage of shot injuries of the abdomen that were reported during the late war is astonishingly small (about .035) when compared to that of the head (.15), which is a smaller but generally more exposed part of the body. The intestines were wounded in over seven per cent. of all the shot wounds of the abdomen reported.

The number or size of the intestinal wounds cannot be determined except by a direct examination, and even then, if the missile be small, great caution must be exercised or some of the points of injury will escape notice. The size and shape of a penetrating shot wound of the abdomen will fairly indicate the extent of injury to the intestines; still, the intestine may escape injury, even though the missile that entered the cavity be large and be transmitted with a great degree of force; yet this is a presumption not to be entertained. A small projectile may cause numerous intestinal perforations, or, like the former, pass through the cavity without seriously damaging its contents. The outlines of shot wounds of the intestine are multiform, and are largely modified by the direction taken by the missile, with reference to their longitudinal or transverse axis. A bullet may pass directly through an intestine, causing the characteristic openings of a gunshot wound at the anterior and posterior surfaces of the bowel only; or it may traverse its longitudinal axis an inch or more, causing a wound of corresponding length at either surface of the gut. Simple isolated contusions of the intestine have been found in the track of a bullet wound; penetration having been obviated, no doubt, by the elasticity of the walls of the intestine. Round balls, as in other parts of the body, often pursue an erratic course, being deflected by seemingly trivial influences. Conical balls are much more certain to take a straight course; yet even these have been known to deviate greatly without apparent reason. The same inherent tendency to spontaneous closure exists in this as in other varieties of intestinal wounds. In the incised and punctured varieties the vitality of the lips of the wound is unimpaired. In the contused, lacerated, and gunshot varieties the lips of the wound are more or less devitalized by the tearing and bruising, and there follows a limited death of tissue, which not only increases the size of the wound and the dangers of extravasation, but also adds another source of irritation to the primary injury itself.

Symptoms.—The symptoms of intestinal wounds are those referable to the intestines and their immediate surroundings, the abdominal symptoms; and those dependent on the constitutional effects of the injury, the constitutional or general symptoms. Both classes are greatly modified by the situation and extent of the injury, as will be shown hereafter.

Abdominal Symptoms. Pain, tenderness, tympanites, and bloody stools are the common indications of local importance in intestinal wounds, to which may be added the protrusion of the viscus and the escape of the intestinal contents, if the abdominal wall be penetrated. Emphysema of the structures about the wound, or of the general connective tissue of the abdomen and trunk, may occur. Emphysema is of great diagnostic importance when taken in connection with its relation to the period of the injury with which it is associated.

Pain and Tenderness. These are among the first of the abdominal symptoms, and become quickly associated with those of shock. The pain is located primarily at the seat of the wound, and is, at first, dull and lancinating, the former quality being more characteristic of contused than of other forms of intestinal wounds. As a rule, the pain increases rapidly, becomes burning, and is accompanied by exquisite tenderness of the abdomen, retraction of the thighs, and obstinate constipation. Sometimes there are griping pains, with a desire to stool. Retention of urine, requiring a frequent use of the catheter, is of common occurrence, and is a result either of peritonitis and shock or of the treatment employed. Any muscular exertion, even the act of breathing, increases the agony; but later, respiration becomes painless, though labored. The pain and tenderness are usually in direct proportion to the acuteness and extent of the peritoneal inflammation, and the inflammation has a corresponding relation to the degree of the injury and to the amount of blood, fæces, etc., extravasated into the abdominal cavity.

Tympanites. Tympanites may depend on a gaseous distention of the intestine, the existence of air in the peritoneal cavity, extensive emphysema of the abdominal walls, or on all these factors present in a single case. If tympanites develop soon after pain and tenderness appear, and increase in proportion with them, being at the onset best marked at and around the situation of the wound, it is quite certain to be due chiefly to intestinal distention. If it follow quickly, antedating the symptoms of inflammation, or be out of proportion to them, or if much distention of the abdomen, with a drum-like sound on percussion, attended by little or limited pain,

and tenderness be present, the tympanites depends, without doubt, on the presence of air in the abdominal cavity. The substitution of tympanitic resonance for normal hepatic dulness may be considered a strongly diagnostic sign of even a small amount of air in the peritoneal cavity. But it may be caused by the adhesion of the intestine to the anterior abdominal wall in this situation, by a distended colon pressing firmly against the under surface of the liver, and by distention of the colon accompanied by a diminished area of hepatic dulness due to a contracted liver. In the former of the last two conditions, however, the area of hepatic dulness will be increased posteriorly by the pressing upward of the liver, provided the lung of that side be not emphysematous. In the latter the posterior area of hepatic dulness will be lessened in proportion to the diminution of the size of the liver. Professor E. G. Janeway has noted that the transverse colon may pass between the liver and abdominal wall, causing tympanic resonance in this situation. Dr. H. M. Biggs has since seen this condition post mortem. If the serous surfaces of the liver and of the abdominal wall be adherent, hepatic dulness may be present, even though air be in the peritoneal cavity. These morbid conditions are so infrequent, however, that tympanitic resonance in the hepatic region, existing in a case of suspected intestinal injury, may be considered pathognomonic of perforation.

Emphysema of the Abdominal Walls. This sign is not associated very frequently with penetrating wounds of the abdomen, but, when present, is almost invariably due to the escape of intestinal gases into the connective tissue situated between the intestine and the abdominal wall; hence it is associated especially with injuries of those portions of the intestinal tract that are not surrounded entirely by peritoneum. Emphysema may be limited to the immediate neighborhood of the injury, or become general by spreading gradually from the seat of the injury into the surrounding connective tissue, and it may also be due entirely or in part to a complicating wound of the pulmonary tissue. Emphysema of the abdominal wall has been considered by some writers as a certain sign of intestinal perforation when associated with a suspected penetrating abdominal wound. This statement must be accepted with a certain degree of caution, since it has happened, in two distinct instances within the observation of the writer, that a circumscribed subcutaneous emphysema has taken place around a non-penetrating stab wound of the abdominal wall. The emphysema was apparently caused by the suction influence exerted by the sudden retraction of the divided fibres of the abdominal muscles on the external air through the narrow and valve-like slit in the integument. Be this as it may, the abdominal wall was found, in one instance at least, by a careful examination not to have been perforated. Air in the peritoneal cavity may cause emphysema, if it be forced through the borders of the abdominal wound into the connective tissue beyond. If decomposing processes occur in the course of a penetrating wound of the abdomen, emphysema of the connective tissues contiguous to the injury may occur, even though the intestines themselves have not been injured. In cases of this kind, however, the emphysematous manifestations are delayed, and are not attended with the usually acute symptoms of penetrating wounds of the abdomen.

Hæmorrhage. The appearance of blood at the natural, or the traumatic, openings in cases of suspected intestinal injury is a very important symptom. It may escape from the mouth, the anus, or the abdominal wound. When it appears at the natural openings it may be either light or dark, fluid or coagulated, digested or undigested, pure or mixed with the contents of the intestinal tube, abundant or scanty. In hæmorrhage from the abdominal wound the blood may come from an injury of the vessels, or of the viscera within the abdominal cavity, or from the abdominal wall itself. Here, also, the blood may be either pure or mixed with fæcal matter and intestinal fluids. It may likewise appear in the urine, either coagulated or mingled with it. The tendency of intra-abdominal wounds to bleeding is especially marked, owing, it is thought, to the feeble support afforded to the walls of the vessels by contiguous tissues, to the respiratory movements which disturb the proper formation of the hæmostatic clots, and to the absence of the stimulating effects of the air.

Escape of Intestinal Contents. It not infrequently happens, within a short time after the receipt of the injury, that fæcal matter, undigested food, intestinal juices, and bile escape from the opening; also, water and other liquids may flow from it almost as soon as they are swallowed. Instances are recorded of intestinal worms crawling from the openings. If the intestinal contents escape through the abdominal wound within the first twenty-four hours of the injury, it suggests that the wound is a large one, followed by profuse extravasation, or that the opening of the intestine is immediately in contact with the abdominal wound; however, the formation of adhesions usually precedes the escape of any of the intestinal contents from the abdominal wound. At a later date the fæcal escape may be directed, from a considerable depth, to the external opening by the adhesions consequent on the circumscribed inflammation.

General or Constitutional Symptoms. Shock is the first link in the chain of constitutional symptoms. It may be slight, or of a gravity sufficient to imperil or even terminate the life of the patient before inflammation sets in. While, as a rule, its gravity is in direct proportion to the degree of the injury, yet, in some patients, from problematical reasons, the gravity of the shock is out of proportion to the severity of the wound. Severe shock at the onset is an almost diagnostic evidence of profuse hæmorrhage, or of extensive visceral implication. In the beginning the countenance is pale; the temperature is often subnormal; nausea exists, with or without vomiting; the breathing is feeble and embarrassed; the mind is bewildered; sighing occurs, with restlessness; there is a desire for fresh air and drink; there is a tendency to syncope and other symptoms of shock that are so generally understood as not to require a complete recapitulation at this time. It is important, as will appear hereafter, to distinguish the shock due to loss of blood from that caused by the injury alone. After reaction from shock has taken place the pulse becomes firmer and less frequent, but soon the frequency increases and it acquires the sharp and contracted character of peritoneal inflammation. In the later stages it is weak and fluttering; the surface of the body is covered with a cold, clammy perspiration, and the extremities are cool and dusky. The feeble and shallow respiration of the earlier stages now becomes labored and oppressed.

Nausea and Vomiting. Nausea commonly occurs immediately after the injury; vomiting may likewise take place; both are frequently present in the earlier and in the later stages.

Hiccough. Hiccough may precede the vomiting, and often accompanies it even into the last stage, and not infrequently it contributes greatly to the sadness of the final scene.

Intense thirst, retention of urine, constant wakefulness, excessive restlessness, and great anxiety often appear in the earlier stages. The features are collapsed and pinched, with a contracted upper lip; the abdomen is tense and tumid, and not infrequently a low delirium occurs, all of which portend a fatal termination; finally, the patient dies from sheer exhaustion within three or four days after the injury, and often in a much shorter period.

Diagnosis.—Injuries of the abdominal wall, with or without an implication of the abdominal viscera or the vessels of the abdomen, may be confounded with wounds of the intestine. The various forms of intestinal wounds must be distinguished from each other. It is also very important to determine, as far as practicable, the situation, size, and extent of an intestinal wound. There are acute conditions, too, such as intussusception and internal strangulation, which present some of the features of an intestinal injury. It is only necessary to allude to this fact, however, because the differences in their early history and exciting causes are sufficient to prevent, almost from the first, any confusion. The diagnosis of the ex-

istence of intestinal perforation with abdominal penetration does not require special mention, since the consideration of the intestinal wounds with abdominal perforation, which is to follow, will fully meet the indication. The differentiation of the various forms of intestinal wounds from each other is not ordinarily difficult, since each one will partake largely of the nature of the abdominal wound with which it is associated ; that is, if the penetrating wound of the abdomen be an incised or punctured one, the corresponding intestinal wound will be of a similar nature and size, unless the agent that caused the injury be freely moved while in the cavity of the abdomen, which act may convert a simple punctured wound of an intestine into a free incised or a lacerated one, according to the tendency of the implement to tear or to cut the tissues.

Contused Wounds.—The diagnosis of contused wounds, while not easy, can nevertheless be readily made from that of all other forms, except, perhaps, the lacerated variety. The duodenum, transverse colon, and small intestines are most liable to this form of injury, and it is especially located at the points where they cross the anterior surface of the spinal column. The vertical portions of the colon are so well protected by contiguous fat and bones that little less than an almost immediately fatal degree of force can seriously damage them. The sigmoid flexure and the caput coli are additionally protected externally by the flaring crests of the ilia. The common symptoms of shock are quite certain to result from a degree of force sufficient to cause a contused wound of the intestine. The respiration is additionally modified by any pain that may attend the act of breathing. Nausea and vomiting may occur, particularly if the injury be located in the duodenum or upper portion of the jejunum. The pain in the beginning is not of the acute peritonitic character that occurs in wounds with a complete solution of continuity of the intestinal wall, with extravasation. It is dull, deep-seated, attended by an occasional stitch that indicates a beginning, or a circumscribed, inflammation. These symptoms may subside in a few days, or be quickly followed by a sudden increase in the pain and other manifestations of a general peritonitis, and even by collapse. These unfavorable symptoms may be caused by the rapid increase of a localized inflammation ; by a sudden hæmorrhage from a previously contused vessel ; or, more commonly, by a sudden extravasation following sloughing of some portion of the intestinal walls. The constitutional symptoms keep pace with the local ones—the temperature rises, the pulse becomes more frequent and harder, and the patient soon shows evidences of collapse. The degree of tympanitic distention of the abdomen is usually proportionate to the extent and intensity of the inflammation ; as before mentioned, the air may be in the peritoneal cavity or in the intestines. When it exists in the former situation, the distention comes suddenly and is of a greater degree than when caused by intestinal distention alone ; when free in the cavity, it indicates to a certainty an opening in the wall of the gut. With a contused wound, blood may be vomited or passed at stool ; if the jejunum or duodenum be injured, it may be vomited ; when passed at stool, if the amount be small and clotted, it indicates that the lower portion of the intestine (ileum) is injured. If the amount be small and has to traverse a considerable portion of the intestinal tract, the fluids of the intestines will have changed its color and consistency. It should not be forgotten that coincident diseases of the stomach or rectum may cause hæmorrhage ; in such a case, however, the blood will be of a bright color, and may be mixed with the normal contents of the viscus.

Lacerated Wounds.—This form of injury is to be diagnosticated from simple contusion of the intestine. The locations of the injuries and their causes are similar in both instances. The symptoms occur earlier and are more pronounced than in contusions, owing to the greater liability of the escape of the intestinal contents into the peritoneal cavity.

Punctured and Gunshot Wounds.—These varieties of intestinal wounds are always associated with those of a similar nature in the abdominal wall, and through which may escape the diagnostic evidences of the intestinal wound. The features of the abdominal injury and the history of its cause will, therefore, indicate quite clearly the variety of the intestinal wound. In determining the existence of a wound of the bowel it is important to note the direction and extent of the lesion by carefully considering the size and shape of the body that caused the injury, together with the position of the patient at that time and the direction of the violence. A carbolized index-finger, or grooved director, or a large probe, may be employed ; and the body and the parts should be placed as nearly as possible in the position occupied at the time of the receipt of the violence. The examination must be conducted with antiseptic precautions and with great care, otherwise the hæmorrhage may be increased or the injured bowel disturbed. But little of importance can be gained by examination of the external wound, beyond determining if it have penetrated the abdominal cavity. The abdominal symptoms have been already considered at length, and will now be employed to designate the probable location of the wound.

Wounds of the Duodenum.—Vomiting of blood mingled with the contents of the stomach is quite common, although the amount vomited is usually small. The appearance at the abdominal wound of bile, partly digested food, and fluids having an acid reaction, and the presence of a portion of the gut in a penetrating wound located over the site of the duodenum from which the above-mentioned fluids escape, when taken in connection with the location and direction of the external wound, indicate a duodenal injury. The relations of the peritoneum to the lower subdivisions of the duodenum sometimes permit the escape of its contents behind the peritoneum instead of into its cavity, as occurs in wounds of other parts of the small intestines. When this happens there is a delay in the development of the acute symptoms that occur with injuries of the small intestines elsewhere ; the amount of peritoneal inflammation is much less, and a certain degree of subperitoneal cellulitis is substituted for it. The escape of the intestinal gases in the same situation not infrequently causes a subperitoneal emphysema that extends to the tissues of the abdominal walls.

Wounds of the Jejunum and Ileum.—Notice the situation and the direction of the injury. Traces of undigested food, stained by bile, may appear at the opening when the jejunum is injured. The vomited matters rarely contain blood, and then only after repeated vomiting or in case of a copious hæmorrhage ; then blood will appear in the stools. If the ileum be injured, the external wound will correspond to its general location ; the discharges from the wound will be of a feculent character, but odorless ; traces of undigested matters and bile are rarely seen ; hæmorrhage from the anus will be more constant, and copious, the nearer to the caput coli the injury of the small intestine is located.

The missile may not pass through the intestine, but may be arrested in the canal, and finally escape per anum. Intestinal worms are not infrequently seen at the openings ; and they may enter the peritoneal cavity, and by their peregrinations not only increase the pain, but also spread the irritating influences that cause it. While the presence of entozoa at an abdominal wound is a positive sign of a solution of continuity of the wall of the intestine, it does not determine the particular portion of the intestine that is wounded, since they infest the entire length of the tract.

Wounds of the Colon.—If the transverse colon be perforated, the escape of blood and fæcal matter into the abdominal cavity will take place freely, since this portion of the large intestine is surrounded by peritoneum. If the gut appear at the wound, its greater size, along with the situation and the more compact and offensive nature of the fæcal discharges, will aid in the discrimination. Hæmorrhage from the bowel will be a common symptom. The general symptoms attending peritoneal extravasation will become quickly and markedly devel-

oped. If the vertical portions of the colon be injured, the wounded intestine can only appear at an opening at the posterior or lateral portions of the trunk, since the attachments of the colon will not admit of its presence in front, and the fæcal discharges will take place from the opening situated posteriorly. Fæcal matter and gases may pass behind the peritoneum, causing conditions similar to those met with in wounds of the duodenum.

COMPLICATIONS.—Hæmorrhage and extravasation of the intestinal contents are common complications. Hæmorrhage may arise from a direct injury to the blood-vessels of the viscera or walls of the abdomen, or from violence done to the thoracic organs. In estimating the prognosis of intestinal wounds, or determining the feasibility of an operative procedure for them, a knowledge of the complications and of their influence on the case is of great importance. If a vessel of the abdominal wall be injured and the source of the hæmorrhage be visible, the vessel can be easily exposed and tied; but if bleeding occur from an intra-abdominal vessel, the patient may succumb before the fact is recognized. The diagnosis of the complications of intestinal wounds is always difficult, and often impossible. The situation and the direction of the external wound will suggest the important organ that may be injured; but if the missile pursues a devious course, the degree and extent of the injury are entirely problematical. If the patient void bloody urine, the kidneys or the bladder may be wounded. If the bladder collect but little urine, and pain and tenderness develop in the pelvic cavity, it points to the probability of a wound of the bladder, with early and even continuous escape of urine into the peritoneal cavity. In complicated intestinal wounds the shock is usually of a grave character, especially if a severe hæmorrhage take place, while uncomplicated intestinal wounds are not attended usually with severe shock, and may be followed by only slight local and constitutional manifestations; yet extensive intestinal injuries, attended by copious extravasation of the intestinal contents, may likewise present similar phenomena at the onset, only to be followed soon by sudden collapse and death.

Septicæmia not infrequently complicates intestinal wounds, if their course be somewhat protracted and decomposing agents have been permitted to remain in the abdominal cavity, or if decomposition has taken place elsewhere in the course of the wound.

TREATMENT.—The indications for the treatment of wounds of the intestines are not numerous, yet it requires not a little fortitude on the part of a surgeon to carry all of them into effect. The first indication is to combat shock, otherwise the patient may die before other means can be employed. The second indication is to arrest hæmorrhage, by which we may not only prevent the death of the patient from direct loss of blood, but may also lessen the amount of blood in the abdominal cavity and the peritoneal irritation caused by its presence. A third and very important dual indication is to prevent and subdue the peritoneal inflammation that arises directly from the injury and from its concomitant effects.

Treatment of the Shock.—Two forms of shock are met with in intestinal wounds—one form due to the direct effect of the injury on the nervous system, and the other caused by an inordinate loss of blood. Not infrequently they are combined. The symptoms of the first variety have already been considered in connection with the constitutional symptoms of abdominal injury. The treatment of this variety in intestinal wounds does not differ sufficiently from that of a similar form in other injuries to require an especial mention (see article Shock). Stimulation, by external warmth and by hypodermic injections, should be employed. Stimulants by the stomach and rectum are to be administered with great caution, and then only when absolutely necessary, since they may escape through the intestinal openings into the abdominal cavity.

The symptoms of shock from loss of blood differ somewhat from those following an injury alone. The pulse is feebler and more fluttering; the buccal mucous membranes are paler; the respirations are more shallow, and are sighing; the patient is very restless, rolls his head from side to side; not infrequently the inspiratory acts are long-drawn, while the expiratory are short and more forcible and accompanied by the exclamation "Oh, dear!" or "How close the room is!" "Give me air!" etc. The demand for fresh air is urgent, and artificial air-currents are accepted by the patient with a grateful appreciation. Such are some of the painful features that are characteristic of a most pitiful picture of apprehension and physical suffering.

The indications are to increase the cerebral circulation and to stimulate the force of the heart's action (see article Shock.)

Local Treatment of Hæmorrhage.—Hæmorrhage through the abdominal wound may arise either from the wound itself or have an intra-abdominal origin. In either case the indication is to tie the bleeding vessel. This can be easily done if it is situated in the abdominal wall, although it may be necessary to enlarge the opening for that purpose. If the blood escape from within the cavity the indication is still the same, but its consummation is hindered by the dread of opening into the abdominal cavity, together with the presumptive difficulty of finding the bleeding point. The treatment of intra-abdominal hæmorrhage, consequently, has partaken much more of a palliative than of an active nature, as it will continue to do, no doubt, until surgeons shall have had their courage sufficiently fortified by isolated successful precedents to encourage them to decide on the conditions that are suitable for carrying active measures into effect. The patient must be kept perfectly quiet, and cold applications should be carefully made to the abdominal wall. The abdominal opening should remain unobstructed, in order to permit the escape of the blood that might otherwise collect in the abdominal cavity. Antiseptics are to be employed in a manner consistent with the indications just stated.

Prevention and Treatment of Peritonitis.—The dual indication to prevent and subdue peritoneal inflammation is the most important one, and to accomplish this means the saving of many patients who have been permitted heretofore to die unaided. The treatment to meet this indication can be divided into the local and the constitutional forms. The local is by far the most important, and may be classed as the expectant and the radical or operative measures of treatment, the latter of which is not only difficult of performance, but is hemmed in by traditional as well as actual dangers. The causes of the peritoneal inflammation are: (1) The injury done to the soft parts by the agent transmitting the violence; (2) the presence within the abdominal cavity of blood and of intestinal contents, which is the direct result of the injury. Hæmorrhage into the abdominal cavity cannot be prevented, although severe shock and the apposition of the intestinal walls exert a very strong repressing influence upon it, and may circumscribe it to a limited area. The escape of fæcal matter into the peritoneal cavity depends on the portion of the intestine that is injured, extent of the wound, the emptiness of the bowel, and the consistency of its contents. Injuries of the ileum and colon are characterized by the escape of fæcal matter; of the jejunum, of feculent matter; of the duodenum, of the more definite products of stomach-digestion. The influence of the size of the wound on the extravasation of the intestinal contents has been considered already. The danger of fæcal extravasation is in direct proportion to the amount and fluidity of the intestinal contents. The degree of the intestinal extravasation into the peritoneal cavity is increased by all vigorous and unusual movements of the abdominal viscera, due to coughing, vomiting, rough handling, or rolling the patient from side to side, and the area of peritoneal irritation is correspondingly increased. If the surgeon had to contend only against the inflammation caused by the injury of the parts from the vulnerating agent, his task would be a simple one and the successes would be numerous. Instead of this, however, the same influence that wounds the intestine causes, both directly and indirectly, the entrance of blood and intestinal irritants into the peritoneal cavity. After a severe injury, blood is always present there, and the absence of intestinal

Intestines.

matters, too, can only be hoped for, not expected. The presence of even a small amount of blood in the peritoneal cavity is dangerous, and the existence of fæcal matter in this situation is, according to the late Professor S. D. Gross, invariably fatal. It therefore follows that any treatment that may be directed to combating the inflammation caused by the injury alone will be inefficient, if not entirely inoperative; a logical conclusion that is confirmed by the death-record. The rational local treatment, therefore, consists in the removal and exclusion of all irritating substances from the peritoneal cavity, and in combating the resulting inflammation in every possible manner. To remove and permanently exclude the irritating substances necessitates opening the abdominal cavity and repairing the damage done to the intestine, even at the risk of hastening the death of the patient, inviting the criticisms of the censorious, and perhaps defeating the ends of justice in a medico-legal complication. That the death of the patient might be hastened by the step is no doubt true; but, in consideration of the great fatality that has attended the common methods of treatment, who can assume for a moment, with any degree of justice, that the operation itself alone caused the death of the patient? With medico-legal complications we have little to do. Our aim must be to benefit the patient, if possible, and leave the legal quibbling, if any arise, to the court and jury. Wounds of the intestines will consequently be divided into two forms—those *not* admitting of abdominal section, and those in which it may be done.

Contused Wounds.—Contused wounds of the intestines do not, as a class, admit of abdominal section; for while it is true that the contusion may be so severe as to be followed by sloughing of the intestinal walls, and consequent extravasation or hæmorrhage, yet the uncertainty of the time of its occurrence, added to the protecting influence of the circumscribed inflammation following local injuries of serous surfaces, makes it advisable, at the present time at least, to rely on conservative treatment alone. The patient must be kept absolutely quiet; the intestinal movements should be subdued by opium. The patient should be nourished by the bowel, if the upper third of the intestinal tract be injured; by the mouth, if the lower third be wounded. In the latter instance the food should have no residue, to escape, perchance, into the peritoneal cavity. These precautions are important alike in all forms of intestinal wounds. Cold to the abdomen, by the rubber-coil or other efficient means, should be persistently employed. The bladder should be emptied with a catheter, else efforts to expel its contents may increase the pain and inflammation. Aside from these special precautions, the generally recognized ones relating to pulse, temperature, pain, respiration, etc., should be carried into effect.

Lacerated Wounds.—A lacerated wound of the intestine may or may not admit of abdominal section. There is less danger of extravasation and hæmorrhage with a lacerated wound than with one associated with abdominal penetration, because in the latter the vulnerating agent drives the intestinal contents into the peritoneal cavity through the numerous openings it may cause, while in the former the tendency to diffusion of the intestinal contents is slight, owing to the nature of the violence and the limited number of the wounds of the intestines. The treatment for contused wounds of the intestine may be appropriate for this form of injury. If, however, collapse and the symptoms of intestinal penetration follow the receipt of an injury of the abdomen, then the feasibility of abdominal section will be governed by rules to be elsewhere stated.

Punctured and Incised Wounds.—In an uncomplicated punctured wound of the intestines not exceeding eight millimetres in length, the question of abdominal section need not be raised. If it be thought to be larger than this, the advisability of the measure will be governed directly by the size of the wound and the acuteness of the symptoms. An incised wound of the intestines is more dangerous than a punctured one, since its extent is greater and the danger from hæmorrhage and extravasation is correspondingly increased. Their general treatment, however, is similar to that of other varieties. The expectant plan is better in these than in gunshot wounds.

Gunshot Wounds.—These are the most dangerous injuries to which the intestine can be subjected, for they not only cause perforation of the bowel in many places, but the impetus of the missile carries the intestinal contents along its track, thereby multiplying the points of irritation. The shock is usually greater, and the symptoms are developed more rapidly and with greater intensity than in the other forms of intestinal injuries. The fatal results before alluded to are due principally to the acute peritonitis caused by the presence of blood and intestinal contents in the peritoneal cavity. While these facts have long been recognized, still the dread of opening the abdominal cavity has repelled the attempt to comply with a most urgent indication. The advent of scientific antisepsis, and the astonishing results which have attended other operations that have involved the peritoneal cavity, and required handling of its contents, establishing the fact that this procedure (abdominal section or laparotomy) exposes the patient to no unusual dangers, are stimulating surgeons to appreciate the feasibility of treating intestinal wounds on the basis of indicated action rather than on that of indefinite expectation. Laparotomy should be done with religious care, and then only after a rigid preparation. It should not be attempted if the patient be suffering from extreme shock, a shock so profound as to warrant the belief that death will ensue before the completion of the operation. It is not well to wait until the patient has recovered from all shock, because early shock, when severe, is more often due to loss of blood than to the injury alone; to wait under these circumstances might sacrifice the only opportunity left of saving the patient's life. The antiseptic precautions relative to the sick-room, the patient, the surgeon and his assistants, instruments, dressing of the wound, etc., must be, when possible, enforced with the same care and pertinacity that distinguishes abdominal operations in other departments of surgery. Space will not admit of a detailed description of the antiseptic *technique* that should be employed, nor should it be necessary at this time, since it has been described so fully in medical journals and special treatises that its details, to the interested, ought to be as household words. The steps of the operation consist: (1) In thorough antiseptic precautions; (2) opening the abdominal cavity; (3) arrest of hæmorrhage and removal of irritants from the peritoneal cavity; (4) detection and repair of intestinal wounds; (5) cleansing the peritoneal cavity and closing the abdominal wound.

1. The details of antiseptic treatment must be found elsewhere (see article antiseptics).

2. In opening the peritoneal cavity the initiatory incision should be made in the median line, at one side of the point of injury. It should be small at first, just sufficient to afford a view of the abdominal contents in the line of the injury, and may thereafter be enlarged upward or downward as the circumstances of the case may require. Before the peritoneum is opened all hæmorrhage from the operation wound must be checked. As the peritoneum is divided, its free borders should be caught with forceps, that are allowed to lie on the abdominal wall, to limit the peritoneal retraction; this will facilitate the perfect coaptation so important in abdominal closure. The sides of the wound should then be carefully raised, to enable the operator to inspect the upper surface of the abdominal viscera, and to examine for the seat of the wound, for the existence of hæmorrhage, and for the presence of foreign matter. It is not probable that the opening of the intestinal wound will be seen, on account of the change in the position caused by vermicular action and the disturbances incident to the movements of the patient—vomiting, etc. Still the omentum will present an injured point beneath the abdominal wound, and more or less blood, and possibly fæcal matter, may be seen near the same situation. If the evidences that are seen on inspection, when taken in connection with the constitutional symptoms, do not warrant the belief that the intestines have been wounded, or that hæmorrhage has occurred, the abdominal opening may be

closed at once. To this procedure should be given the appellation *explorative laparotomy*, in contradiction to *laparotomy in entirety—i.e.*, when intestinal wounds are found and repaired, hæmorrhage checked, and the peritoneal toilet carefully performed.

3. The importance of arresting the hæmorrhage will depend upon its degree and location. The site of the greatest amount of blood will direct the attention to the probable situation of the bleeding vessel. It should at first be noticed if the vessels of the abdominal wall be bleeding, or if the hæmorrhage come from the probable course taken by the vulnerating agent through the abdominal contents. In either instance tie the vessels as soon as practicable, for their ligation must be the leading indication if the hæmorrhage be severe. It is easy to secure the bleeding points in the abdominal wall, since, if necessary, the wound can be enlarged for that purpose with impunity. It is not an easy matter, however, to find the bleeding point when the blood flows from between the intestinal folds. The source of the hæmorrhage in this instance should be searched for by a preconcerted method rather than in a hap-hazard manner. The former plan will enable the surgeon to remove the blood or foreign matter as he meets it; by the latter method these agents will be disseminated by illogical handling and their baneful influences will be correspondingly increased. If the hæmorrhage be so severe as to immediately imperil the life of the patient, great haste must be made. Raise the omentum and make firm pressure with a large sponge, which has been rendered antiseptic, at the portion of the peritoneal cavity where the blood appears. Digital pressure on the abdominal aorta as it escapes through the diaphragm, if the hæmorrhage be arterial—or on the large veins conducting the blood toward the seat of the injury, if it be venous—will no doubt exert a palliative influence on the degree of the hæmorrhage. The hæmorrhage once checked, the pressure is maintained and the bleeding point carefully sought after without prescribed method. It will occur probably only when the movements of the abdominal contents or the influence of reaction have disturbed a clot that one will have to contend with such a complication. Usually, if a vessel of large size be injured, the patient will die from loss of blood before medical assistance can be had. Ordinarily the surgeon will be able to check the hæmorrhage and remove the blood and other foreign matters simultaneously. To fully accomplish the third indication the most careful search must be made, otherwise a clot of blood, a bit of fæcal matter, or even an intestinal wound, may escape the eye. The probable course of the missile must be studied, and, irrespective of the conclusion arrived at, it must not be forgotten that a ball can make ten or fifteen openings in the intestines, or an agent producing a punctured or incised wound may cause half that number; each one of which may become the seat of hæmorrhage and fæcal extravasation. To be certain of the extent of the injury, it therefore becomes necessary to examine the entire length of the intestinal tract, and also the crooks and pockets between the intestines, the omentum, the mesentery, and the peritoneal pouches.

4. The detection and repair of intestinal wounds is a most difficult indication to meet; it will consume much time, and will call for all the patience and the resources possessed by the surgeon. The fourth indication is so closely allied to the third that they should go hand in hand, they should begin together, and cease at the same time. The bleeding points of the third indication will always determine the location of the injuries to be sought for in the fourth, and inasmuch as the blood and fæcal extravasation will be found at the points of injury, the third and fourth indications must be carried into effect simultaneously. The especial agents necessary for the fulfilment of this indication are: (1) Those for protection of the intestines during their examination and repair, and for the removal of irritants from the abdominal cavity; (2) those to be employed in the repair of the intestine. The agents of the first division are antiseptic sponges of two kinds, one the common variety of surgical sponges; there should be at least a dozen of these, and they should always be carefully counted at the beginning of the operation, and as carefully recounted before the abdomen is closed, otherwise one may remain in the abdominal cavity. A half-dozen good sponge-holders should also be at hand. The second kind of sponges should be broad, flat, and fine-textured. A half-dozen of these should be at hand. There should also be a dozen fine-textured towels of ordinary proportions, or in lieu thereof a number of pieces of carbolized gauze cut of a corresponding size; an abundance of antiseptic solutions at the temperature of the body, and a ready means of replenishing them and maintaining their warmth. Thiersch's fluid (composed of one grain of salicylic acid and six grains of boracic acid to an ounce of water), bichloride-of-mercury solution (1 to 10,000), solution of carbolic acid (1 to 100), can be used in contact with the peritoneal surfaces; for other purposes a solution of mercuric bichloride (1 to 2,000) or of carbolic acid (1 to 40) may be used; non-metallic basins in abundance, to hold antiseptic fluids and the clean and soiled sponges. If possible the operating-room should have been made aseptic, and the temperature raised sufficiently before the operation is commenced to contribute largely to the maintenance of the normal warmth of the exposed parts.

The agents of the second division comprise materials for ligatures and sutures: Carbolized, iron-dyed silk may be employed for both purposes; antiseptic catgut of small size may be used exclusively for ligatures, while both agents can be used for suturing; there are also required curved needles of small size, and without sharp edges, for sewing peritoneal and intestinal surfaces; thumb- and mouse-tooth forceps, to raise the borders of the wound; artery- and needle-forceps, for obvious purposes; large catch-forceps, with horseshoe-shaped blades, to close the openings at the side of the intestine of a similar shape; two or three long-bladed catch-forceps, with the blades protected by rubber-tubing, to compress the intestine transversely above and below a point of partial or complete division of its transverse diameter. Abbe's intestinal pincers are useful, yet the nimble fingers of an assistant, supplemented by the closure of the lumen of the intestine by narrow strips of iodoform gauze tied loosely around it, will be found quite as efficient as any mechanical means that have as yet been devised. Curved and straight scissors; aneurismal needle and grooved director; tenacula; a half-dozen or more goldbeater's-skin bags, to be used inflated in the open ends of the gut in excision of the intestine; scalpels and other common surgical instruments are likewise needed. The blood and fæcal matter should be removed with the small sponges as soon as seen, all bleeding points caught and tied, and all intestinal wounds temporarily closed with clamps to prevent the further escape of irritants. The examination of the intestines, omentum, mesentery, peritoneum, etc., should be conducted systematically from above or below, according to the site of the wound, all surfaces of the intestines and their attachments being inspected. As soon as they are thoroughly examined they should be pushed aside, and kept separated from those remaining unexamined by means of one or more of the large, warm, flat sponges before mentioned. If it be impracticable to examine the abdominal cavity and its contents while the intestines remain *in situ*, the intestines should be removed without hesitation, and be carefully and entirely wrapped in the towels or pieces of antiseptic gauze that have been saturated by the warm Thiersch's fluid or other proper antiseptic solutions, and laid on the anterior surface of the abdomen. They should be kept well warmed, and should be moistened frequently by the antiseptic solution. This course is far safer than to hustle and crowd them from side to side in the abdominal cavity, in the almost vain efforts to entirely remove the blood and fæces or to detect the last intestinal wound. The attention of the surgeon must now be directed to repairing the intestine. This is accomplished by one of two methods: (1) By directly closing the openings; (2) by excision of a portion of the intestine, and the union of the divided extremities. The former may be done when the closure of the wound will not diminish the intestinal calibre more than one-third; the

latter when the gut is gangrenous, or when its proper closure will reduce its calibre unduly. The parts to be repaired must be completely isolated by the warm, moistened antiseptic sponges and towels, not only to keep the intestines warm and moist, but also to prevent the blood and fæcal matters from coming in contact with other serous surfaces. The borders of the intestinal wound should be thoroughly cleaned, and the ragged edges trimmed off; and the cavity of the intestine near to the wound should be entirely relieved of its contents. The wound may then be closed by either the Gély, Lembert, or continuous sutures; a double row of the Lembert or continuous varieties may be made; or a single row of each instead, or the Czerny-Lembert suture. In either instance the sutures should extend to and not through the mucous membrane, and not be more than three lines apart. Catgut or silk may be used, but I now think the loose-textured, carbolized, iron-dyed silk to be the more suitable. If the mesenteric border only of the intestine be injured, the gut should be excised, because gangrene is liable to follow from injury to the vessels of this part. When the intestine is completely severed, either by the original injury or by the knife of the surgeon, the difficulty of adjusting the cut borders is much increased. The portion to be repaired must be carefully isolated by towels and sponges, as in the first instance.

The uppermost extremity of the divided intestine will be known by the greater amount of fæcal matter seen at its open end. The intestinal contents must be pushed aside for some distance from the portion to be operated upon; at this situation the intestine is clamped transversely, or, as is usually preferred, is held between the fingers of an assistant—as the use of clamps has been shown by Parkes to impair the circulation at the points grasped to a degree that, if carelessly or continuously applied, may cause circumscribed sloughing of the part. The transverse compression of the lumen of the intestine prevents the escape of intestinal contents, and while the assistant accomplishes this with one hand, with the other he can aid the operator in his manipulations. The excision is made with sharp, straight-bladed scissors, at a right angle with the long axis of the intestine. The length of the portion removed will depend on the extent of the injury—always sufficient to include it, even though it be six or eight inches in extent. The vascular supply of the intestine at the seat of the injury must be carefully examined, and all that portion of the gut excised that has an impaired supply of blood, else gangrene of the bowel may ensue. In fact, it is a wise precaution in excision always to divide the gut at those points which will afford the best vascular supply to the extremities to be united—that is, close to the entrance of a mesenteric vessel into the unimpaired portions. The mesentery corresponding to the portion of the gut removed can be cut away in the form of an isosceles triangle, the base of which shall correspond to its intestinal attachment; or it may be ligated *en masse* or in sections at its point of attachment, and allowed to remain free in the abdominal cavity. Parkes considers the latter plan as unsafe, since, owing to the feeble vitality of its tissue, gangrene of the distal extremities of the mesenteric stumps frequently resulted; he advises that the entire mass be included in one ligature drawn tight enough to check the bleeding, and that, after the sewing of the divided extremities is completed, the stump be stitched to the seat of the operation, thereby forming again as nearly as possible a continuous mesenteric surface. This method was, in his experiments, certainly followed by less mortification and consequently better results than the one just mentioned. It is suggested that the excision can be satisfactorily made without a division of the mesenteric vessels by the following plan: Make two incisions, one on each side of the mesenteric vessels at a distance of about half an inch from them, through the wall of the intestine in its long axis, corresponding in length to the portion of intestine to be removed; tear away the mucous lining of this mesenteric strip, and unite its peritoneal borders by a continuous suture of fine catgut. After the excision is completed, and the ends of the intestine have been united, the mesenteric strip will present a looped appearance, due to the approximation of the intestinal extremities. The opening of the loop should then be closed by sutures. This method will obviate the division of blood-vessels, render the presence of ligatures unnecessary, and leave no raw surfaces exposed in the abdominal cavity. The same observer found it advisable to resect, if the intestine were injured at its mesentery border, not alone on account of the danger of gangrene, but because a simple closure of a wound in this situation caused an objectionable elbow in the intestine. Almost immediately following the division of the intestine, in excision, the calibre of the gut is diminished by contraction of its circular fibres, and the mucous membrane is markedly everted and becomes the chief obstacle to the apposition of the borders of the divided extremities. As soon as all hæmorrhage is checked, the extremities of the intestine are approximated by an assistant, and a Czerny-Lembert or other form of suture introduced at the mesenteric border of the intestine, care being taken to thoroughly close the triangular space at this point caused by the reflection of the peritoneum from the walls of the intestine. After this the protruding mucous membrane is pushed into the intestine, and a suture is introduced at each of the three remaining aspects of the bowel, and then the intervening spaces are properly sewed. This plan is far better than to commence to sew at any given point and complete the union of the borders by sewing directly around the intestine. In no instance should a suture be passed through the mucous membrane. If a Lembert or Gély be used, at least three or four lines of peritoneum should be included in the grasp of the suture at each extremity of the intestine. A suture should be drawn only sufficiently tight to bring the severed borders in close apposition, for if drawn too tightly the tissue grasped by it will slough; if a single row of sutures alone is to be made, they should be placed about five millimetres apart. If a double row is to be employed, those of the first row can be deposited within six or seven millimetres of each other, while those of the second row (continuous or interrupted) should be placed at the intervals between those of the former. The Lembert suture is the simplest, and of equal efficiency to any other, and is therefore to be recommended, although any suture that properly approximates and retains the divided surfaces can be used. Treves has recommended and figured an instrument, as an aid to sewing the intestinal extremities—since discarded by him—that distends and fixes the open ends of the intestine at the same time. This more elaborate instrument can be quite satisfactorily extemporized by the introduction into the divided extremities of the intestine of a distensible goldbeater's-skin bag, or condom. A macaroni or gelatine tube may be used instead; in fact, any agent may be introduced that will support the extremities of the intestine which are drawn over it, and will thereafter escape from the bowel without harm to the patient. The rubber or goldbeater's-skin condom is the best, however, and can be disposed of after the operation in either of two ways: (1) A string can be tied loosely around its centre after it is suitably distended, and allowed to escape between the extremities of the intestine; with this, when the intestinal extremities are about three-fourths united and after the condom has been collapsed, the tube can be drawn through the ununited portion of the intestine, after which the remaining opening is closed. (2) After the extremities of the intestine are united, a narrow-bladed tenotome can be passed through the intestine into the extremity of the distended tube, causing it to collapse and be subsequently discharged by the bowel. The small opening made by the tenotome in the intestine must be closed by a Lembert suture.

Cleansing the Peritoneal Cavity and closing the Abdominal Wound constitute the fifth indication. All bleeding points must be closed by ligaturing, if possible; if not, by cautery. It must not be forgotten that the tendency of the intra-abdominal vessels to bleed, when not exposed to air, is very great; therefore a simple oozing before the closure of the abdominal walls is likely to become a formidable hæmorrhage thereafter, and even

though the secondary oozing be not sufficient to imperil the life by loss of blood, it will be almost certain to do so by causing peritonitis or septicæmia.

The blood, other fluids, fæcal matters, and all foreign agents must be removed from the abdominal cavity; and its contents and *culs-de-sac* thoroughly wiped by warm, soft, antiseptic sponges soaked in Thiersch's fluid, a two-per-cent. solution of carbolic acid, or a solution of bichloride of mercury (1 to 10,000). Too great care cannot be taken in sponging away the foreign matter. The same portion of sponge should be applied to a serous surface but once, for to apply it repeatedly causes quite as surely the dissemination as the removal of the irritating agents. The abdominal wound is now closed by a deep and superficial row of sutures, or by a single deep row, as in abdominal section for other purposes, and is drained, if necessary, then dressed antiseptically; the patient should be quieted by small doses of an opiate; the diet must be light at first, and of a nature to leave little or no residue; the bladder should be evacuated with a catheter.

Expectant Treatment of Gunshot Wounds.—This method of treatment, like the active, can be divided into constitutional and local, and the constitutional treatment in this form of injury differs in no essential particular from that employed for other kinds of intestinal wounds. Since shock has been considered already, the leading indications now are to arrest hæmorrhage, relieve pain, and subdue inflammation. If the blood escape externally, its flow should not be impeded, and the patient should be placed so as to facilitate its discharge. If it be suspected that the hæmorrhage come from a wounded vessel of the abdominal wall, the opening should be enlarged to secure the bleeding point. If the blood come from within the cavity, the patient should be retained in a recumbent posture, and the flow from the external wound aided by the force of gravity. All movements of the abdominal wall and its contents should be kept under control as much as practicable, by limiting the action of the diaphragm with bandages or adhesive strips carried around the lower portion of the thorax. Talking, coughing, vomiting, and hiccoughing, especially the last three, must be checked, if possible. The intestinal peristalsis, too, should be controlled. The patient should be kept absolutely quiet in body and mind, and the bladder emptied frequently with a catheter. Opium, in moderate but repeated doses, meets the requirements of the aforegoing manifestations in the best possible manner. Cold applied to the abdominal wall, by means of the rubber coil or by similar devices, will be serviceable, provided it be not annoying to the patient. Loose-textured, moistened, antiseptic cloths should be placed over and around the wound, to exclude septic influences as much as possible. This texture will not only absorb the blood as fast as it flows, but may even aid in its escape by the influence of capillary attraction. Little, if any, good can be expected from the administration of cold water, sedatives, astringents, etc.; and, moreover, such administration will expose the patient to the danger of the fluids entering the abdominal cavity through the intestinal wound. If the hæmorrhage be abundant and persistent, the abdominal wound may be closed and the wall compressed by means of a many-tailed bandage, which may exercise a restraining influence upon it; yet, a case demanding a measure of this kind can receive little more than transient benefit from its application. If the intestinal contents escape from the abdominal wound, quiet must be enforced by every possible means, and no influence should be permitted to interfere with their exit. The hope for the patient's life may rest alone on the fact that the feculent matters may not have extended from the region of the line of the injury, and that inflammatory adhesion may quickly occur and not only limit the extension of the extravasation, but also guide it through the external opening. It is therefore evident that little else can be done safely, except to secure perfect quiet to the patient and an unobstructed flow from the external opening. Opium will accomplish the former, while the latter may be aided by increasing the size of the abdominal wound and by placing the patient in such a position that the force of gravity will exert its continuous influence. An attempt to find the wound in the intestine by enlarging the abdominal opening, and drawing a gut through it, is much more likely to increase the area of the extravasation and to break up the limiting adhesion than to improve the original chances of recovery. If an intestine escape from the wound of the abdominal wall, and an opening into its lumen be seen, this opening should be closed at once, the intestine sponged clean, and gently returned into the abdominal cavity, but the abdominal wound should not be closed, because other portions of the gut may be wounded as well. If the wounded portion of a gut present itself at the abdominal opening, it is better to stitch it in position than to draw it out with the view of closing the wound and replacing the viscus, since to do the latter may cause fæcal extravasation without affording the patient a compensating advantage. There is good reason to believe that a less number die under this course of treatment, supplemented by the operations for the cure of artificial anus resulting therefrom, than from the more radical procedure—laparotomy. If other viscera than the intestines escape from the abdominal wound, they should be cleansed and returned at once, provided, of course, that their conditions fully comply with the requirements of like conditions in intestinal wounds.

It will be seen that the operative treatment—laparotomy—has been given the greater space and is considered with the greater detail. It does not follow, however, from this, that the writer believes that the radical method should supersede all other plans of treatment; on the contrary, it is very essential at this time that the cases to be subjected to the radical method be selected with great caution, and with a lively apprehension of the fact that any abuse at this the period of its infancy may consign again that which bids fair to become a life-saving expedient to the regions of traditional fear and distrust, from which it is but slowly emerging guided by the modern established principles of cleanliness and antiseptics. It is the belief of the writer that exploratory laparotomy under favorable surroundings will soon become an accepted procedure. Then the conditions calling for laparotomy in entirety can be established with as much certainty as those that are decisive in the solution of less fatal though not less troublesome surgical problems.

Prognosis.—The prognosis of intestinal wounds is invariably bad. Their complications, the amount of violence, the nature and situation of the wound, the degree of fulness of the intestinal canal, the strength of the patient, the nature of his surroundings, together with the availability of suitable means of treatment, are of the greatest importance in computing the narrow chances of the life of the patient. The prognosis of contused wounds is better than of the other forms, since no immediate extravasation of fæcal matter and but limited hæmorrhage can occur. If a subsequent sloughing of the bruised tissues occur, the circumscribed reparative influences that have already taken place may exclude all foreign matters from the abdominal cavity. Ruptured or lacerated wounds of the intestine have thus far proved more fatal than either of the other forms; five cases occurred during the late war, all of which were fatal. Of those thus far reported from all sources the jejunum was injured in fifty per cent. of the cases, all of which were fatal. Ruptures of the duodenum and ileum are more frequent and more fatal than those of the colon.

Punctured and incised wounds of the intestine are less fatal than are the ruptured and gunshot varieties. These forms are not frequent, and are more often inflicted in private brawls than in war.

The rate of recovery when the opening in the gut is closed by suture, and the gut is returned into the abdominal cavity through the opening in the abdominal wall through which it has protruded, with an enlargement of the same in some cases for the purpose of securing the bleeding points, certainly warrants an early and active interference, since the percentage of recoveries in such cases in civil life in American practice is nearly twenty-nine. Gunshot wounds of the intestine are exceedingly dangerous injuries; during the late war the

percentage of recoveries from these wounds ranged from seven to ten per cent. The prognosis in all forms of injuries is more unfavorable in military than in civil life, since the greater exposure, the handling of the patient, and adverse hospital influences are more potent factors in military than in civil practice. The prognosis is modified by the portion of the bowel injured, as wounds of the duodenum are especially fatal on account of the associated complicating wounds of the stomach, liver, gall-bladder, nervous plexuses, etc. The wound of itself is not so immediately or certainly fatal as a wound of a portion of the intestine more completely invested with peritoneum, because of the less liability of intra-peritoneal extravasation. Wounds of the jejunum are less fatal, if possible, than those of the ileum, since the jejunum is less plethoric than the ileum and its contents are less irritating. It is not worth while, however, to split hairs between the two, since in either instance the escape of intestinal contents into the abdominal cavity has almost invariably proved fatal. On account of the anatomical reasons already given, wounds of the large intestine are much less fatal than those of the small intestine, with perhaps the exception of those of the transverse colon, which, like the small intestine, is entirely surrounded by peritoneum. Wounds of the sigmoid flexure and descending colon are less fatal than those of the caput coli and ascending colon. Of the fifty-nine cases of wounds of the large intestine that occurred during the late war, forty-one made a partial or a complete recovery. The prognosis of all intestinal wounds will be modified by the existence and treatment of the attending complications. If an important viscus be injured, if gangrene of the intestine or mesentery follow an operation, if the omental tissue be filled with blood, requiring the removal of that portion, or if it be not removed and abscess of the omentum occur; or if secondary hæmorrhage set in, and if almost innumerable other complications, which can only be anticipated and prevented by great care, close observation, and experience, happen—then, of course, the result must be correspondingly modified.

The prognosis of gunshot wounds of the intestine when treated by laparotomy in entirety is as yet unsettled, although the results thus far obtained are indeed sufficiently satisfactory to warrant the belief that it must become ultimately a generally recognized method of procedure. Fitzgerald, of Australia, in February, 1882, enlarged the abdominal opening and excised ten inches of intestine for a gunshot wound. Kinloch, of South Carolina, in November, 1882, and also Lloyd, in February, 1882, operated by median incisions for gunshot wounds. These cases did not recover. Dr. W. T. Bull, of New York, operated successfully in November, 1883, and again in August, 1886, for similar wounds. Dr. J. B. Hamilton, of the United States Army, operated successfully in July, 1885. Kocher, of Berlin, has recorded a favorable result following laparotomy for gunshot wound of the stomach. Drs. Ramsey, Park, Annandale, Dennis (2), and Seymour have each performed laparotomy for penetrating wounds, but the patients died. The writer knows of four cases, as yet not reported, for which this operation has been performed unsuccessfully for similar injuries; still, with these added, the rate of recovery is then even double that of the expectant plan. It is also to be seen that, of the thirteen cases here considered, four terminated favorably, giving a percentage of recoveries of thirty, as against five to seven per cent. from the methods employed during the late war. If the case of Kocher be eliminated the percentage of recoveries is twenty-five. It is no doubt true that the percentage of recoveries given here would have been much less had the patients been surrounded by the unfavorable influences incident to war.

SEQUELÆ.—The most common sequel of all forms of wounds of the intestines is a fæcal fistula, the treatment of which, however, is elsewhere considered. Strangulation may occur at any period of after-life from the fibrous bands following the inflammatory action, or rents resulting from the injury in the omentum, mesentery, or other tissues of the abdominal cavity.

Obstinate obstruction to the passage of the intestinal contents may follow an undue narrowing of the lumen of the intestine from the closure of a wound without excision. When the intestinal contents escape behind the peritoneum, as in some wounds of the colon, an abscess may form in the subperitoneal tissue, which not only often becomes a dangerous complication, but likewise a troublesome and persistent sequel. *Joseph D. Bryant.*

INUNCTION. Properly, the rubbing into the surface of the body of oils or fats, with or without the addition of medicinal agents.

Used by the ancients as a luxury and to prepare the body for violent exercise, or to give relief from fatigue, inunction gradually found its way into medical practice, and was employed to warm the body and to fortify it against the influence of external cold and heat, as well as to ward off or modify various diseases, as fevers, pustular eruptions, gout, palsy, lethargy, tetanus, cholera, hydrophobia, melancholy, dropsy, profuse sweating, and psora. In surgery it was supposed to allay irritation after severe operations, etc.

The employment of inunction was at that time carried to such an extent as to become a distinct branch of medicine, called *Iatraliptic* medicine, and the persons who directed unctuous applications to the sick were known as *Iatraliptes*. These inunctions were often used in connection with bathing and massage. The power of oil to destroy vermin was known to Pliny.

In the East at the present day inunction is employed to prevent the occurrence of certain skin diseases, as miliaria or prickly heat, and to modify or cure others. The belief in its efficacy to ward off contagion is strengthened in the East by the fact that the oil-porters of Smyrna and Tunis, whose garments and bodies are constantly saturated with oil, are thought to invariably escape contagion even in the severest epidemics of the plague.

In modern medical practice the inunction of oils and fats has been employed with a view to give relief to the dryness and burning sensations in fevers and generalized inflammatory skin diseases, and to prevent the spread of contagion by means of the distribution of fine, dry, epidermic scales, cast off particularly in the desquamative stages of measles and scarlatina. In these affections, and also in bronchitis and croup, particularly in children, inunction is employed with the intention of guarding against the impression of cold. In addition to the affections mentioned, inunction is practised in variola, typhoid fever, dropsy, and other diseases.

The employment of oils and fats by means of inunction, with the view of imparting nourishment to the system, particularly in the wasting diseases of children, is quite common.

While direct and indubitable proof of the absorption of fixed oils through the skin is wanting, we can readily gain clinical proof of the facility with which fatty matters can be rubbed into the skin by watching the rapidity with which the liquid is absorbed and disappears from the surface of those who use oil-frictions, and particularly in the case of such persons as have followed the practice for a considerable time, and in whom the power of cutaneous absorption is hence increased. Besides, we have a further proof of this cutaneous absorption of oil in the fact that those who use oil-frictions show exactly the same constitutional effects from this mode of introducing it as those who introduce oil into the system by swallowing it (Simpson).

When cod-liver oil cannot be taken internally, its use by inunction is often followed by quite as good effects. Indeed, according to Simpson's experience, olive-oil will often fulfil the same indication, while it is much more agreeable to use. In one case under Simpson's observation, a patient, anointed daily with olive-oil, increased twenty-four pounds in weight in forty-two days; while a child, two years of age, increased in weight one ounce a day for eight weeks, under assiduous oil-inunction. And in the external as in the internal use of oil, the increase of weight obtained is often greater than the mere weight of oil introduced into the system. The oil, then, evi-

dently leads to increased weight, not only by its own simple addition, but apparently by furnishing to the constructive masonry of the body an article the previous want or defect of which prevented the other materials of nutrition from being duly assimilated.

The rules laid down by Simpson for external oil-inunction are essentially as follows: The oil should be bland and inodorous, as olive-oil (though in certain cases cod-liver oil is preferable, in spite of its disagreeable odor). It should be applied warm, as this is more agreeable, less likely to give occasion to chilling, and the act of absorption is increased by an elevated temperature. The friction should be thorough and long continued, so that the oil may be more completely taken up. While the oil should be rubbed in over the whole surface, those parts where the skin is thin, and the function of absorption greatest, as the sides, the flexures of the limbs, the insides of the thighs, etc., should be made the especial seat of inunction. The average quantity of oil required to be used at each inunction is about a large wineglassful, though this must necessarily vary with the size of the individual. In cases in which it is an important object to introduce the oil into the system as freely and rapidly as possible, the inunction of it may be practised twice or oftener in twenty-four hours, especially with children; but the best time for a single daily oil-inunction is immediately before retiring to bed, as the imbibition of any free oil left on the surface may afterward go on during the night; and to save the bedclothes the patient should sleep in a dress of flannel, linen, or other material, that stretches beyond the feet. In order to maintain the full absorbing action of the skin in conjunction with the practice of oil-inunction, occasional warm sponging or bathing of the whole cutaneous surface with tepid water, or with a weak solution of soda in water, should be employed, either immediately before or several hours after an inunction. It should be remembered that the absorption of oil is more difficult at first than after inunction has been practised some time, and that, therefore, more friction is at first necessary.

The inunction of oils and fats containing medicinal substances, with a view to impressing the system in this way, was at one time carried to quite a considerable length. Not only such substances as mercury and quinine were employed, but cathartics, diuretics, antispasmodics, and opiates were thus administered. At the present time, however, the only medicinal inunctions are those practised with mercury for the cure of syphilis.

These inunctions, which are employed extensively all over the world, and in some parts of Germany to the exclusion of all other forms of antisyphilitic treatment, are found particularly successful when it is desirable to bring the system under the influence of the drug with great rapidity, or when, for any reason, it is not thought advisable to give remedies by the mouth.

The vehicles commonly employed for the conveyance of mercury into the system through the skin are oleic acid and ordinary fat. The oleate of mercury, which is liquid up to the strength of ten per cent., may be used pure. Dr. R. W. Taylor, who has had a large experience in the employment of mercurial inunction, prefers, however, the twenty-per-cent. preparation, combined with an equal weight of simple cerate: ℞. Hydrarg. oleati, cerati simplicis, āā, 30.00 (℥ j.).

This forms a consistent mass of a light fawn-color, which is free from the objection of soiling and staining sometimes brought against the mercurial ointment. The writer, however, believes the latter to be the more active preparation of the two, and therefore preferable.

In making the inunctions it is better, Dr. Taylor thinks, to avoid the more delicate portions of the skin, and also those portions which are exposed to motion or are usually covered with hair. For the sake of cleanliness, the application may be suspended and a bath of hot water with soap be taken once a week. For the sake of convenience, the following directions may be written out or printed for the use of patients:

Before commencing the treatment take a hot bath and cleanse the skin thoroughly with soap.

The evening, before retiring, is the most favorable time for the application, when a piece of the ointment, about the size of the terminal joint of the forefinger, is to be rubbed with the palm of the hand into some portion of the surface of the body or extremities for about fifteen minutes.

At each application a fresh surface should be selected, so as to avoid irritation from excessive friction of any one portion.

Any of the ointment which remains after the rubbing should be left upon the skin and not washed off; and the patient should wear the same flannel or merino underclothes constantly, night and day. The following order may be followed in the applications:

First evening, to the buttocks; second evening, to the thighs, but not near the groins or scrotum; third evening, to the sides of the chest, but not in the armpits; fourth evening, to the internal surfaces of the arm and forearm; fifth evening, to the back or belly—the former application is best made by an assistant, whose hand is protected by a glove; sixth evening, omit the application; seventh day, take a bath in the morning, change underclothes, and in the evening resume the applications as above.

Keep the mouth and teeth clean by the use of a brush and an astringent lotion, and the bowels open. If any symptoms of salivation occur, such as increased flow of saliva, tenderness or swelling of the gums, fetor of the breath, etc., the inunctions should be suspended and the body cleansed with soap and water.

When only a mild effect from mercury is desired, the extent of the application may be limited. Thus the ointment may be rubbed into the soles of the feet, or some of it may be spread upon pieces of chamois-leather which are to be stitched to the drawers at points corresponding to the hams and the calves of the legs.

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Arthur Van Harlingen.

IODIDES. I. GENERAL MEDICINAL PROPERTIES OF IODIDES.—Iodides whose basic radicle is sufficiently innocent to permit of the taking of the salt in decided quantity show special and marked physiological and therapeutic powers, unquestionably due to the iodine of their composition. Physiologically, the properties they share in common are, first, to excite symptoms analogous to those of catarrh, affecting sometimes the mucous membranes of the head alone, and sometimes also the gastro-intestinal mucous tract; secondly, to bring out an acne-form eruption on the face; and thirdly, when given in large doses long continued, to favor emaciation. These derangements, constituting the condition known as *iodism*, present themselves clinically as follows: The subject experiences the general feeling of discomfort preceding feverishness, and soon follow running at the nose and watering of the eyes, with frontal headache and sneezing. In sensitive persons the conjunctiva may be blood-shot, and the circumjacent tissues swollen and œdematous. A salty taste is perceived, and the salivary flow is somewhat freer than usual. From extension of the influence to the lower mucous membranes, there may next be cough, with hoarseness, from irritation of the throat, and epigastric sinking, with even nausea, and a watery diarrhœa, with colic, from affection of the gastro-intestinal tract. An eruption, like acne, is apt to break out, first upon the face, the papules being generally large and indurated, and later to appear upon parts of the trunk or extremities. Sometimes purpuric blotches have also appeared, or blebs, and sometimes the main eruption is

eczematous instead of acneform. Nervous symptoms are not so very uncommon, of the general type of listlessness and depression, and, even in one case of long-continued heavy dosage, H. C. Wood observed the subject to be "intensely sleepy and stupid," as in the allied condition of bromism. As regards the tendency to emaciation, this certainly is insignificant, even in the very large dosage with iodides of current medical practice; and the alleged special tendency of the mammæ or the testicles to atrophy under the influence of the iodides, if it exist at all, shows itself with such infinite rarity that it may be dismissed from consideration as a practical possible danger in the use of the medicines. An important point in connection with the phenomena of iodism is the very different susceptibility of different individuals, on the one hand, and of the same individual at different times, on the other. Thus, with some, coryza is developed by doses of only a few centigrammes each (between one and two grains), and, with some, the disagreeable symptoms spontaneously subside, even during a continuance of the medication. In persons who are keenly susceptible the necessary therapeutic dosage may yet be attained by beginning with very small doses, such as 0.03 Gm. (half a grain) of an alkaline iodide, and gradually increasing. Under any circumstances, the taking of copious draughts of fluid during the course of the medication tends to lessen the chance of iodism occurring, or the severity of its manifestations, doubtless by hastening the elimination of the iodide salt. And even when occurring, the phenomena of iodism are, with rare exceptions, distressing rather than dangerous, and promptly and fully disappear upon discontinuance of the dosing.

The therapeutic power of the iodides resides in an influence tending to determine retrograde metamorphosis in the products of many morbid processes, inflammatory or hyperplastic. This influence, however, proves to be of very different degrees of potency in the different circumstances where morbid products develop. It is, in general, most powerful where the parts involved belong to the nervous or the connective-tissue structures, and, in particular, where the process is determined by the syphilitic, the rheumatic, or the scrofulous cachexia. Over purely idiopathic hyperplasiæ or inflammatory products the resolvent power of the iodides, though often decided, and sufficiently so to be clinically exceedingly valuable, yet is distinctly less pronounced. In affections of epithelial structures the influence of the iodides is perhaps most marked in bronchocele, and much more so in the idiopathic variety than in that belonging to Basedow's disease; next in scrofulous enlargement of the lymphatic glands; and least in enlargement of the spleen and organic disease of the kidney. To develop the full potency of the iodides it is necessary, more often than not, to give large doses, especially in organic disease of the nerve-centres, whether syphilitic or idiopathic. In such cases a most marked alleviation of symptoms, or, in possible instances, even a cure, may often be wrought by bold exhibition of an iodide, where previously inadequate dosage by timid hands had failed to produce any obvious effect whatsoever. In brain disease such quantities as from 8.00 to 24.00 Gm. (two to six drachms) of an alkaline iodide are not unusual daily allowances. Besides the foregoing, iodides have a few special medicinal applications, as follows: In chronic poisoning by mercury or lead, the alkaline iodides, taken internally, tend to determine a reabsorption into the blood, in soluble condition, of such of the mineral as had been fixed in the tissues. Thus elimination of the poison is favored; but thus also the phenomena of acute poisoning may be re-established, if too much of the metallic compound is made to enter the blood at once. Hence, in this particular therapeusis of the iodides, the doses must at the beginning be small, and any increase is to be made gradually and with careful watching of the effects produced. Another peculiar application of the iodides has been to determine shrinkage of internal aneurisms, an application advocated especially by Balfour, of Edinburgh. The effect claimed is regarded by this observer to be due primarily to a lessening of the force of the heart-beats and of blood-pressure, and secondarily to a diminution in size of the aneurismal sac and a thickening of its walls. Full dosage, systematically persevered in, is necessary for the result.

II. The medicinally used Iodides.—The iodides officinal, or entering into the composition of pharmaceutical preparations officinal in the United States Pharmacopœia, are, of the heavy metals, the iodides severally of *iron*, *mercury*, *silver*, *zinc*, and *lead*; of the alkali metals, the iodides of *potassium*, of *sodium*, and of *ammonium*; and of non-metallic elements, the iodides of *arsenic* and of *sulphur*. Of these various iodides, the salts of the alkali metals can alone be given in sufficient dosage to develop the full therapeutic iodide influence. In the other iodides the medicinal effects of the basic radicle practically outshine what can be gotten from the iodine, and such of the list given above as are compounds of heavy metals or of non-metals will therefore be found discussed under the several titles of the basic elements. The group of iodides medicinally important simply as iodides comprises, of the officinal list, only the potassic, sodic, and ammonic salts, to whose action alone the foregoing remarks concerning effects and uses apply in full.

Potassic Iodide, KI. The salt is officinal as *Potassii Iodidum*, Iodide of Potassium. It occurs in "colorless, translucent, cubical crystals, slightly deliquescent, having a peculiar faint odor, a pungent, saline, afterward somewhat bitter taste, and a neutral reaction. Soluble in 0.8 part of water, and in 18 parts of alcohol at 15° C. (59° F.); in 0.5 part of boiling water, and in 6 parts of boiling alcohol. The commercial salt generally appears in white, opaque crystals, having a faintly alkaline reaction; but single crystals laid upon moistened red litmus paper should not at once produce a violet-blue stain (absence of more than about 0.1 per cent. of alkali). At a dull-red heat the salt melts without losing weight. At a full-red heat it is slowly volatilized without decomposition" (U. S. Ph.). The salt should be kept in well-stoppered bottles. Potassic iodide is chemically incompatible with metallic mercury and the pharmaceutical preparations containing mercury in that state, and with the oxides, sulphates, and chlorides of the same metal, including mercurammonium chloride ("white precipitate"). In the case of mercuric chloride (corrosive sublimate), however, the chemical incompatibility does not impair the medicinal efficiency or pharmaceutical elegance of a mixture of the two salts in solution; for if, as must be the case in a medicinal prescription, the potassic iodide be in excess, the mercuric iodide forming upon addition of mercuric chloride immediately redissolves through the secondary forming of a double salt. And such solution produces to full degree the medicinal effects of the mercurial. Corrosive sublimate may, therefore, be very conveniently prescribed in a solution of potassic iodide. Potassic iodide is incompatible with alkaloids, and practically so also with potassic chlorate; for though no reaction occurs at ordinary temperatures when potassic iodide and potassic chlorate alone are mixed, yet upon the addition of a mineral acid iodine is liberated and apparently iodic acid is formed in the solution. And, according to Melsens, the giving to dogs of potassic iodide and chlorate in conjunction leads to speedy, and even possible fatal, poisoning, presumably because of the occurrence of some such reaction as just described.

Potassic iodide is the best known and most used of the alkaline iodides, and is probably rightly considered the most effective one of the group. Being a salt of potassium, and one given medicinally in large doses, it produces, in addition to the typical effect of the iodides, those peculiar to potassic salts as such. Full doses may thus be generally depressing, and, in particular, weakening to circulatory activity, may be diuretic, and, if swallowed in strong solution, be decidedly irritant to the stomach. As regards the diuretic effect, upon which much stress is often laid, this occurs to about the same degree as with other potassic salts, such as the citrate or acetate (see Potassium), a degree which, though not absolutely very pronounced, yet may lead to valuable clinical results; for the establishment of diuresis will often favor the re-

solvent effect sought to be obtained by an iodide, so that, where a dropsy is an element of a case for which an iodide is to be prescribed, the potassic salt is peculiarly the one to be selected. As to the gastric irritation apt to follow large doses of potassic iodide, this is a well-recognized feature of the action of the salt if the same be given in strong solution; but by the simple device of making the solution quite dilute, this and also all other symptoms of iodism are rendered much less likely to occur. According to Seguin,[1] the tendency to stomach derangement is yet further and very greatly lessened by slightly alkalizing the water in which the iodide is dissolved for administration, and yet further, again, by having the solution also effervescent. This author, therefore, recommends giving potassic iodide in from half a tumblerful to a tumblerful of Vichy water, or, where this is not obtainable, in the same quantity of plain water alkalized by a pinch of sodic bicarbonate.

Potassic iodide is available for all the purposes of the iodides as set forth in the first section of this article. As to dosage, it is rare that any useful effect follows a smaller daily allowance than 1.00 Gm. (fifteen grains); generally, indeed, from two to three times such quantity will be necessary; and very often—notably in organic affections of the central nervous system—the daily quantum must rapidly be pushed to a range between 8.00 and 24.00 Gm. (two to six drachms), else a valuable, possibly even curative, effect will be wholly missed. In all cases the daily allowance should be broken up into at least three doses; and, especially where the quantities are large, the precautions of giving the salt in an abundance of fluid, and also of giving frequent draughts of water during the whole period of the medication, should be carefully observed. For a vehicle, the one described above is decidedly preferable to the syrupy mixtures so often prescribed, and what other medicines may be also indicated in a given case are best administered by themselves at different times from the iodide.

Sodic Iodide, NaI. The salt is officinal as *Sodii Iodidum*, Iodide of Sodium. It occurs as "minute, colorless or white, monoclinic crystals, or a crystalline powder, deliquescent on exposure to air, odorless, having a saline and slightly bitter taste, and a neutral or faintly alkaline reaction. Soluble in 0.6 part of water, and in 1.8 part of alcohol at 15° C. (59° F.); in 0.3 part of boiling water, and in 1.4 part of boiling alcohol. At a dull-red heat the salt melts without losing weight. At a full-red heat it is slowly volatilized with partial decomposition. A fragment of the salt imparts to a non-luminous flame an intense yellow color, not appearing more than transiently red when observed through a red glass" (U. S. Ph). The salt should be preserved in well-stoppered bottles.

Sodic iodide bears to the potassic the usual relation of a sodic to a potassic chemical brother. It is less depressing, less irritating, and less diuretic, but also, though efficient enough in ordinary cases, probably not so reliable in those cases that test medicinal potency most severely. The salt is to be given in the same doses as potassic iodide, and with the observance of the same precautions.

Ammonic Iodide, NH_4I. The salt is officinal as *Ammonii Iodidum*, Iodide of Ammonium. It occurs as "white, granular salt, or minute crystalline cubes, very deliquescent, and soon becoming yellow or yellowish-brown on exposure to air; odorless when white, but emitting a slight odor of iodine when colored, having a sharp, saline taste, and a neutral reaction. Soluble in 1 part of water and in 9 parts of alcohol at 15° C. (59° F.); in 0.5 part of boiling water, and in 3.7 parts of boiling alcohol. When heated on platinum-foil, the salt evolves vapor of iodine and volatilizes without melting" (U. S. Ph.). From the proneness of this salt to deliquesce and to generate free iodine, the Pharmacopœia enjoins that it be kept in small, well-stoppered bottles, protected from light, and that samples deeply colored be not dispensed until deprived of all but traces of free iodine by washing with stronger ether and rapidly drying.

Ammonic iodide exhibits the usual properties of the iodides, and may be used for the usual purposes. As usual, contrasting ammonic with potassic salts, the ammonic is less depressing than the potassic, but is inconvenient because of its readiness to decompose with the objectionable evolution of free iodine. Ammonic iodide is generally prescribed in smaller dosage than the potassic salt, the daily average being from 1.00 to 2.00 Gm. (fifteen to thirty grains). It should be given in plenty of fluid, and the solutions should not be kept too long, and while kept should be well protected from light.

Edward Curtis.

[1] E. C. Seguin: Archives of Medicine.

IODINE. Iodine is officinal in the United States Pharmacopœia as *Iodum*, Iodine. It is described as "heavy, bluish-black, dry and friable, rhombic plates of a metallic lustre, a distinctive odor, a sharp and acrid taste, and a neutral reaction. Iodine imparts a deep-brown, slowly evanescing stain to the skin, and slowly destroys vegetable colors. It is sparingly soluble in water; soluble in about 11 parts of alcohol at 15° C. (59° F.); very soluble in ether, disulphide of carbon, and chloroform. It is slowly volatilized at ordinary temperatures. When heated to 114° C. (237.2° F.) it melts, and then rises in purple vapor, being gradually dissipated without leaving a residue. With gelatinized starch, in a cold solution, it produces a dark-blue color" (U. S. Ph.). Iodine must be kept in glass-stoppered bottles, in a cool place. The commercial sources of iodine, at the present time, are mainly the native beds of sodic nitrate in South America, where sodic iodate occurs in association with the nitrate salt. Some iodine, however, is still prepared from kelp—the ashes of burnt sea-weeds.

Iodine, like its close chemical congeners, chlorine and bromine, has an affinity for hydrogen, but its action, by virtue of this affinity, in decomposing compounds containing hydrogen is not so pronounced as in the case of chlorine or of bromine. But, on the other hand, the medically more manageable character of iodine and the freedom of the element, even in concentrated solutions, from the overpowering pungency and offensiveness of chlorine and bromine, in like state, make the property in question, in the case of iodine, often more serviceable than with chlorine or bromine. Probably, mainly because of this affinity for hydrogen, vapor of iodine is deodorant, and iodine solutions applied directly to foul and infectious matter prove both deodorant and disinfectant. Sternberg,[1] experimenting with the micrococcus of gonorrhœal pus, found iodine to be antiseptic (*i.e.*, inhibiting development) in solutions of the strength of one part to four thousand (one-fortieth per cent.), and permanently germicidal in solutions representing one part to five hundred (one-fifth per cent.)—percentages which, as compared with those of other so-called antiseptics similarly studied, show for iodine a high germicidal potency. As regards the effects of the element upon the living animal system, iodine is locally irritant and even caustic; and taken into the stomach, undergoes ready absorption and develops, constitutionally, generally similar effects, physiological and therapeutic, to what follow the ingestion of the alkaline iodides (see Iodides). Many consider, indeed, that the greater part of a dose of iodine finds entrance into the blood in the condition of sodic iodide. Others hold that probably some, at least, of the iodine enters into combination with albumin, and is absorbed in the state of the compound so formed. The local effects of iodine, which are medically of more importance than the constitutional, are in detail as follows: Applied to the skin, iodine solutions stain the cuticle a yellowish-brown and excite some tingling and pricking, or, if strong, even pronounced smarting. The stain tends to spontaneously disappear, and, if the solution have not been over-strong, an increased rapidity of epithelial desquamation is the only physiological after-effect. If, however, the solution be strong, or if the application be frequently renewed upon the same spot, a blister may rise, with distinct circumjacent inflammation of the dermis, or even the skin may be destroyed. In all cases, however, the healing action following the direct effects of the iodine is rapid and kindly. Upon serous membranes iodine easily induces an active inflammation, which, if the application have been within

pounds in strength, is almost certainly of the adhesive character, leading to permanent agglutination of opposing surfaces. Upon mucous membranes, also, the irritation of iodine solutions is considerable, and, by swallowing, dangerous, and even fatal, irritant poisoning is possible. But from the pronounced color and taste of such solutions accidental or criminal poisoning is unlikely, and the element is not popularly enough known to be a poison to make it often the choice of a proposed suicide. In case of poisoning, substances containing starch should be freely given as the best chemical antidote, and the symptoms treated upon general medical principles. Connected with the local effects of iodine is the matter of possible absorption into the blood of the element from surface applications of its solutions. That it can be absorbed by serous surfaces is beyond doubt, since a case has been reported in which fatal poisoning, with constitutional symptoms, followed an injection of an iodine solution into an ovarian cyst (E. Rose, quoted by H. C. Wood). When applied, as is so commonly done, to the unbroken skin, it is possible that, if the solution contain also an alkaline iodide (by whose presence iodine becomes soluble in aqueous fluids), a little iodine may be absorbed; but if a simple alcoholic solution of iodine be employed, theoretical considerations are certainly against the probability of absorption, and, so far as the writer knows, absorption under these circumstances has never been demonstrated by the chemical detection of iodine in the secretions. It is most probable, therefore, that the therapeutic consequences of painting the skin with tincture of iodine occur mainly as a reflex phenomenon determined by the local irritation.

Concerning the constitutional effects of iodine, the physiological derangements are, as said, substantially similar to those that follow dosage with the alkaline iodides. The main point of difference is, as might be inferred, that where iodine is taken as such, gastro-intestinal disorder is more apt to occur, or to develop to a greater degree, than where an equivalent grade of general iodism is obtained by the use of iodides. The alleged occasional atrophy of the breasts or of the testicles following prolonged iodizing, in the case of Swiss *crétins*, is also more commonly averred of administration of iodine than of iodides. As used in America, however, the writer does not know of any authenticated case of such atrophy fairly attributable to iodine. The therapeutic effects of constitutional iodizing are also similar in kind to those obtained by the giving of iodides (see Iodides), but, perhaps more from habit than from any demonstrated advantage, iodine is often preferred to iodides for the treatment of scrofulous affections and of goitre.

The therapeutic possibilities of iodine are as follows: The substance is undoubtedly powerfully disinfectant, and at the same time deodorant, and iodine liberally mixed with noxious material, or thrown down privies or drains, would certainly be one of the most efficient of disinfectants; but, unfortunately for any such general use of the agent, the cost of iodine is too considerable. Applied to the skin, solutions of iodine are of avail to destroy life or arrest development of the organisms in parasitic skin disease, such as ringworm, although they are not so powerful for the purpose as mercurials; to set up healthy action in sluggish sores; and, painted in repeated coatings over the sound skin, to operate by ordinary counter-irritant methods to allay pains or determine resolution of engorgements, reabsorption of hyperplasiæ, or abatement of chronic and sluggish inflammations in underlying parts. For the purposes of the latter general category, however, iodine is certainly of little, if any, greater efficacy than other agents of equal irritant power; and its very common preference, apparently because of an idea of getting by the application also a constitutional iodine influence, cannot be justified. To serous surfaces iodine solutions are applied in order to excite adhesive inflammation for the purpose of obliterating a serous tract, such as, for instance, that of the *tunica vaginalis* in cases of hydrocele, or that of a *spina bifida*, or that of a knee-joint in cases of chronic serous effusion, or even that, or a portion thereof, of the pleura in cases of pleurisy with effusion, or of empyema. But in the case of serous cavities of considerable extent and importance, iodine injections, even when the solutions are fairly dilute, are risky, and many cases are on record of undue irritation, of serious constitutional reaction, and even of death, following such procedures. Internally, iodine is given almost exclusively for its constitutional effects, namely, for the determining of healthier nutritive ways in chronic diseases of nutrition, particularly those of so-called strumous character, and in goitre. Because of the gastric irritation it so easily excites, iodine is not so available for full iodizing as are the alkaline iodides. In the treatment of syphilis, rheumatism, organic affections of the central nervous system, etc.—conditions calling for heavy dosage—the iodides are nowadays quite generally, and quite properly, preferred to iodine. A reputation of iodine, rather recently acquired, of a curative power over malarious diseases, has not been sustained by the latest experiences.

For use, iodine may be dissolved in alcohol, or, by the addition of potassic iodide, in water or glycerine. "Morton's solution," employed by Dr. Morton, of Glasgow, and others, for injection in cases of *spina bifida*, consists of ten grains of iodine and thirty of potassic iodide to an ounce of glycerine. Of this, from twenty-five to thirty minims have been injected into the sac in the affection in question. In this country the officinal preparations are almost exclusively employed, and are as follows:

Tinctura Iodi, Tincture of Iodine. This preparation is a simple eight-per-cent. alcoholic solution of iodine. It should be kept in well-stoppered bottles. Tincture of iodine is a dark-brown, limpid fluid, of a strong odor and taste of iodine. It stains skin and fabrics a rusty brown, and is strong enough of iodine to blister the skin, if repeatedly applied to the same area, to actively inflame serous surfaces, and, swallowed clear, to dangerously irritate the gastro-intestinal tract. It precipitates with water, from the very feeble solubility of iodine in that fluid. Because of this fact the tincture is not eligible for internal giving, and its use is limited to local application. For treatment of skin disease, or for purposes of counter-irritation, the tincture may be used without dilution, lightly painted upon the part with a camel's-hair brush. If the skin be not too sensitive two coats may be laid on, the second painting being effected after the first has dried—which result happens in a few seconds, from the speedy evaporation of the alcohol. Such paintings may be renewed in the course of two or three days, but always only after a judicious observance of the degree of reaction still persisting from the immediately previous application. Too frequent and vigorous laying on of the tincture will easily blister and greatly irritate the skin. For injection into serous cavities tincture of iodine must be diluted, the degree depending upon the area and importance of the tract to be affected, but ranging from twofold to tenfold. The fluid for the dilution is water, to which, to prevent the precipitation of the iodine, potassic iodide must be added in proportion about equal to sixteen per cent. of the quantity of tincture taken for the mixture. In some cases, as of *spina bifida*, and even empyema, some practitioners have injected small quantities (from 2.00 to 4.00 Gm. (thirty to sixty minims)) of undiluted tincture of iodine.

Under the title of *decolorized* or *colorless tincture of iodine*, preparations are made in various ways, in all of which the addition of water of ammonia to tincture of iodine is an essential feature. Such preparations are indeed colorless, but they are no longer tinctures of iodine in the sense of containing iodine uncombined, most of the iodine in these solutions having seized upon the ammonia with the formation of ammonic iodide. The preparation of this character of the German Pharmacopœia is compounded of iodine, sodic "hyposulphite," spirit of ammonia, water, and alcohol. The resulting composition is complex, but the essential ingredient is ammonic iodide.

Liquor Iodi Compositus, Compound Solution of Iodine; Lugol's Solution. This preparation is a joint aqueous solution of iodine and potassic iodide, containing five per

cent. of the element and ten of the salt. It must be kept in well-stoppered bottles. This solution is dark-colored and stains, like the tincture, but, unlike that preparation, does not precipitate on admixture of aqueous fluids. It is intended for internal taking, and is, indeed, the only preparation of free iodine ordinarily so administered. The dose is about 0.30 Gm. (five minims), several times a day, largely diluted with water.

Unguentum Iodi, Iodine Ointment. This ointment consists of four per cent. of iodine and one of potassic iodide, smoothly incorporated with benzoinated lard. The iodine and iodide are first rubbed with a little water, whereby the iodine is more ready to mix with the lard. Iodine ointment should always be made fresh when wanted, since it suffers spontaneous change upon keeping. It is of a deep-brownish color, stains the skin yellow, and exerts thereupon a moderate iodine effect.

Edward Curtis.

[1] Sternberg: American Jour. of the Med. Sciences, April, 1883, p. 323.

IODIZED STARCH. Under the title *Amylum Iodatum*, Iodized Starch, the United States Pharmacopœia makes officinal the peculiar substance that results from treating starch with free iodine in the presence of water. To five per cent. of iodine, triturated with a little distilled water, ninety-five per cent. of starch is slowly added, with continued trituration, until the mixture "assumes a uniform blue color, approaching black." The compound is then dried at a gentle heat, pulverized, and put up in glass-stoppered vials.

The true chemical character of the compound formed by the action of iodine upon starch has long been a matter of dispute. Some have maintained that there is true chemical union between the substances, while others deny it. It suffices for the physician to know that the material very readily yields free iodine, such agencies as sunlight, boiling water, alcohol, etc., easily causing disengagement of the element; while under its own form iodized starch is locally quite bland, and its suggestion in medicine is with the view of its employment as an internally given remedy capable of yielding iodine to the blood without the irritation of the stomach which iodine itself so frequently determines. It has been advised in heaped teaspoonful doses, given in water-gruel several times a day. *Edward Curtis.*

IODOFORM. Iodoform, chemically *triiodomethane*, or *methenyl iodide*, CHI_3, is officinal in the United States Pharmacopœia as *Iodoformum*, Iodoform. It is prepared in a variety of different ways, in which the essential reaction is between alcohol and free iodine with the resulting formation of iodoform. Iodoform occurs in "small, lemon-yellow, lustrous crystals of the hexagonal system, having a saffron-like and almost insuppressible odor, and an unpleasant, slightly sweetish, iodine-like taste. Not perceptibly soluble in water, to which it imparts a slight odor and taste; soluble in 80 parts of alcohol at 15° C. (59° F.), in 12 parts of boiling alcohol, in 5.2 parts of ether, and in chloroform, benzol, benzin, disulphide of carbon, fixed or volatile oils. Its solutions have a neutral reaction. Sp. gr. 2.000. It sublimes slightly at ordinary temperatures, and distils slowly with water; at about 115° C. (239° F.) it melts to a brown liquid, and at a higher temperature yields vapors containing iodine and carbonaceous matter" (U. S. Ph.). Iodoform should be kept in well-stoppered bottles in a cool place. The matter of the odor of iodoform is peculiar in the features that the smell, though not intrinsically strong in the common acceptation of the word, is yet very penetrating and persistent, and that a very little of the drug will evolve the odor in full intensity. To very many nostrils the smell is positively offensive, to others disagreeable merely, to others not at all objectionable. Concerning the solubilities of iodoform, it should be noted that a very common text-book error is the unqualified statement that the substance is "soluble in alcohol," leading to the inference that it is freely so, instead of, as is the fact, but sparingly soluble in cold, and only moderately soluble in boiling, alcohol (see above).

The combination of medicinal virtues presented by iodoform is unique. The drug is, in the first place, as its chemical alliance to chloroform instinctively suggests, anæsthetic, but from its solid condition and its insolubility it differs from chloroform in being locally wholly unirritating. Then, probably through decomposition by the action of the fluids of moist surfaces, and the setting free of some of its very heavy charge of iodine, it comes also to exert both a local and constitutional healing or resolvent potency, similar to what is found to belong to preparations of iodine or to the alkaline iodides. Lastly, iodoform, locally applied to wounds, is found to be very potent to repress tendencies to suppurations and septic infections—to be, in short, for the purposes of surgery, antiseptic. In a word, then, iodoform is a locally bland conjoint anæsthetic, antiseptic, and healing or resolvent agent. Taken internally in small dose (0.30–0.40 Gm. = 5–6 grains), iodoform produces little obvious effect upon the healthy human organism, but in the class of diseases apt to be benefited by the alkaline iodides is thought by some to be of similar avail to those medicines. In large dosage iodoform is capable of toxic effect, even possibly fatal in issue. In animal experimentation profound nervous derangement is easily produced, notably tetanoid convulsions, and after death fatty degeneration of heart, liver, and kidneys is observed. In man, toxic effects have occurred by absorption from wound-surfaces. In mild cases these effects consist only of a feeling of malaise, with loss of appetite, some headache, and wakefulness or restlessness, and a distinct taste of iodoform in the mouth. In a more pronounced type of poisoning a rise of temperature may occur after each renewal of an iodoform dressing, or, with or without such pyrexia, an increase in the pulse-rate, often very considerable; or, of graver consequence, nervous derangement affecting the functions of the great centres, so that the poisoned individual may present the aspect of one ill of meningitis or of delirium tremens. In such case death may occur by coma or syncope. If not too far advanced, these toxic symptoms generally rapidly subside after removal of the iodoform dressing. Poisoning is most apt to occur from absorption by freshly cut surfaces, and is especially common in cases where a considerable quantity of iodoform in bulk is tightly packed and sewed up in a newly made wound-cavity of some size.

The uses of iodoform are internal and external. Internally, the drug is vaunted by some for the category of diseases cited above, but in such therapeusis the remedy has as yet not shown any very striking results. The dose is from 0.06 to 0.20 Gm. (one to three grains), three times a day, preferably in pill, in order that the odor may be concealed. Externally, iodoform is a good anodyne application to painful surface-affections of all kinds; is specifically healing, also, especially in syphilitic lesions, and is an efficient agent for antiseptic purposes in surgery. It may be applied dry (finely pulverized, so as to obviate the mechanical irritation of the edges by the crystals), by dusting from a dredger, and then covering the dressed surface with cheese-cloth, lint, or absorbent cotton; or, for antiseptic purposes an iodoformized gauze may be used. Such gauze may be prepared by rubbing powdered iodoform into the meshes of the material, or the latter may be soaked in an ethereal solution of iodoform which, by drying, leaves a fine powder of the drug evenly diffused through the texture of the fabric. As a healing dressing, the officinal preparation may be used, entitled *Unguentum Iodoformi*, Iodoform Ointment, which consists of iodoform, ten per cent., thoroughly incorporated with benzoinated lard. To mask the diffusive and persistent *smell* of iodoform, the addition of a great many substances has been proposed, of which substances some, such as the tonquin bean and the more powerfully odorous of the volatile oils, simply overwhelm the smell of iodoform with their own odor, and are hence unobjectionable. A bit of tonquin bean may be kept in the iodoform bottle, or one part of oil of bergamot, peppermint, spearmint, or gaultheria, may be added to twenty parts of iodoform (Hager). Tannic acid and balsam of tolu, two substances suggested for the present purpose, act by chemical

attack upon the iodoform, and hence are not to be recommended. *Edward Curtis.*

Iodoform Poisoning, by Elbridge G. Cutler, M.D. Reprinted from the Boston Medical and Surgical Journal of July 29 and August 5, 1886.

IPECAC (*Ipecacuanha,* U. S. Ph., Br. Ph. ; *Radix Ipecacuanhæ,* Ph. G. ; *Ipécacuanha annelé où officinal,* Codex Med. ; *Brechwurzel,* German). The name of this drug, which is adopted into most European languages, is borrowed from the South American Indians, with whom it is used to designate, not only this, but several other emetic roots. *Poaya* is another Brazilian name, also rather loosely applied to other roots besides the one under consideration. "Ipecac" is a natural and convenient abbreviation.

The plant from which this drug is obtained, *Cephaëlis Ipecacuanha* A. Rich. (*Uraroga Ipecacuanha* H. Bn., *Cephaëlis emetica* Pers., *Calicocca Ipecacuanha* Brot., etc.),

FIG. 1869.—Ipecac Plant. (Baillon.)

Order, *Rubiaceæ Psychotriæ,* is a low, gregarious shrub, growing in the deep tropical woods of Brazil, with partly creeping stems and thickened annulated roots.

The roots, several in number, are long, tortuous, simple or slightly branching, white and filiform when young, but at maturity thickened to three or four times the diameter of their woody columns by the accumulation of starch-bearing tissue in the bark. This occurs in crowded, narrow, irregular, and generally incomplete, transverse rings, separated by deep, also incomplete circular, fissures, and is greatest in the middle portion of the root, which tapers toward each end, especially the lower. The woody column does not take part in either the rings or furrows of the bark. The stems of *Cephaëlis* are of soft woody, sometimes almost herbaceous, texture ; rounded, smooth, creeping, and rooting below ; ascending, square, pubescent, and green above, with well-marked nodes and leaf-scars. Leaves few, near the ends of the stems, opposite, short-petioled, oval or ovate, many entire, nearly smooth. Stipules interpetiolar, with fimbriated borders. Flowers in terminal heads, arising from four-leaved calyx-like involucres ; small, white, each with a five-parted calyx, a funnel-shaped, five-lobed corolla, five stamens, and a usually two-celled, two-ovuled, two-styled pistil. (At first glance the inflorescence resembles that of the dwarf cornel of our own woods.) Fruits, a few clustered, red, drupaceous, one-seeded carpels. *Cephaëlis,* like many other *Rubiaceæ—Houstonea, Cinchona,* etc.—shows a tendency to the diœcious condition in what is known as dimorphism—that is, while all the flowers are perfect, those of certain plants have the stamens more strongly developed and longer, and in those of others the pistils in like manner preponderate. Further, the ovules fertilized from stamens of the other form are more prolific than if reached only by pollen from their own stamens. These observations in regard to the plant under notice were made by Professor Balfour, of Edinburgh.

HABITAT.—The district of Matto Grosso, in Southwestern Brazil, is the principal source of Ipecac ; but the plant is said to grow also in the adjoining parts of Bolivia, as also in Colombia and a few other parts of South America. It is rather variable, and several varieties are mentioned, of which two—one with woody stem, firm, wavy-margined, not at all, or only slightly, hairy leaves ; and another (from Rio Janeiro) with herbaceous stem, softer, more hairy, and flat leaves—are described by Professor Balfour (Pharmacographia). The Ipecac plant has been long cultivated as an object of interest in botanical gardens, especially in that at Edinburgh. Mr. McNab made the important discovery that it could be propagated by minute fragments of its roots, or even of its leaf-stalks. By means of this plan a large number of plants has been obtained and sent to India and elsewhere for experiments in regard to its practical cultivation ; so far, however, for some reason or another, its culture has not been commercially successful, and we are still obliged to rely upon its native country for our supply. It is collected by the Indians in Brazil throughout the year, but mostly during the dry season, by simply grasping the stems in one hand and prying out the roots with a pointed stick held in the other. The gravel is then shaken out and the roots dried in the air. When dry, they are sifted and sorted and packed in serons (bales made of hide) for transportation. The dangers and accidents of getting it to the coast must be considerable, as a very large proportion of what reaches us is damaged by water. Ten or twelve pounds per day is said to be a good average collection.

HISTORY.—The following paragraph is condensed from Flückiger and Hanbury. A doubtful reference to Ipecac is made in an old treatise upon Brazil, published by Purchas in 1625. Piso and Marcgraf (1648), described it, and stated that it was in common use in Brazil. It was first carried to Europe in 1672, and its usefulness established by Helvetius about 1686, who kept its identity a profound secret until he received from Louis XIV. a handsome price for publishing it to the world in 1688. This early use of Ipecac was not as an emetic, but in the treatment of dysentery, which is still its principal employment in tropical countries. As an emetic its scope has widened somewhat since tartar emetic, lobelia, and other depressing emetics have passed out of use.

DESCRIPTION.—Ipecac, as we see it, consists of fragments of simple tortuous roots from ten to twenty centimetres long down to one or two, and from two to five millimetres in diameter, of a gray-brown or blackish color externally and yellowish-gray section. It is very brittle, and the thick bark easily breaks in sections away from the wood, which is smooth, cylindrical, and whitish. The bark, which in the thicker pieces comprises their principal portion, is finely wrinkled longitudinally, and divided transversely into narrow rounded rings by fissures or sulci, one or two millimetres or more apart, extending nearly or quite to the wood. Odor slight, disagreeable ; taste bitter, acrid, nauseating. The bark of Ipecac consists entirely of thin-walled, polyhedral cells scarcely longer than broad, and pretty well filled with clustered and faceted starch-grains. Liber wanting. All the medicinal activity of the drug resides in the bark, the wood being worthless and nearly tasteless ; those roots which are con-

siderably thickened, therefore, are to be preferred to the thinner and smoother ones.

COMPOSITION.—The active principle of Ipecac is the alkaloid *emetine*, discovered by Pelletier in 1816, and afterward prepared in a purer condition by the same chemist, in connection with Magendie, in 1820. It is, therefore, one of the earliest discovered alkaloids. It has been prepared by a number of methods; one of the simplest is as follows: The root or extract is treated with "milk of lime," and evaporated to dryness; it is then exhausted by means of ether or chloroform. The emetine is washed from the ether by shaking it with acidulated water, and precipitated from the latter by ammonia. It is a white or brownish amorphous powder of decidedly alkaline reaction and affinities, of no odor, but having a very bitter, sharp taste. It dissolves in about a thousand parts of warm water; in alcohol and ether freely. The yield is about one per cent. of the root, in which it probably exists as a salt of *Ipecacuanic acid*. This is another peculiar constituent of the drug, related to the forms of tannin in other plants of the order (cincho-tannic, caffeo-tannic, etc.). The starch in Ipecac is considerable, but of no medical importance.

ACTION AND USE.—As the physiological activity of Ipecac depends entirely upon its emetine, these substances differ only in degree, and will not be treated separately. Ipecac (and still more emetine), is a moderate local irritant, producing smarting, redness, and, if a long-continued application is made to the skin, finally troublesome pustulation. The powder of either, inhaled, produces sneezing, stinging, and increased secretion from the nostrils and deeper air-passages; in susceptible persons a severe coryza may be simulated. In experiments upon animals, diarrhœa and even dysentery, with bloody discharges and inflamed intestinal mucous membranes, have followed large doses. The general action of Ipecac, as shown by experiments upon animals, when given subcutaneously, or to animals which cannot vomit, in large doses, shows it to be an active poison. Sudden death by cardiac paralysis has been observed after injecting it into the jugular vein of a dog. Paralysis of the vessels, with marked diminution of the arterial pressure, hyperæmia, emphysema, or even consolidation of the lungs, and fall of surface-temperature are also noted; but these results of toxic quantities give very little guidance to its therapeutic usefulness. In man and most animals, moderate doses produce vomiting as their most uniform effect, and it is to cause this that they are, at least in temperate countries, most often given. The emesis of Ipecac has naturally been the subject of considerable observation, but the exact way in which it is produced is not at all clear. It is evidently not caused by immediate local action upon the mucous membrane of the stomach, since it takes a considerable time (ten to thirty minutes), long enough for absorption to come about, and, further, when injected into the subcutaneous tissues it also produces vomiting. After section of the pneumogastrics, Dr. Dyce Duckworth found that emetine failed to cause vomiting. It generally fails or is very slow in opium narcosis or in profound coma, after convulsions. It has been maintained that the vomiting is effected by the irritation caused by the emetine while being eliminated through the mucous membrane of the stomach. Probably the total effect is the combined result of more than one mode of action. It is generally agreed that this drug has a direct influence upon the intestinal secretions, upon the liver, and upon the respiratory mucous membrane. There are well-established clinical uses based upon each of these actions.

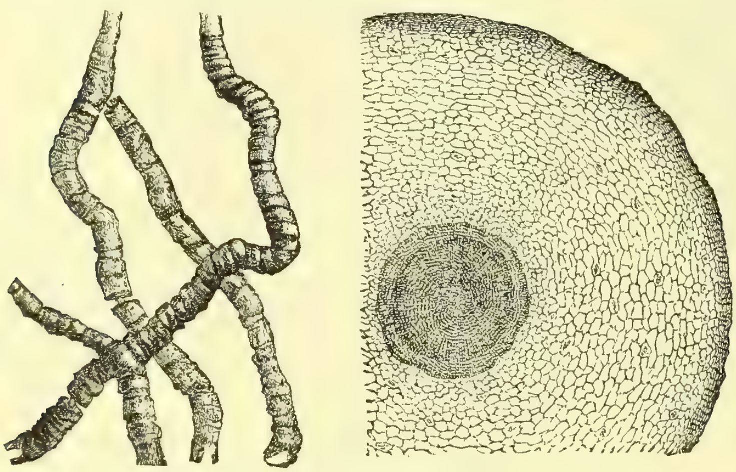

FIG. 1870.—Ipecac and Section the latter magnified. (Baillon.)

As an emetic, Ipecac is in every-day use, although from what has been written above it is not suitable when the most immediate action is needed, as for the ejection of poisons. In convulsions in children, from overloaded stomachs, an immediate dose, if it can be given, of Zinc Sulphate is to be preferred, by reason of its quicker action; if, on the other hand, convulsions have not occurred and do not seem to be imminent, the article under consideration is better, on account of its more prolonged and thorough effects. Zinc or an irritant emetic may be given, and followed by Ipecac after the first emesis with advantage, where thoroughness is essential. When Zinc and Ipecac are given at the same time, as they sometimes are, only the former in all probability has any effect, since the Ipecac would be generally ejected before it had had time for much absorption. As a slight depressant and emetic in spasmodic and simple croup, or even as an emetic in membranous croup, and in diarrhœa and dysentery, it has been used for generations. It is also used, more or less empirically, for other effects upon the digestive tract; small doses are occasionally given to allay nausea, as in pregnancy, with very good effect; in "bilious attacks," in catarrhal jaundice, and some cases of dyspepsia, small and non-emetic doses are sometimes of considerable value. As a specific for diarrhœa and dysentery, both small and large doses have been employed for two or three centuries. This is, indeed, the original purpose for which it was employed by the aborigines of Brazil, and for which it was first introduced into Europe, about three hundred years ago. The usefulness of Ipecac in these complaints appears to have been early and generally recognized, yet after a while it fell into disuse in Northern lands excepting as an emetic. In the South, on the other hand, its employment in dysentery took firmer hold, and continues until this day. It is in general use in its native country in Southern Asia and in the warmer parts of our own country for this purpose, but it is more rarely so prescribed at the North. The cases and reports given by those who employ it are certainly very convincing. Among those in our own country who have used it in this way is Dr. A. A. Woodhull, of the United States Army, who, in a number of interesting papers and reports, gave the results of his own cases and also collected many others in which it was remarkably efficient. Dr. Woodhull gave large doses (x. to xxx. grains), and guarded the patient with great care against vomiting. As a hepatic stimulant the use of Ipecac is pretty well recognized; small and repeated doses are given. As a hæmostatic its efficiency probably depends upon the emesis it produces. In post-partum hæmorrhage it is the vomiting that contracts the womb; in intermittent fever its usefulness, although doubtful, is attested to by authors. Ipecac has long been considered a diaphoretic, and for this purpose is united with opium in the well-known Dover's powder.

ADMINISTRATION.—As the doses of Ipecac are small, and its powder easily made fine and smooth, it is often, perhaps generally, given in substance. It may be given dry,

mixed with a little water or rolled into pills, or packed in capsules. As an emetic a gram (grs. xv.) is a fair dose, and will generally produce efficient vomiting. A common way of administering it is to mix it with a little molasses or syrup, and to follow it with copious draughts of warm water. If vomiting does not occur in twenty minutes the dose may be repeated. As an expectorant, or for its effect upon the liver, or in dyspepsia, small doses of one or two decigrams (gr. j.), repeated a number of times a day, are indicated. Or a liquid preparation may be inhaled from the atomizer, or mixed with any ordinary cough-mixture. In dysentery two methods have been followed: frequent small doses, and less frequent large ones; with the latter method vomiting has generally been a part of the programme, but Dr. Woodhull, in his exceedingly interesting brochures,[1] insists that vomiting should be avoided when we desire the systemic effect of the drug, and gives the following requirements for its successful administration:

1. A pure drug (less difficult to obtain now, perhaps, than at the time when he wrote).
2. Administration upon an empty stomach after at least a four hours' fast. If the stomach contain undigested food, the first dose will undoubtedly produce vomiting.
3. Give simultaneously, or a few minutes before, ten or fifteen minims of laudanum,* or a dose of paregoric, and a few minutes after apply a mild sinapism, or a coating of tincture of iodine, to the epigastrium.
4. Give the medicine in pill form, or with as little water as possible (6 or 8 cubic centimetres = ʒ jss. ad ʒ ij.). Add a few drops of some aromatic.
5. Insist on recumbent position, and abstinence from all food for from four to six hours. If the first dose is rejected, repeat as soon as the stomach is quiet. Twenty-five grains (1.5 Gm.) is a medium dose, and may be repeated in four, six, or eight hours. "The more ill the patient is," says Dr. Woodhull, "the better will he tolerate the ipecac." "It is the exception not to have decided relief after the second dose."

Ipecac is sometimes used abroad as an ingredient in a stimulating ointment. It has been given by the rectum with some advantage, and it is occasionally vaporized and inhaled.

Although the powdered drug itself is frequently used, there are several good preparations: The Fluid Extract (*Extractum Ipecacuanhæ Fluidum*, U. S. Ph.), strength $\frac{1}{1}$, of which fifteen or twenty drops will usually act as an emetic. The Wine (*Vinum Ipecacuanhæ*, U. S. Ph.), strength $\frac{7}{100}$, more generally used in expectorant and nauseating doses. The universally used Dover's Powders (*Pulvis Ipecacuanhæ et Opii*, U. S. Ph., formerly *Pulvis Ipecacuanhæ Compositus*) contain one grain of Ipecac in ten, but are really preparations of Opium rather than of Ipecac. Troches of Ipecac and Morphine (*Trochisci Ipecacuanhæ et Morphinæ*) contain five milligrams of Ipecac each. Tincture of Ipecac and Opium (*Tinctura Ipecacuanhæ et Opii*), strength $\frac{1}{10}$, represents Dover's Powder, minim for grain. The Syrup (*Syrupus Ipecacuanhæ*), strength $\frac{5}{100}$, is used in cough-mixtures and as a nauseant for children.

Allied Plants.—The genus *Cephaëlis* comprises about seventy plants, mostly of tropical America, but the one above described is the only one of medicinal or economic importance. One or two allied genera (*Psychotria*, *Richardsonia*, etc.) yield roots which have been offered as substitutes for genuine Ipecac. For the order, see Cinchona.

Allied Drugs.—Vomiting is one of the effects of a great variety of irritant, nauseating, and poisonous substances, and of overdoses of many more generally inert, but insoluble or indigestible, things; but the uncertainty of their action, or its complication by other effects, makes a comparison of Ipecac with them improper. The substances used in medicine as emetics are indeed sufficiently various in many respects, but have a certainty of effect in this one not shared by many other medicines. They are generally divided into two groups: Irritant or local emetics, which act with great rapidity when introduced into the stomach, by the direct impression which they make upon the surface of that organ, and without absorption into the general circulation. They are Alum, Sulphate of Zinc, Sulphate of Copper, Mustard, Salt, Subsulphate of Mercury, etc. The second group includes those in which the vomiting is only effected after absorption. It is in some cases thought to be connected with their elimination by the stomach. A considerable amount of nausea, muscular relaxation, and depression, usually accompanies their action. Tartar emetic, Lobelia, Apomorphine, Squill, American Ipecac, Senega, some Euphorbias, Buckbean, Hellebore, and a host of emeto-cathartics are associated with Ipecac in the latter group, but all of them, excepting Apomorphine, are nearly out of use as simple emetics. In its character as an expectorant, the antimonials, Lobelia, Apomorphine, are again related, as well as Jaborandi, Chloride of Ammonium, and, more remotely, the various turpentines and resins. As a hepatic stimulant, Calomel, Aloes, Wahoo, Blue Flag, Leptandra, Podophyllum, and various other purgatives are probably more valuable than Ipecac; in dysentery, Opium combined with salines or Castor-oil, occasionally the mineral astringents, ice-water injections for tenesmus, Corrosive Sublimate, etc., and in some cases Coto.

W. P. Bolles.

* Laudanum has been slightly increased in strength since the doctor's directions were given.

[1] Clinical Studies, with Large, Non-emetic Doses of Ipecacuanha, p. 63; reprint from Atlanta Medical and Surgical Journal. Clinical Studies, with the Non-nauseating Use of Ipecacuanha, chiefly in Intermittents, p. 23; reprint from the same journal. Studies, chiefly Clinical, in the Non-emetic Use of Ipecacuanha, with a Contribution to the Therapeusis of Cholera. J. B. Lippincott & Co., 1876. Also article in Western Lancet, pp. 341–343, 1879–80.

IPECAC, AMERICAN. The root of *Gillenia Stipulacea* Mott; Order, *Rosaceæ*. A perennial herb with *spiræa*-like habit, slender stems, three-parted, sessile leaves, and slightly irregular flowers; growing in the Middle and Southern United States. The root is slender, about as large as a quill, longitudinally wrinkled and occasionally fissured transversely, somewhat knotty; bark light brown, brittle; wood white, tough, inert; taste bitter; odor none. Active principle, *gillenin*, a bitter, slightly odorous, permanent powder.

Gillenia is a mild and gentle emetic in a dose slightly larger than that of Ipecac. Dose, one or two grams (grs. xv. ad xxx.).

Allied Plants. — *Gillenia trifoliata* has the same properties as *G. stipulacea*. The *Potentillas* are an allied genus. For the order, see Roses.

Allied Drugs.—See Ipecac. *W. P. B.*

IRIDECTOMY (Gr., ιρις, ιριδος, the iris, and εκτομη, a cutting; εκ, out, and τομη, a cutting, from τεμνω, to cut), the operation of cutting out a portion of the iris for the purpose of forming an artificial pupil.

The instruments needed for the operation are: A spring speculum. A pair of fixation forceps, for steadying the eyeball (Fig. 1871); these must be light and catch accurately, and the teeth must not be too sharp and pointed, otherwise they may tear through the conjunctiva. A broad lance-shaped knife, the shape of which varies with the direction in which the iridectomy is to be made—if made outward (toward the temple), a straight knife may be used; if made inward or upward, the blade must be bent at an angle (Fig. 1872), according to the prominence of the nose or the upper margin of the orbit. If the anterior chamber is narrow, and the iris close upon the cornea, a very narrow Von Graefe knife should be used in place of the lance-shaped one. The narrow knife represented in its actual size by Fig. 1873 has, in the hands of the present writer, almost entirely supplanted the lance-knife in this operation; with it, it is possible to skirt the edge of the anterior chamber and make a large incision without risk of wounding the lens. The iris forceps, which should be lightly bent (Fig. 1874), should catch accurately, but when closed the arms of the forceps should come together only for a distance of 2 to 3 mm.

from their end. The iris scissors; these may be bent at an angle (Fig. 1875), or curved on the flat (Fig. 1876); the blades must close tightly. Lastly, the rubber spatula, to replace the iris with, if necessary.

Before the operation, the eye is to be thoroughly washed with a solution of corrosive sublimate of the strength of 1 to 25,000, or with a solution of biniodide of mercury (1 to 25,000).


Fig. 1871.

All instruments to be used are immersed, first in a 2.5 per cent. solution of carbolic acid, and then in 95 per cent. alcohol. The hands of the operator, as well as those of the assistant, and the parts adjacent to the eye are carefully washed with a solution of corrosive sublimate of the strength of 1 to 1,000.

Operation.—The patient is to be placed on a bed or operating-table, and an anæsthetic administered. In all cases of iridectomy, the patient should be brought completely under the influence of the anæsthetic before the operation is attempted. If the eye to be operated on is the right, the surgeon places himself behind the patient; if the left, he seats himself on the bed in front of the patient, that he may make the incision with his right hand. Complete anæsthesia having been brought about, the spring speculum is introduced and locked in place. With the fixation forceps in his left hand, the surgeon seizes the conjunctiva on the same meridian as that in which the coloboma is to be, but at the opposite side of the cornea and close to it. Care is to be taken that the forceps exert no pressure on the eyeball—they simply hold it or roll it. The lance-knife is now taken in the right hand, and its point entered either at the limbus or one millimetre back from the circumference of the cornea. When the point has entered the anterior chamber, and the operator recognizes this by the sudden absence of resistance, the handle of the knife is lowered and the blade is pushed forward in the direction of the plane of the iris until an incision long enough for the purpose in view has been made. We shall see that the length of this incision varies with the size of the portion of iris that is to be removed.

The position of the point of the knife is carefully watched. The handle of the knife is still more lowered, so that its point comes almost in contact with the posterior surface of the cornea, and avoids contact with the anterior surface of the lens, which comes forward when the aqueous humor flows off. As the knife is now slowly withdrawn, its cutting edge is kept close to one or the other of the angles of the incision, and by this means the inner opening of the section is made of equal extent with the outer. We have said that the knife is to be slowly withdrawn, and this is most important. A quick withdrawal of the knife, and sudden evacuation of the aqueous, may be followed by intra-ocular hæmorrhage or rupture of the suspensory ligament of the lens.


Fig. 1872.

The Narrow Knife.—If in place of the lance-shaped knife the narrow one of Von Graefe is used, the procedure is as follows: Let us suppose an iridectomy is to be made upward, for the relief of glaucoma of the right eye. The anterior chamber is narrow, the iris and the lens system being well pushed forward; there is slight corneal haziness. The patient is to be completely anæsthetized, the speculum is introduced, and, as was described above, the eye is lightly fixed by means of the forceps. The surgeon stands behind the patient, the knife is held vertically in the right hand, and at the corneal margin its point is entered in the anterior chamber; the handle is now lowered and the point of the knife directed to the point of counter-puncture, kept parallel with the plane of the iris, and made to skirt the edge of the anterior chamber. The distance between the point of entrance and of counter-puncture is determined by the size which it is desired to give to the pupil. In completing the section the blade of the knife is given a slight inclination upward, so that the external and internal lips of the wound are directly over each other. The counter-puncture is at the corneal margin, and the wound, when completed, lies opposite the peripheral insertion of the iris. Whether the lance-shaped or narrow knife is used, it may happen now that the iris is spontaneously prolapsed in the wound and may be excised *in situ*. Ordinarily the next step of the operation is as follows: The fixation forceps is given over to an assistant, and the bent iris forceps entered, closed, through the incision; when the point of the forceps is opposite the sphincter of the pupil the forceps are opened as widely as may be, and the iris is seized and drawn out through the corneal incision. The operator, now holding the iris thus secured and drawn out of the corneal wound to the requisite extent with the forceps in the left hand, takes the scissors in the right, and, holding them parallel with the corneal wound, cuts the exposed portion of iris. After the excision it is of great importance to see that the edges of cut iris are not entangled in the wound. There are different degrees of this entanglement—the edge of the cut sphincter may be drawn into the corneo-scleral section, or the ciliary portion of the iris may be thus entangled. In either case, care should be taken to replace the iris. This may be often accomplished by simply stroking the region of the incision with the rubber spatula, or it may be necessary to enter the wound again with the spatula and gently replace the iris. Should neither of these measures succeed, it may be necessary to use the iris forceps again and excise the portion thus entangled with the scissors. After the operation it sometimes happens that hæmorrhage into the anterior chamber takes place. In such an event the edges of the wound are gently separated by a Daviel spoon or by the india-rubber spatula, and the blood slowly runs out; or the eye is closed for a few minutes, and, waiting until the aqueous humor is secreted, the same attempt with the spatula is made again. If the hæmorrhage is considerable and is continuous, sponges wrung out in ice-water may be held for a few minutes against the eye until all sign of active bleeding has ceased. Any coagulum lying in the wound should be removed by means of the iris forceps.


Fig. 1873.

A bandage is now applied to the eye as after cataract extraction (see Cataract), and within six hours the bandage is renewed. On the following day, if there has been no accident, the patient may be allowed to leave his bed, but he should still remain for forty-eight hours in a moderately dark room. A few drops of a two-per-cent. solution of atropine should be instilled in the eye the second day, and this may be repeated twice daily so long as the patient remains under treatment. The length of the after-treatment will depend on the circumstances under which the operation has been performed, and where the iridectomy has been made merely for optical purposes, the confinement of the patient need be very brief. It sometimes happens that after the operation the sclero-corneal wound fails to unite, and that this condition of things lasts for days and even weeks. In cases of simple glaucoma,[1] immediately after the operation there may remain a marked increase of intra-ocular tension, and the anterior chamber is not at once restored. Indeed, the intra-ocular tension may increase, the iris and lens be pressed against the cornea, and the eye become painful and congested. In such a case as this the bandage can no longer be tolerated—indeed, it does harm. Occasional warm compresses may be used, and the pain quieted by injections of morphine, until the inflammatory symptoms have subsided.


Fig. 1874.

In conclusion, it is proper to consider the care that must

be exercised in performing an iridectomy, both for the accomplishment of our object and that no harm may ensue to the eye from the operation. It may happen that an inexperienced operator does not succeed in the excision of a piece of the iris, that he tears the iris from the ciliary body, that he causes a rupture of the hyaloid membrane, or that he wounds the anterior capsule of the lens. More than this, the operation, when performed *secundum artem*, is not absolutely free from danger. Occasionally, if rarely, such an eye is lost by purulent irido-choroiditis. Where, after the operation has been performed, there ensues cystoid cicatrization of the iris in the wound, increased intra-ocular pressure may take place, or the eye may be lost by purulent irido-cyclitis. Mooren[2] found among two hundred and forty iridectomies one corneal suppuration, and Von Graefe[3] saw two suppurations of the cornea after simple iridectomy.

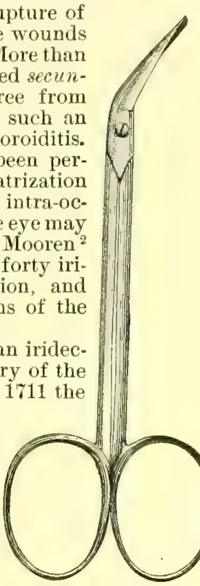

Fig. 1875.

Before speaking of the uses of an iridectomy a brief reference to the history of the operation is in place. As early as 1711 the operation was performed by Woolhouse, and again in 1728 by Cheselden. The method of operation was modified and improved by Beer, in 1796. The new pupil, in these earlier operations, was made to enable the rays of light to again enter the eye; it was done for optical purposes. Scarcely thirty years have passed since the applicability of the iridectomy has been vastly increased. It was left for Albrecht von Graefe, in 1855, to prove that in this operation we had a means in many cases of reducing an increased intra-ocular tension. A new and greatly enlarged field for the operation was found. Its influence in combating inflammation of the inner membranes of the eye was studied, and a more exact knowledge of the prophylactic action of an iridectomy, especially in its relation to subsequent operation for cataract, was acquired.

In considering the conditions of the eye in which the iridectomy is made for optical purpose, the first in order would be corneal opacities. A central circumscribed corneal opacity, the rest of the cornea being transparent, offers the most favorable opportunity for benefit to the vision from a new pupil. The iridectomy in such a case should be made as small as possible, for the new pupil, under the influence of light, will not contract and dilate as the normal pupil does. The most advantageous position for such a pupil is either opposite the inner side, or at the lower and inner side of the cornea.

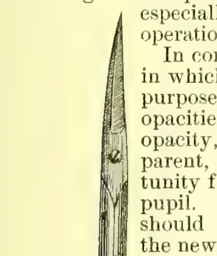

Fig. 1876.

The pupil may be either free or adherent to the cornea at a single point, or its entire margin may be fast to the corneal cicatrix. In cases where the iris is completely adherent to the cornea an iridectomy is impossible.[4] If the anterior chamber is no longer present, the cornea flattened, opaque, and its curvature gone, the iridectomy is useless, if not an actual impossibility.

In cases of keratoconus an iridectomy has been of service. Here the object of the operation is twofold—first, to offer to the rays of light a portion of the cornea relatively of normal curvature, and secondly, to secure a permanent reduction of the intra-ocular pressure.

Again, an iridectomy is often indicated where the region of the pupil is occupied by a membrane, the remains of an exudation. We shall speak later of the value of the iridectomy in such a case as this, where there are adhesions between iris and lens-capsule, and where these adhesions furnish a cause for relapse in iritis.

When a fragment of metal has penetrated the cornea and lodged on or in the iris, an iridectomy must often be made in order to remove the foreign body, and in such a case a small wound is to be made at the limbus, and then with the iris forceps a fold of the iris, including the foreign body, is to be gently seized and excised. It happens in such cases, sometimes, that a piece of steel lies on the surface of the iris, or is lightly imbedded in its tissue, and we are enabled by the use of the magnet to remove the foreign body through a corneal wound without causing prolapse of the iris. An iridectomy is indicated in certain cases of opacity of the lens. Especially does it benefit certain cases of zonular cataract. In it the centre of the lens is clear, while around it is a cataractous layer or zone. Certain of these cases are progressive. It is for the stationary form that the operation is indicated (see Cataract). If the central opacity is not extensive, and if, upon dilating the pupil with a mydriatic, the patient secures a reasonable vision and can read, a new pupil can be made inward. Von Graefe[5] advised in such cases that the incision be made with the lance-knife inward, not at the margin of the cornea, but a line within the limbus; then with the forceps the pupillary margin of the iris is seized and a small piece excised. The new pupil should be as small as possible, on account of the dispersion of light through the lens, and on account of the irregular astigmatism that is usually found in the periphery of the lens.

Iridodesis, or displacement of the pupil, has been recommended in these cases, and the form of the pupil secured by this operation is most desirable; but experience has shown that it is not without its dangers, and the anterior synechia which it entails may be a source of lasting injury to the eye.

Anterior polar cataract, where the peripherical portions of the lens are transparent, furnishes sometimes an indication for iridectomy. In such a case the condition of the lens and the vision must be carefully examined after artificial dilatation of the pupil.

So, too, in cases of secondary cataract, either after an extraction or where a traumatic cataract has undergone spontaneous absorption, an iridectomy may be of benefit. In the majority of such cases, however, either a discission of the membrane or its removal from the region of the pupil is necessary.

We have thus far considered the operation of making a new pupil in the light of its serving an optical purpose. There is an equal, if not larger, application for it in combating inflammations of the eye. One well-recognized effect of an iridectomy is the consequent reduction of intra-ocular tension.

In cases of chronic iritis[6] and irido-choroiditis an iridectomy holds a foremost place in treatment. The most frequent cause of recurrence in iritis is found in the adhesion that takes place between the posterior surface of the iris and the anterior capsule. The broader these adhesions are, the more frequent is the recurrence, and with complete fixation of the pupil, further complications occur in the form of chronic choroiditis, and this may go on to atrophy of the eyeball and loss of sight. The period at which the iridectomy is made in these cases is of great importance. It should not be made when the eye is in a condition of acute inflammation. Cases of irido-choroiditis, in which a certain degree of atrophy of the eye has taken place, have been arrested by the performance of iridectomy. Von Graefe, in the article we have cited, shows how here the stasis and congestion in the choroidal vessels are relieved, and the nutrition of the vitreous humor improved by the operation.

In cases of exclusion of the pupil, that is, where there is complete adhesion between the edge of the pupil and the capsule of the lens, and consequently no communication between the anterior and posterior chamber, an iridectomy is indicated. As the object of the operation in such cases is the re-establishment of connection between the anterior and posterior chambers of the eye, success will depend on the condition of things back of the iris.

If there is firm membranous exudation there the operation will be difficult, and may have to be repeated again and again.

Another class of cases in which iridectomy may be practised to ward off inflammation, is where there are local changes in the iris, as in the case of small cysts, usually following a penetrating wound and situated at the sclero-corneal junction. Again, where a foreign body has penetrated the cornea and lies in the iris tissue, and where its removal may be impossible without iridectomy.

In cases of extensive ulcerations of the cornea, or suppurative keratitis with tendency to hypopyon, the iridectomy often renders service. The operation would not be indicated if the corneal affection were likely to heal and ultimately leave the centre of the cornea clear, nor in cases where the corneal disease was dependent on purulent or diphtheritic conjunctivitis. The operation is rather for cases of idiopathic keratitis where there has been a considerable loss of corneal surface, and here, as Von Graefe pointed out, the reduction of the intra-ocular tension relieves the strain upon the cornea and allows the process of repair to go on.[7]

In cases of beginning staphyloma of the cornea, and cases where there has been corneal ulceration with entanglement and prolapse of the iris, with staphylomatous tendency, an iridectomy is necessary. In these cases the power of resistance of the cornea, even to the normal intra-ocular pressure, is reduced, and the operation should be made even before there is an increase of the tension, with a view to averting it. More than this, the operation is of value in combating the severe pain that is present even if the eye is blind, and in warding off sympathetic affection of the fellow-eye.

Partial staphyloma is often relieved by an iridectomy.

We come now to a consideration of the value of an iridectomy in cases of glaucoma. For the relief of this disease the operation was first performed by Von Graefe, in 1856.[8] The incision is to be made at the sclero-corneal junction, and of sufficient extent to remove a segment of the iris from pupillary to ciliary margin, and at least three millimetres in width. The results attained by the operation will depend on the period of the disease at which it is undertaken. It may be said in general, that the sooner the operation is made after the disease has declared itself, and before serious changes have occurred in the structures of the eye, the better. In the ordinary history of a case of glaucoma there are so-called premonitory symptoms. These are of periodic occurrence, leaving the eye in the interval apparently perfectly well. Among these symptoms are increase in the tension of the eyeball, a rapid increase in the amount of the presbyopia, compelling the patient to make frequent change in the strength of the reading-glass; there is periodic dimness of sight; on looking at a light the patient sees a rainbow or halo around it; there is pain in the forehead and temples; there is contraction of the visual field, and generally this limitation begins at the inner or nasal side. With these symptoms, some or all of which may be present, there may be cloudiness of the aqueous or vitreous humor, and the pupil is sluggish and moderately dilated. On the optic disk we see arterial pulsation. So soon as these periodic symptoms leave no longer a normal pupil, and so soon as a lasting impairment of the vision takes place, we can no longer speak of the premonitory stage; the disease of glaucoma is established, and the iridectomy can no longer with safety be delayed. The prognosis is most favorable where the iridectomy has been performed during the premonitory stage.

In acute inflammatory glaucoma the iridectomy may accomplish good results, if it is made at a sufficiently early period. Even if the sight is reduced to a mere quantitative perception of light, the operation may restore vision, provided that the sight was good before the attack. At this period of the disease the operation is attended often with peculiar difficulty. The increased intra-ocular tension causes the lens and iris to be pressed forward and the anterior chamber to be narrowed. Here the narrow Von Graefe knife can be, with great advantage, substituted for the lance-knife in making the section. Indeed, we have seen cases where the iridectomy could be accomplished with no other instrument.

Von Graefe gave the name glaucoma fulminans to a class of cases where blindness ensues in apparently healthy eyes within a few hours. He explains the process as one in which the sudden increase of intra-ocular tension shuts off the supply of arterial blood to the retina. Here, if the iridectomy brings any relief, it must be made within two or three days of the beginning of the attack.

In chronic inflammatory glaucoma the iridectomy will often arrest the disease and preserve such vision as the patient has at the time of the operation. The prognosis in these cases should be guarded, however, and the result will largely depend upon the extent of the limitation of the visual field, and upon the degree of the excavation of the optic disk. The greater the intra-ocular tension at the time of the operation, the better are the chances from the iridectomy. If, after the operation, there should still be increased tension, Von Graefe has recommended that another iridectomy should be made, diametrically opposite the first, so as to cut off the two halves of the iris from each other. There are cases, however, of chronic inflammatory glaucoma where, notwithstanding all treatment, blindness ensues in consequence of progressive atrophy of the optic nerve, and not through a recurrence of the glaucomatous inflammatory symptoms with increased tension.

In cases of glaucoma where there are no evident inflammatory symptoms, iridectomy often proves of service. This class of cases has received the name of glaucoma simplex, or amaurosis with excavation of the optic nerve. Von Graefe pointed out that in most of these cases an iridectomy reduces the tension of the eyeball to its normal condition and keeps it there. In some cases the tension is reduced and the vision remains as it was directly before the operation for a time, and then fails; while the tension is later on again increased, and only after a second iridectomy is the process brought to a standstill. In a certain number of cases Von Graefe[9] found that the iridectomy actually increased the tension instead of diminishing it, and the sight was suddenly lost as if by an acute attack of glaucoma; in other words, the operation precipitated the fatal issue.

As we owe to Von Graefe the discovery of the fact that iridectomy alone permanently reduced the abnormally increased intra-ocular tension, so do we owe to him a knowledge of the class of cases in which the operation may be employed. According to Von Graefe,[10] there is hardly any inflammatory disease of the eye which may not lead in its course to secondary glaucoma. That we may enumerate the cases in which an iridectomy may be called for, we will briefly allude to the diseases in which secondary glaucoma most frequently supervenes. Of the affections of the cornea, diffuse keratitis comes first in order, then chronic keratitis, associated with the so-called sclerotico-choroiditis anterior, pannus, cicatrices of the cornea, and especially cicatricial ectasia of the cornea. In this last class of cases the iridectomy is to be made, not alone when there are signs of increase of tension, but already at an earlier period, and with a view to protecting the eye against an attack of secondary glaucoma.

Von Graefe has described a peculiar affection of the cornea which is prone to develop secondary glaucoma, and calls for an iridectomy for its relief. This is the so-called "band-shaped" keratitis, which occupies the centre of the cornea, the rest of the cornea being transparent. The opacity extends over that portion of the cornea which would be exposed when the lids are but slightly open. When this affection is recognized, an iridectomy should be made as early as possible. Secondary glaucoma supervenes on plastic iritis, where numerous posterior synechiæ have formed, and in iritis serosa. In both classes of cases an iridectomy is the only measure which offers permanent assistance to the eye.

Traumatic cataract leads sometimes to secondary glaucoma, and an iridectomy may, under certain circumstances, afford relief. With rupture of the anterior capsule, and rapid swelling of the lens-substance, the iris is pushed

forward, and increased tension is the result. Von Graefe has here pointed out that, if the signs of secondary glaucoma are present, either simple iridectomy or extraction of the lens is indicated. The eyes of young children withstand the deleterious effects of an increased tension much better than the eyes of adults.

In cases of dislocation of the lens, if symptoms of glaucoma arise, Von Graefe advises that an iridectomy should be made, especially if the dislocation is moderate, and the iris pushed forward to a limited extent. The incision should be as near the periphery as possible, on account of the danger of the vitreous humor entering the anterior chamber and pushing back the iris in such a way that its excision is difficult. The operation should not be undertaken in these cases until the patient is completely under the influence of an anæsthetic, and the muscles are completely relaxed, for there is great danger of escape of vitreous, and consequent intra-ocular hæmorrhage.

Secondary glaucoma supervenes on serous choroiditis, and if repeated paracentesis fails to permanently reduce the increased tension, and the disease resists other treatment, an iridectomy should be made.

In posterior staphyloma, or sclerectasia posterior, secondary glaucoma may, and often does, supervene.[11] Von Graefe states that the disease here always attacks both eyes sooner or later, and that it assumes the character of glaucoma simplex, or that of the inflammatory form. The secondary affection, if its character is not early recognized and an iridectomy made, leads to grave impairment, or even to total loss, of sight.

Richard H. Derby.

[1] Graefe-Saemisch, iii., pp. 359, 360. [2] Ophth. Beobacht., Berlin, 1867.
[3] Archiv f. Ophth., B. xii., 1, p. 214.
[4] Graefe-Saemisch, B. iii., S. 340.
[5] Archiv f. Oph., i., Band ii., p. 243. [6] Ibid., ii., ii., 202.
[7] Ibid., ii., ii., 243. [8] Ibid., iii., ii., 456. [9] Ibid., xv., iii., 202.
[10] Ibid., xv., iii., 121. [11] Ibid., iv., ii., 153, and ibid., xv., iii., 173.

IRIDOTOMY and **IRITOMY** are the names which have been given to the operation of cutting the iris, thus making a distinction between that in which the iris is simply cut and the *iridectomy* in which a portion of the membrane is removed. The operation has been used chiefly for the production of an artificial pupil for optical effect.

A cut through the pupillary margin of the iris in any direction will allow the fibres to separate and enlarge the pupil toward that side; so this would seem to be at once the most rational and elegant method of producing this result, but experience teaches that, in most cases, it is a much more difficult operation than iridectomy.

It is comparatively easy to seize the iris from the front with a pair of delicate forceps, and to withdraw and remove a portion; but when iridotomy is to be performed, the knife or one blade of the scissors must necessarily pass through or under the iris, and the cut must be made within the globe, and with nothing to give support to that flimsy membrane other than what is furnished by the delicate tissues of the eye itself. The probability of doing this without injury to the front of the lens, or the back of the cornea, is considerably less than that of accomplishing the same result by means of an iridectomy, as previously described.

Thus it happens that this operation is usually reserved for the cases where, as in secondary cataract, the absence of the lens has removed one source of danger, and for cases where thickened capsule and the presence of inflammatory membranes make it impossible to withdraw the iris from the wound without putting too much tension on the ciliary body, or for cases where the iris itself has become so fragile and tender from long inflammation that it will not follow the lead of the forceps, which tear out when even an attempt is made to grasp it.

Iridotomy can be done by using a thin Graefe knife, which must enter the anterior chamber outside of the pupillary edge and at a point on the cornea directly opposite the proposed cut. The point of the knife can be pushed directly across the chamber to the edge of the iris, and insinuated between that and the lens, and after it has penetrated the iris at the desired point the cut can be made upward against the inner wall of the cornea. If care is taken not to put any more pressure on the cornea than is necessary, no injury will result.

Iridotomy can also be performed with a delicate sickle-shaped knife, which should enter the cornea just outside of the peripheral extremity of the proposed cut, pass down through the iris, and under it until it has reached the pupillary margin, when the edge of the knife can be made to cut through that part of the iris under which it has passed by depressing the handle of the instrument and lifting the edge backward against the cornea as it is withdrawn. The success of either of the operations just described depends very much on the sharpness of the point and cutting edge of the knife used. But when the lens is present they partake too much of the nature of jugglery to be indulged in when an iridectomy can easily be made to produce the same result.

Most of the iridotomies which are done nowadays are for that class of cases for which they were recommended by Von Graefe, where, following the iridectomy of the cataract operation, the new pupil is closed by inflammatory processes, and the iris, drawn up toward the wound, stretches itself like a diaphragm, completely separating the anterior and posterior chambers. The consistency of this membrane is often so firm that it cannot easily or safely be withdrawn from the eye for an iridectomy. There being no lens behind it, it is sometimes feasible to cut it through from before backward with either of the knives used above, but the favorite method is that introduced by De Wecker.

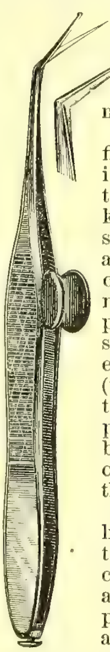

Fig. 1877.

The instruments needed are speculum and fixation forceps, of course; besides these, any instrument with which a cut can be made in the cornea, as for a small iridectomy; a Graefe knife or a lance-knife may be used; a lance stop-knife is recommended by De Wecker, and also a pair of Wecker's scissors with short delicate blades (Fig. 1877), on which latter instrument the success of the operation largely depends. A glance at the cut will show both size and shape of these scissors, which are operated by pressure on the sides of the handles (which somewhat resemble the handles of fixation forceps), with a hinge along one side so placed that the blades rotate and open laterally, but do not spring apart at the ends. One blade of the scissors-like extremities is probe-pointed, the other is sharp.

In operating on an eye from which the lens has been removed and the iris drawn into or toward the wound, as above described, the incision in the cornea is to be made at right angles to the meridian, passing through the point toward which the iris-fibres converge, and about one millimetre from the sclero-corneal margin. The knife making this incision may or may not be made to pierce the iris at the same time. It is sometimes necessary to use great care in the attempt to penetrate the iris, as it may be so thick and tough from inflammatory action as to resist even the point of a Graefe knife, and to make it imperative to cut an opening before trying to penetrate it with the point of the scissors. Then, after the knife has been withdrawn, the scissors, which should be held closed, are inserted into the wound in the cornea and allowed to open gradually as they enter it, so as not to stretch it apart more than is necessary, and they are held in such a manner that, as they open, the probe-pointed blade will pass between the iris and cornea, while the sharp point passes under the iris, either through its substance or through the cut which had been previously made with the knife. They are then quickly closed, so as to make a cut whose length is one-half or two-thirds of the corneal diameter, and are then gently withdrawn. If the wound thus made gapes and shows a black pupil, no further operation is necessary; if not, a second cut may be made with the scissors at an acute angle to the first.

The after-treatment should be the same as for an iridectomy under similar circumstances.

It is possible to do an iridotomy with Wecker's scissors when the lens is present, even in a healthy eye, by introducing the blades closed until the points reach the margin of the pupil on the opposite side from the corneal wound, and then allowing them to open carefully in a plane only a little inclined to that of the iris, so that one blade will pass over and the other under the pupillary edge which is to be cut: or both blades may be passed over the anterior surface of the iris and made to cut the fold of that membrane, which presses up between them as they are opened.

It remains only to say, of all these operations, that where the lens is still in the eye, they are often feasible, sometimes necessary; but it becomes the surgeon to look around for some easier and safer method before deciding on one in which mistake or accident will often occur to all who are not possessed of more than ordinary dexterity. *William S. Dennett.*

IRIS, CILIARY BODY, AND CHOROID. The *iris, ciliary body,* and *choroid* form, together, the uveal tract (*tunica uvea, tunica vasculosa, tunica media*) of the eye. The greater portion of this continuous membrane, choroid and ciliary body, is situated between the sclerotic and the retina. These portions, lying close to the sclerotic, follow also closely the shape of this membrane. The third portion of the uveal tract—the iris—forms an obtuse angle with the ciliary body, and is bent inward toward the axis of the eyeball. The portions of the uveal tract which lie in close contact with the sclerotic in numerous places are attached to this membrane by means of interchanging connective-tissue fibres, and by blood-vessels and nerves. There are, however, two places where the uveal tract is more firmly attached to the sclerotic; the one lies at the optic-nerve entrance, and the other near the corneo-scleral margin, or *sulcus scleræ.* The iris, forming a round screen behind the cornea, has a central opening, the pupil.

The uveal tract has a nutritive and regulatory function, and it therefore consists mainly of blood-vessels, nerves, and muscular fibres, and a quantity of connective tissue which is just about sufficient to hold these parts together.

The choroid is that part of the uveal tract which lies the farthest backward. At the place of its firm attachment around the optic-nerve entrance, this membrane takes part in the formation of the *lamina cribrosa,* and does not show one large opening for the passage of the optic nerve, as it has formerly been described under the name of the *foramen opticum choroideæ,* but a great number of small ones, which give a sieve-like appearance to the membrane. Near the anterior third, between the two firm attachments of the uveal tract to the sclerotic, which were mentioned above, small folds make their appearance, which increase considerably in volume near the anterior attachment. These are the ciliary processes (*processus ciliares*). At the same time the uveal tract becomes here considerably thicker, and this thickening is due to the interposition of the ciliary muscle within the uveal tissue. This portion of the uveal tissue, together with the ciliary muscle and the ciliary processes, forms a ring behind the insertion of the iris, with numerous alternating depressions and elevations running in a radiating direction toward the axis of the eyeball, and to this portion is given the name ciliary body (*corpus ciliare*).

The most anterior portion of the uveal tract, the iris, is again considerably thinner, and lies almost at a right angle to the ciliary body. Near its pupillary edge it contains the ring-muscle (*sphincter pupillæ*) by means of which the size of the pupil is regulated.

The tissue of the uveal tract contains much pigment; this pigmentation, however, varies in intensity very materially. While the eyes of albinos and new-born infants have almost no pigment, or actually none, in the tissue of the uveal tract, the eyes of negroes are very darkly pigmented, and between these extremes all intermediate shades may be observed.

When taken from the eye, the inner surface of the choroid proper appears smooth and shiny, while its outer surface is rough and shows numerous torn fibres, as does the sclerotic on its inner surface. That portion of this loose and torn tissue which adheres to the choroid is called the *lamina suprachoroidea.* On both the inner and the outer surfaces of the choroid the delicate tracings of the blood-vessels may be seen; on the outer surface, especially, may be seen those of the veins by which the blood is carried from the eyeball, and which, on account of their vortex-like arrangement, have received the name of *venæ vorticosæ.* There are from four to six of these outlets, and they lie behind the æquator of the eyeball, just about where the posterior and middle thirds of the eyeball meet.

The average thickness of the choroid varies between 0.04 and 0.08 mm. The anterior portion near the ciliary body is considerably thinner than the posterior part. This thinnest portion of the choroid is called the *orbiculus ciliaris.* Just in front of it begins the ciliary body, in which the ciliary muscle lies embedded. This muscle begins as a thin layer, but gradually increases in size until it reaches a thickness of about one millimetre. The inner surface of the ciliary body shows about seventy ciliary processes, which, as has been said, are arranged in a radiating manner around the crystalline lens. At the anterior point of attachment of the uveal tract these ciliary processes recede rapidly toward the sclerotic.

From this portion, the third part of the uveal tract, the iris springs forth. It forms a round screen with a central perforation, the pupil. At its periphery it is attached to the cornea by means of a fine network of fibres, the *ligamentum pectinatum* (*pectineum*). On the anterior surface of the iris we may distinguish three different portions, viz., the pupillary, the ciliary, and the intermediate portion. The pupillary portion, nearly corresponding to the width of the sphincter muscle (*circulus iridis minor*), shows a large number of irregular indentations (crypts) and elevations, which change their form with the movements of the iris. Similar formations are found at the ciliary margin of the iris. In the intermediate portion usually three circular ridges (concentric with the periphery of the iris) may be detected. The pupillary portion begins at the pupillary margin quite thin, but rapidly grows thicker until the intermediate portion is reached. The remainder of the iris is about uniform in thickness, except its most peripheral portion, which (just at its ciliary insertion) is again somewhat thinner.

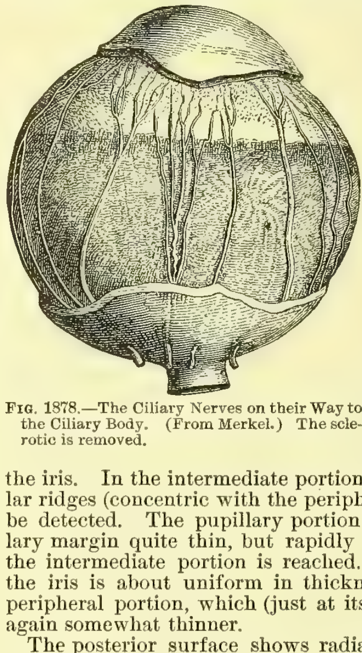

FIG. 1878.—The Ciliary Nerves on their Way to the Ciliary Body. (From Merkel.) The sclerotic is removed.

The posterior surface shows radiating ridges and indentations about equal in number to the ciliary processes, and numerous small circular indentations. It is covered with the dark uveal pigment.

The diameter of the pupil is, according to Henle, between 3 and 6 mm., and the diameter of the iris between 3.5 and 4.5 mm.

The *stratum pigmenti,* a thin layer of darkly pigmented cells, the so-called pigmented epithelium, which lies between the choroid and retina, is now generally considered to be a part of the latter membrane.

The nerves of the uveal tract come from the *ganglion ciliare* (*nervi ciliares breves*) and from the *pars nasociliaris nervi trigemini* (*nervi ciliares longi*). These nerves pierce the sclerotic near and around the optic-nerve entrance, and, lying in the *lamina suprachoroidea,* pass forward to the ciliary body and to the iris, giving off numerous smaller branches to the choroid on their way (see Fig. 1878).

The blood-vessels of the uveal tract are the following (Leber):

A. *Arteries.*—1. The short posterior ciliary arteries (*arteriæ ciliares posteriores breves*) are five or six little branches coming from the ophthalmic artery. These are divided into a number of branches (twenty to twenty-five) on their way to the eyeball, and pierce the sclerotic near the optic-nerve entrance.

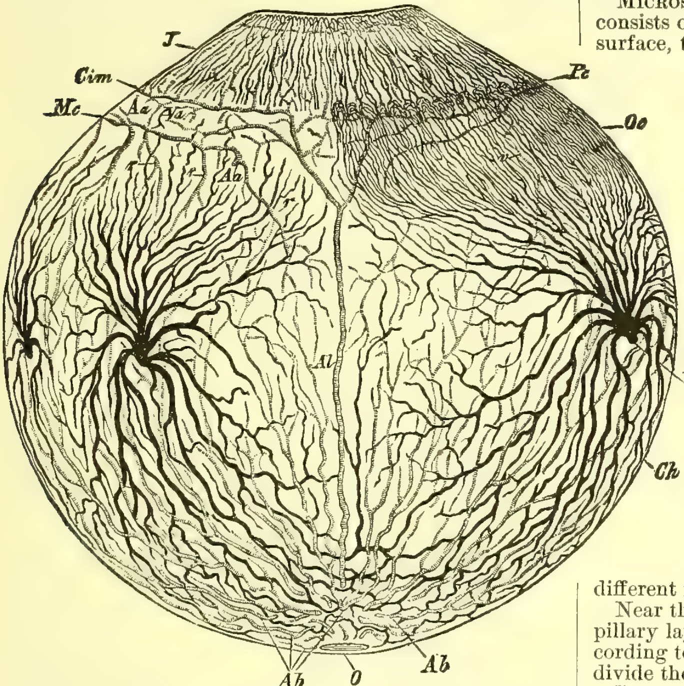

FIG. 1879.—(From Leber.) *J*, iris; *Mc*, musculus ciliaris; *Pc*, processus ciliaris; *Oc*, orbiculus ciliaris; *Ch*, choroidea; *O*, optic nerve entrance; *Ab*, short posterior ciliary arteries; *Al*, long posterior ciliary arteries; *Aa*, anterior ciliary arteries; *Cim*, large arterial iris circle; *Vv*, venæ vorticosæ; *r*, *r*, recurrent arteries.

2. The long posterior ciliary arteries (*arteriæ ciliares posteriores longæ*). They have the same origin as the former ones. There are usually only two of them, one of which enters the eye on the medial, and the other on the lateral side of the sclerotic. They pierce this membrane in a very oblique way, and in consequence their sclerotic canal is from four to five millimetres long.

3. The anterior ciliary arteries (*arteriæ ciliares anteriores*) come from the arterial branches of the four recti muscles of the eyeball, and they pierce the sclerotic at the place of insertion of the tendon of these muscles on this membrane.

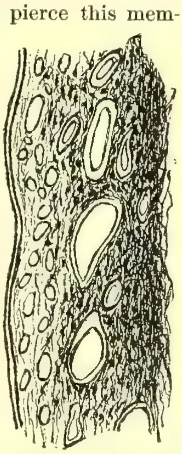

FIG. 1880.—Transverse Section of Choroid.

Veins.—1. The posterior ciliary veins (*venæ vorticosæ*). These, to the number of from four to six, pierce the sclerotic behind the æquator from in front backward, and empty the blood, either directly into the *vena ophthalmica*, or into the muscular branches of this vein.

2. The anterior ciliary veins (*venæ ciliares anteriores*) correspond to the anterior ciliary arteries and go to the veins within the recti muscles.

The choroid proper receives its blood-supply through the short posterior ciliary arteries; the ciliary body and iris receive it through the long posterior and through the anterior ciliary arteries. The anterior portion of the choroid is, furthermore, partly nourished by recurrent arterioles coming from the arteries of the ciliary body. The bulk of the venous blood of the choroid is carried off by way of the *venæ vorticosæ;* the venous blood of the ciliary muscles is partly carried off by means of the anterior ciliary veins, partly by the *venæ vorticosæ* (Fig. 1879).

MICROSCOPICAL ANATOMY.—The tissue of the *choroid* consists of an exterior endothelial coat upon its scleral surface, the *lamina suprachoroidea*, the vascular *parenchyma*, and the *lamina vitrea* on its inner surface. Its thickness varies between 0.08 and 0.16 mm.

In transverse sections of the choroid, we see that the smaller (capillary) blood-vessels lie chiefly near the *lamina vitrea*, the larger (venous) ones in the outer portion, and, furthermore, that the capillary portion is almost unpigmented, while the outer portion appears darkly pigmented (Fig. 1880).

The tissue of the parenchyma of the choroid is made up largely of cells. These cells are either pigmented or unpigmented, round cells, or bipolar cells, or cells with a number of offsets which, in turn, are again branched off and anastomose with others. These offsets may be long and gradually tapering off, or they may be short and broad. The cells have a large unpigmented, oval or rounded nucleus (Fig. 1881). Near the inner surface of the choroid the unpigmented cells are more numerous; near the outer surface the pigmented cells are, by far, more prevalent. The pigment appears in the shape of granules, and its tint varies considerably in the different races, and even in one and the same eye.

Near the inner surface of the choroid (behind the capillary layer) a number of nuclei are found which, according to Sattler, belong to two endothelial layers which divide the capillary from the venous layer.

The cells of the choroidal parenchyma are mingled with fine connective-tissue fibres. These fibres are easily demonstrated in the outer portions of the choroid, especially in the *lamina suprachoroidea*, but are more difficult to detect in the chorio-capillary layer, on account of their being here extremely fine.

Embedded in this largely cellular tissue are the innumerable blood-vessels of the choroid. These form two distinct groups, viz., the capillary blood-vessels, which lie near the inner, and the venous blood-vessels, which lie near the outer surface, of the choroid. By these two groups of vessels the parenchyma of the choroid is divided into two layers, viz., the chorio-capillary layer and the venous or Haller's layer.

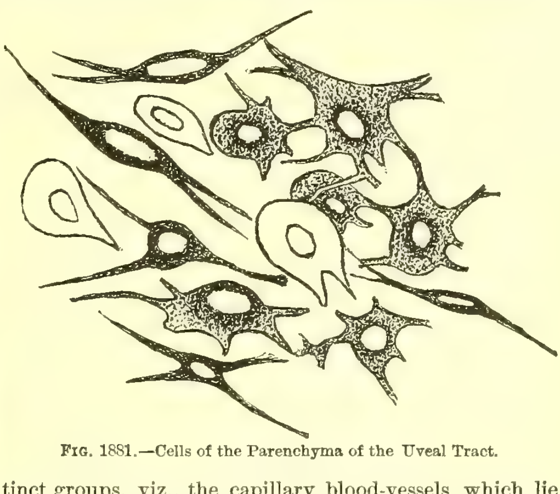

FIG. 1881.—Cells of the Parenchyma of the Uveal Tract.

As has been stated, the arteries which supply the bulk of the choroid are the short posterior ciliary arteries. After having entered the eyeball (Leber) in the posterior portion of the choroid they lie at first for a short distance in the

outer layers of this membrane, then branching off dichotomously they dip into the tissue of the choroid, and their finest branches are spread equally over its inner portion and there form the network of capillaries known as the *chorio-capillaris.* All branches going to the anterior portion of the choroid appear very straight, until, finger-like, they branch off into fine capillaries. The capillaries have

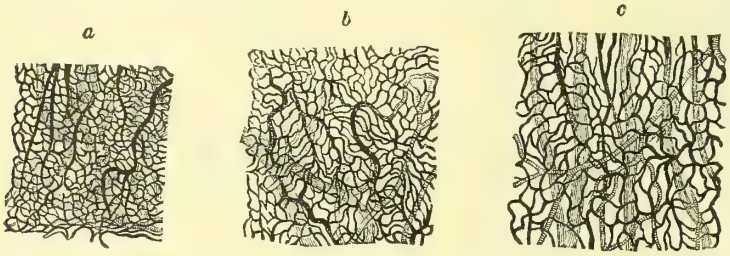

FIG. 1882.—(From Leber.) Shows the Capillary Network of the Choroid: *a*, Near the optic nerve entrance; *b*, from the æquator of the eyeball; *c*, near the anterior margin of the choroid. The veins are striated longitudinally, the arteries transversely, the capillaries are black; the latter are, however, only half as broad as they ought to be.

a wider lumen than have the capillaries in other tissues. Their walls appear almost homogeneous, their nuclei are numerous and easily distinguished.

The meshes of the capillary network vary in size in the different regions of the choroid. They are smallest and more rounded near the optic-nerve entrance, and gradually grow larger and more oblong toward the orbiculus ciliaris (see Fig. 1882).

The tissue between the capillaries appears perfectly homogeneous and free from cellular elements. The capillary network ends at the beginning of the ciliary body with an irregularly indented margin. At the optic-nerve entrance its blood-vessels anastomose with those of the optic nerve.

According to Sattler, the first endothelial membrane of the two described by him, and mentioned above, lies immediately outward from the capillary network. Then comes a fine network of elastic fibres, in which are embedded the smaller and medium-sized arteries and veins, and farther outward from this lies the second endothelial membrane. All veins and arteries are provided with a perivascular sheath, which disappears at their entrance into the capillary layer in such a way that an open communication exists between the interstices between the capillaries and these perivascular sheaths of the venous blood-vessels. Outward from the last-mentioned endothelial membrane the pigmented portion of the choroid begins. Embedded in this are the larger veins. This pigmented layer is then covered by the different layers of the *lamina suprachoroidea* with the external endothelial coat.

The *lamina suprachoroidea* consists chiefly of fibres and pigmented cells. While in the outer portions of the choroidal parenchyma the cells are mostly long and have thin offsets, we find the cells of this layer to be nearly all broad and their offsets short.

Suprachoroidea and choroidal parenchyma contain, furthermore, a large number of nerves. After having pierced the sclerotic these nerves, on their way to the ciliary body, lie in the *lamina suprachoroidea* (see Fig. 1878). Here they give off numerous branches, which at first form a superficial network within the *lamina suprachoroidea.* From this network, again, numerous branches are given off, and go deeper into the parenchyma of the choroid. These small nerve-branches can be traced along the blood-vessels of the larger orders, but they disappear in the capillary layer. In these networks of nerve-bundles and fibres a great many ganglionic cells are found. They are arranged in groups of from a few to twenty and more, and are often very large (Mueller, Schweigger, Saemisch, Krause, etc.).

The *lamina vitrea,* which covers the inner surface of the choroid, is an elastic, homogeneous membrane. It is firmly bound down to the choroidal parenchyma, but the manner in which the two tissues are thus united is as yet unknown, although Sattler describes a very fine and pale "lattice-work," consisting of very fine lines of weak refraction and forming a part of the outer surface of the *lamina vitrea.*

The tissue of the ciliary body consists mainly of the same elements as does that of the choroid, with the addition of muscular tissue with its tendon. We have an outer endothelial coat, the *lamina suprachoroidea,* the parenchyma, the *lamina vitrea,* and upon this the uveal pigment layer, which on its inner surface is covered by the ciliary portion of the retina.

The parenchyma of the ciliary body contains less pigment than does that of the choroid of the same eye. It consists, however, of the same kind of cells, and a larger quantity of connective tissue and elastic fibres. The connective tissue prevails in the outer portion, while the inner portion of the ciliary body is chiefly made up of cells.

The ciliary muscle lies embedded in this tissue. It has a prismatic shape (base forward, apex backward), and is by its tendon firmly attached to the sclerotic. Its thickness (Iwanoff) is on an average 0.8 mm., its length 3 to 4 mm. Its elements are non-striated muscular fibres, and according to their arrangement we distinguish between æquatorial (circular) and meridional (longitudinal) fibres, as we see them in meridional sections. The meridional fibres are less numerous, and occupy the inner anterior portion of the muscle prism, while the longitudinal fibres form its larger, outer, and posterior portion. From æquatorial sections through the ciliary body it is evident that the well-marked distinction between circular and longitudinal fibres, as seen in meridional sections, is only apparent, and that the fibres interlace in such a way that the longitudinal fibre may become a circular one, and *vice versa.*

Anteriorly the muscular fibres are joined in a tendon attached to the corneo-scleral tissue in a manner to be described later on. Posteriorly they end in the sclerotic and in the superficial layers of the choroid; in the latter membrane their ending takes place in peculiar, star-like formations (Jeropheeff and Iwanoff).

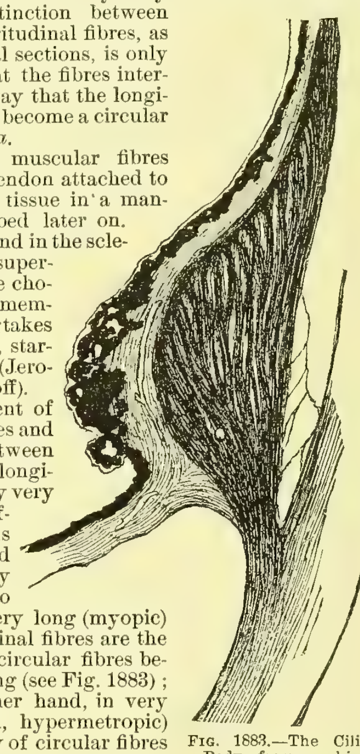

FIG. 1883.—The Ciliary Body, from a highly Myopic Eye.

The arrangement of the muscular fibres and the proportion between the circular and longitudinal fibres vary very materially in different eyes. This has been pointed out, at first by Iwanoff, who stated that in very long (myopic) eyes the longitudinal fibres are the prevailing ones, circular fibres being totally wanting (see Fig. 1883); while, on the other hand, in very short (far-sighted, hypermetropic) eyes, the quantity of circular fibres is increased above the average, and the longitudinal fibres are comparatively reduced in numbers (see Fig. 1884). Figs. 1883 and 1884 are drawn from specimens in the author's possession, and show these conditions in a well-marked manner. They furthermore show that we have two kinds of circular fibres, one which results from the union of the longitudinal fibres near the inner surface of the

ciliary body, and one which appears distinctly as a separate circular muscle (Fig. 1884). The latter has been called Mueller's muscle, from the name of the author who first detected and described it.

The longitudinal fibres form a number of *lamellæ*, spreading fan-like inward toward the axis of the eyeball, coming from a broad tendon which is inserted into the corneo-scleral tissue inward from Schlemm's canal, and outward from the *ligamentum pectineum* of the iris.

The arterial blood-vessels of the ciliary body come from the long posterior ciliary arteries, which, after having pierced the sclerotic, run along the outer surface of the choroid without giving off any branches for this membrane (Leber). When they have reached the ciliary body they branch off into two larger branches, which go into the ciliary muscle, and, having reached its anterior extremity, change their direction so as to run in an æquatorial sense. Thus the two arteries from the medial and the two from the lateral side of the eyeball are running toward each other, giving off smaller branches on their way. This arterial circle, lying near the anterior margin of the ciliary muscle, is furthermore fed by the anterior ciliary arteries which pierce the sclerotic at the side of the ciliary body and go directly to the ciliary muscle. The arterial circle, being formed in the manner just described, is called the large arterial circle of the iris (*circulus arteriosus iridis major*). The branches coming from this circle feed the iris and the ciliary processes; the arteries for the ciliary muscle and the recurrent arterioles for the choroid, too, partly spring from this circle, but also directly from the main branches or the long posterior and the anterior ciliary arteries. The branches coming directly from these arteries form an arterial network in the ciliary muscle (*circulus arteriosus musculi ciliaris*). The arteries of the ciliary muscle proper coming from this circle form a fine network within the muscle, which is to some extent independent of the arterial network within the ciliary processes.

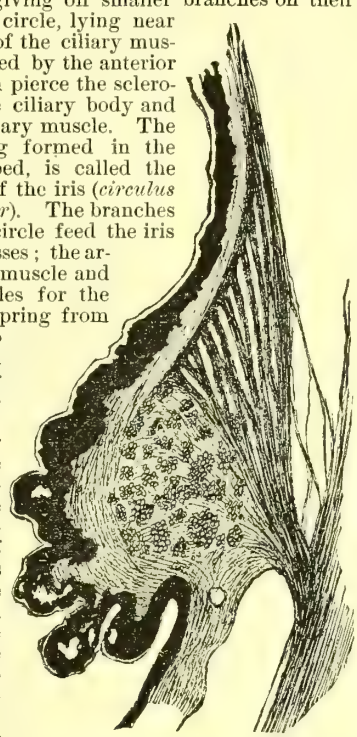

FIG. 1884.—The Ciliary Body, from a highly Hypermetropic Eye.

The arteries for the ciliary processes come, as stated, from the large circle of the iris. They do so in such a manner that one small branch feeds one or two, or even a larger number of neighboring processes. They enter the processes at their anterior margin, and, having first passed through the ciliary muscle, they are here rapidly divided into a large number of smallest branches, which anastomose with each other, and finally go over into the venous blood-vessels. These venous blood-vessels form the bulk of the vascular network of the ciliary processes.

The veins of the ciliary muscle, after having collected the blood, empty it into some larger branches, which in turn unite with the veins of the ciliary processes, and finally reach one of the *venæ vorticosæ*. A smaller number of the veins of the ciliary muscle pass out through the sclerotic near the anterior part of this muscle, and go to the anterior ciliary veins.

The veins of the ciliary processes lie immediately under the inner surface of these processes, following all their folds and projections. Having taken up the venous branches from the iris and the ciliary muscle, they run backward to one of the *venæ vorticosæ* in such a manner that the small branches of each ciliary process are collected into one larger branch, which, passing on backward, goes to the outer surface of the choroid.

The ciliary nerves form a larger network on the outer surface of the ciliary body, from which branches go into the deeper layers, forming there a smaller network between the fibres of the ciliary muscle, and probably ending within the latter.

The *lamina suprachoroidea* of the ciliary body is in no way different from the same *lamina* of the choroid.

The *lamina vitrea* of the choroid, when reaching the ciliary body, undergoes some material changes. It becomes somewhat thicker and is no longer so smooth. On its inner surface a reticulum of ridges appears, the meshes of which grow smaller and more numerous the farther forward we go. These meshes between the ridges contain pigment.

On the inner surface of the *lamina vitrea* lies the uveal layer of the ciliary body. It consists of cells varying in shape and size, which are densely filled with dark pigment molecules, which, however, leave the round or oval nucleus free. There is a structureless cementing substance which holds the different layers of cells together.

Inward from this layer we find the retinal layer of the ciliary body (*pars ciliaris retinæ*). The cellular elements of this layer are to be considered as the continuation of Mueller's supporting fibres of the retina. The retinal layer of the ciliary body consists of a single layer of more or less cylindrical cells, which gradually decrease in height toward the insertion of the iris on the ciliary body. They have one round or oval nucleus. This is situated near their outer end (base), and they contain no pigment. The inner limiting membrane of the retina (*membrana limitans interna retinæ*) can sometimes be traced on their inner surface.

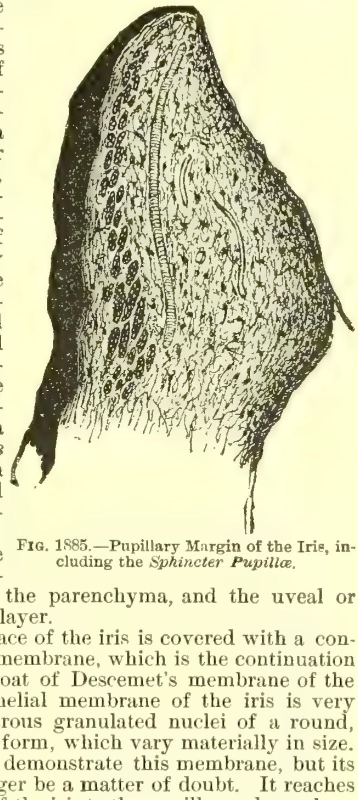

FIG. 1885.—Pupillary Margin of the Iris, including the *Sphincter Pupillæ*.

The tissue of the *iris* consists of an anterior endothelium, the parenchyma, and the uveal or posterior pigmented layer.

The anterior surface of the iris is covered with a continuous endothelial membrane, which is the continuation of the endothelial coat of Descemet's membrane of the cornea. The endothelial membrane of the iris is very thin, and has numerous granulated nuclei of a round, oval, or bean-shaped form, which vary materially in size. It is very difficult to demonstrate this membrane, but its existence can no longer be a matter of doubt. It reaches from the periphery of the iris to the pupillary edge, where it meets the uveal layer coming from the posterior surface of the iris (Fig. 1885).

The vascular parenchyma of the iris consists mainly of pigmented and unpigmented cells. These are stellated cells with a varying number of offsets, and a more or less fusiform body (Fig. 1881), cells with one or two offsets, and round (lymphatic) cells. The offsets of these cells frequently anastomose with each other. The cells are intermingled with very fine connective-tissue fibres, which are more numerous and more plainly visible along the blood-vessels and nerves than in other parts of the iris. The parenchyma of the iris shows plainly three characteristic layers, although they pass over into each other. The anterior layer, just behind the endothelial coat, is made up mainly of densely crowded fusiform cells with

many offsets, which are mostly pigmented. Their pigment is not as dark usually as that of the pigmented cells of the choroid of the same eye. The offsets of these cells undergo manifold anastomoses with each other, so as to form one solid cellular network. Wherever the surface of the iris is interrupted by one of the above-mentioned crypts, this cellular network forms a ring around the orifice of such a crypt.

The bulk of the iris and its middle layer appear like a spongy tissue. It consists of a very much looser network of cells, which partly contain pigment molecules, partly not. The spongy appearance is due to the comparatively smaller number of cells and large interstices (iris-fissure, see below).

The posterior layer of the parenchyma of the iris consists of two distinct layers, one made up of fine, parallel, tough fibres without nuclei (Fuchs), and the other consisting of bipolar, fusiform pigmented cells, with an oval or round nucleus (Fig. 1886).

This layer of fusiform cells reaches from the periphery of the iris to the region of the *sphincter pupillæ*.

Near the pupillary margin the tissue of the iris contains a muscular ring, the *sphincter pupillæ* (Fig. 1885). This muscular ring lies near the posterior surface of the iris, and is from 0.9 to 1.3 mm. in width. Close to the pupillary margin it is thin (0.10 mm.), and gradually grows thicker outwardly. Its thickest part is 0.25 mm. thick (Iwanoff). It consists of non-striated muscular fibres, which are held together by connective tissue (Fig. 1887).

Fig. 1886.—Cells from the Posterior Surface of the Parenchyma of the Iris, the uveal layer having been removed.

A number of authors have also described a layer of muscular fibres which is said to lie near the posterior surface of the iris, and to be arranged in a radiating direction, called the *dilatator pupillæ*. Such a muscle does, however, not exist—at least the writer, in conjunction with many other authors, has never been able to find such a muscle. Iwanoff undoubtedly, from his drawings, mistook the layer of fusiform cells (Fig. 1886) for a layer of muscular fibres. In animals' eyes a *dilatator pupillæ* is easily demonstrated, and its fibres unite with those of the *sphincter*, changing their course arch-like when, or just before, they have reached the periphery of this muscle. In the human iris there is, however, no tissue which has the characteristics of muscular tissue, antagonistic to the *sphincter pupillæ*, and which, therefore, could and would have to be styled the *dilatator* muscle.

One of the latest authors on this subject states as follows: "There is in the human iris no organ to which a pupil-dilating action can be ascribed, excepting the posterior limiting membrane (the layer of transparent parallel fibres just in front of the layer of fusiform cells). Whatever the physiological functions of this layer may be (whether it acts simply by its inherent elasticity or by active contraction), we must insist upon the fact that its anatomical properties differ very materially from those of muscular tissue." And farther on: "It is certain that the active dilatation of the pupil is not due to the blood-vessels, and, furthermore, that there is no layer of muscular fibres in front of the posterior limiting membrane which could bring about a contraction of the iris. We are, therefore, forced to ascribe to this limiting membrane the possibility of active contraction. On the other hand, the tissue of this limiting membrane is devoid of nuclei, and its fibres differ also in other points materially from non-striated muscular fibres. The observation of the living eye seems to force us to addict to such a tissue the faculty of active contraction. We must hope that in the future this riddle will be solved."

The writer perfectly agrees with Fuchs on this question. There is no muscular organ in the human iris which would fill the physiological want of a *dilatator pupillæ*.

Embedded in the parenchyma of the iris, that is, in the spongy middle portion, we find innumerable blood-vessels, which, in a general way, run from the periphery of the iris toward the pupillary margin.

The arteries of the iris take their origin from the *circulus arteriosus iridis major*. They enter the iris where the ciliary processes meet the iris. In the iris tissue they give off many branches, like a tree, which run in many curves, but generally in a radiating direction toward the pupillary margin. These blood-vessels have a peculiarly thick wall, their *muscularis* and *adventitia* being noticeably thicker than in blood-vessels of the same calibre elsewhere. Near the pupillary margin some of these arterial blood-vessels form another circle, called the *circulus arteriosus iridis minor*. It lies where, in fœtal life, the *membrana pupillaris* is inserted on the iris. The smallest arteries then again form a network of capillaries within the *sphincter pupillæ*, and then join the finest venous branches. This capillary network of the iris has much wider meshes than that of the choroid (Leber).

The veins of the iris run in the same radiating manner backward from the *sphincter pupillæ* to the periphery of the iris. Here they enter the ciliary body and join the veins of the ciliary processes, thus finally emptying the venous blood from the iris into the *venæ vorticosæ*.

Fig. 1887.—Isolated Non-striated Muscular Fibres, taken from the *Sphincter Pupillæ*.

The nerves of the iris come from the ciliary nerves. They seem to be as numerous as are the blood-vessels. They form in the parenchyma of the iris a network of fibres, from which numerous branches run toward the anterior and posterior surfaces, and into the sphincter pupillæ. Iwanoff states that there are three kinds of fibres: *a*, pale fibres, probably from the sympathetic nerve, going to the posterior surface of the iris, *i.e.*, to the *dilatator pupillæ* (?); *b*, medullated fibres, going to the anterior surface of the iris, which he thinks are the sensitive fibres; and *c*, a network of fibres within the *sphincter pupillæ*, which he thinks are mostly motor fibres.

The posterior surface of the iris is covered by the dark uveal pigmented layer. This is a continuation of the uveal layer of the ciliary body, and reaches anteriorly to the pupillary edge (see Fig. 1885). It is very difficult to demonstrate any cellular elements in this layer. There may, however, be isolated cells which vary in shape and have a round unpigmented nucleus. It seems, however, that this layer, at least in its posterior part, is a continuous mass of protoplasm filled with pigment molecules without any distinct cellular elements, while its more anterior layer is, perhaps, altogether composed of cells. This opinion seems to be supported by the fact that the protoplasm of the uveal layer, in transverse sections, is often seen as a fine, light streak, forming the posterior limitation of the iris. This fine streak has been described by some authors as a separate limiting membrane, but, the writer thinks, erroneously so.

The crypts and indentations of the anterior surface of the iris have of late been especially studied by Fuchs. The results of his study should find a place here. He states that the crypts lie in the pupillary and in the peripheral zone of the iris. These crypts are openings in the anterior surface of the iris, which reach into the depth of the parenchyma of this membrane. The crypts are thus the external orifices of a fissure-like space within the iris tissue, the walls of which are not well defined. The orifices of the crypts are often bridged over by trabeculæ

of a tissue consisting of the anterior layer of the parenchyma of the iris with its endothelial cover. The endothelial cover does not reach down into the crypts, and the tissue of the parenchyma of the iris is, therefore, bare and in direct contact with the aqueous humor. The crypts in the peripheral zone of the iris are scarcely different from those of the pupillary zone. Fuchs finally concludes that we have within the iris a system of fissures which surround the blood-vessels of its middle layer. He calls this the "iris-fissure," and goes on to say that this iris-fissure is in direct communication with the lymphatic spaces of the *ligamentum pectinatum*, and with the anterior chamber of the eye, by means of its pupillary and ciliary orifices (crypts.) He further finds that, when the pupil is contracted, the surface of the iris becomes broader, the tissue thinner and stretched in a radiating direction, and the pupillary orifices of the lymphatic fissure of the iris become narrowed, while at the same time its ciliary orifices are enlarged. When the pupil is dilated these conditions are simply reversed.

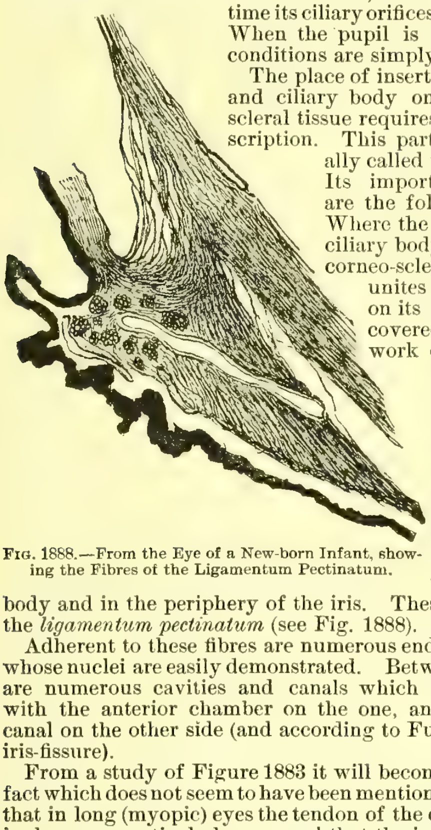

Fig. 1888.—From the Eye of a New-born Infant, showing the Fibres of the Ligamentum Pectinatum.

The place of insertion of the iris and ciliary body on the corneo-scleral tissue requires a special description. This part is now usually called the iris-angle. Its important features are the following ones: Where the tendon of the ciliary body reaches the corneo-scleral tissue and unites with it, it is on its inner surface covered by a network of fine tough fibres which anteriorly merge into the posterior layers of the cornea and Descemet's membrane, and posteriorly are lost in the ciliary body and in the periphery of the iris. These fibres form the *ligamentum pectinatum* (see Fig. 1888).

Adherent to these fibres are numerous endothelial cells, whose nuclei are easily demonstrated. Between the fibres are numerous cavities and canals which communicate with the anterior chamber on the one, and Schlemm's canal on the other side (and according to Fuchs, with the iris-fissure).

From a study of Figure 1883 it will become apparent (a fact which does not seem to have been mentioned elsewhere) that in long (myopic) eyes the tendon of the ciliary muscle is also comparatively longer, and that the insertion of the iris on the ciliary body lies farther away from the corneo-scleral tissue, thus rendering the iris-angle wider. Figure 1884 shows that, on the other hand, in a short (hypermetropic) eye the tendon of the ciliary muscle is comparatively shorter, and the insertion of the iris lies nearer the corneo-scleral tissue. The iris-angle in such an eye, therefore, is much narrower. *Adolf Alt.*

IRITIS. Iritis, or inflammation of the iris, is one of the common affections of the eye. It arises from a variety of causes, may attack one or both eyes, and while almost always amenable to treatment, if recognized in its inception and judiciously managed, it usually impairs the sight more or less seriously and permanently damages the integrity of the eye if allowed to run its course unchecked, or if improperly, or only tardily, treated. It is of the first importance, therefore, that its true character should be recognized at the outset, and that the requisite therapeutic measures should be resorted to without delay. The diagnosis of inflammation of the iris is commonly not a difficult matter, and the indications for its treatment are usually plain. It is, nevertheless, true that it is frequently confounded with other forms of inflammation of the eye, and improperly treated; and in consequence of this, or because of the ignorance or indifference of those whom it attacks, it is by no means an uncommon cause of blindness.

Speaking generally, the presence of iritis is to be suspected whenever, without increase of intra-ocular tension, or other evident cause, pain in and around the eye, usually worse at night, is complained of, and is accompanied by peri-corneal subconjunctival injection and a contracted pupil. This concourse of symptoms does not necessarily indicate the presence of iritis, but it should put us upon our guard, and make us search carefully for other evidences of its existence. A dull, lack-lustre appearance of the iris, with appreciable change of color and more or less swelling of its tissue; immobility of the pupil, and, perhaps, loss of its circular form; loss of transparency of the aqueous humor, and frequently of the cornea as well, with consequent indistinctness of vision; adhesions between the margin of the pupil and the anterior capsule of the lens, which, however, are frequently not evident until a mydriatic has been used; and in severe cases a grayish opacity of the pupil from the deposition of lymph upon the lens-capsule, are the other changes which should be sought for, and which, if found, establish the diagnosis beyond question.

Among the causes of iritis, syphilis doubtless deserves the most prominent place. Traumatism is another frequent cause, not only when the iris itself is involved in the injury, but also when the cornea, lens, or ciliary body is wounded. Rheumatism and gout also deserve to be mentioned in this connection, and gonorrhœa, though doubtless a very infrequent cause, probably does occasionally give rise to it, the ocular inflammation having the same relationship to the urethral disease that gonorrhœal arthritis has. Iritis may also be a consequence of inflammation of other structures of the eye, as, for instance, abscess or perforating ulcer of the cornea.

There is also another cause of iritis to which the writer is disposed to attach great importance, and which he believes to be an essential factor in the production of several apparently distinct varieties of the disease. He refers to an influence transmitted through vaso-motor or "trophic" nerves, which is frequently reflex in its character, and is probably always dependent upon structural changes in gray nerve-matter, either in the cerebral ganglia themselves, or in the ganglia connected with the fifth nerve, or in both. It is such an influence as this, he believes, that determines the development of sympathetic iritis, the iritis which is frequently found associated with herpes zoster ophthalmicus, that which occasionally follows malarial attacks, and, probably, also certain cases of serous iritis. In this category belong also those cases of iritis which he thinks have been rightfully ascribed to reflex dental and uterine irritation, as well as certain intractable forms of irido-keratitis, which are not infrequently accompanied by anæsthesia of the cornea. Obstinacy and intractability are the common characteristics of these several varieties of iritis, and in the pathological changes which they exhibit, there are also striking resemblances.*

The consequences of a severe attack of iritis which has not been properly treated are disastrous to the integrity of the eye in several ways. In the first place, especially in syphilitic iritis, the other structures of the eye are liable to become involved in the inflammatory process, the ciliary body, choroid, retina, lens, and cornea not infrequently suffering irreparable damage. Again, the pupil may be closed or obstructed by lymph (occlusion), so that vision is reduced to mere perception of light; or the iris may become adherent to the anterior surface of the lens, at its pupillary margin only (exclusion), or throughout its whole extent (complete posterior synechia). In the two former conditions operative interference may accomplish

* The writer realizes that, from the standpoint of the prevalent school of pathology, it is heterodoxy to express such an opinion as this regarding the pathogenesis of inflammation. He hopes, however, some day to see a change of opinion upon this point.

great good; in the latter, the prognosis is less favorable, as the nutrition of the eye is apt to be seriously impaired, and in time the deeper tunics suffer, and the lens loses its transparency. Sympathetic inflammation of the fellow-eye is another result which, though not of frequent occurrence, happens often enough to deserve mention.

In the treatment of iritis the chief indications are, first, by local and constitutional remedies to control and overcome as quickly as possible the inflammation; and, second, by the use of mydriatics, to keep the pupil widely dilated, so that adhesions shall not form between the posterior surface of the iris and the lens-capsule. For the latter purpose atropine is the best agent that we possess, and, as a rule, should be preferred to the more recently introduced mydriatics. We shall see later that when there is a tendency to hardening of the eyeball, as in serous iritis, mydriatics must be used with caution; but with this exception, their systematic and liberal employment is essential to success. Of constitutional remedies the most valuable are mercury, iodide of potassium, and salicylate of soda.

Although there are so many causes of iritis, there are not, strictly speaking, so many different kinds of iritis. Indeed, it seems scarcely necessary to describe more than three varieties—plastic iritis (*iritis plastica*), suppurative iritis (*iritis suppurativa*), and serous iritis (*iritis serosa*, Descemetitis) (see Fig. 1889). The first-named variety is by far the most comprehensive. It includes most cases of syphilitic, of rheumatic and gouty, and of sympathetic iritis. Many cases of traumatic iritis are also of this character, and so are most of those which have been spoken of as due to "trophic" nerve influence. Suppurative iritis is less common. It is usually the result of penetrating

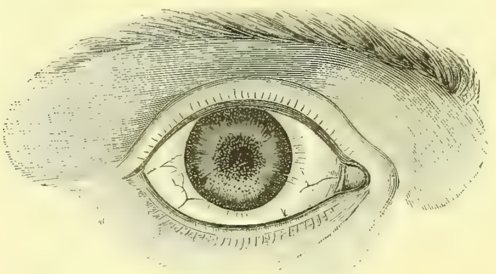

FIG. 1889.—Serous Iritis (Noyes).

wounds of the eyeball, or of operations in which the globe is opened, and is, perhaps, always due to the presence of pathogenic micro-organisms. It may also follow extensive suppurative inflammation of the cornea. Iritis serosa is a disease of by no means rare occurrence, but it is one about the pathology of which we have yet much to learn. There is no doubt but that it is often only a small part of an inflammatory process which involves not only the iris and the membrane of Descemet, but the ciliary body, the choroid, and the vitreous humor as well.* In some instances it seems to be dependent upon a rheumatic diathesis, and, as has already been intimated, in others a pathogenic nerve influence, if such an expression be permissible, appears to offer the best explanation of the phenomena presented. It often exhibits a mixed type, the characteristic spots upon the membrane of Descemet and a tendency to glaucomatous tension, which belong to the usual form of the disease, being associated with a decided disposition to the formation of posterior synechiæ. When the deeper portions of the uveal tract are involved in the inflammatory process, cloudiness of the vitreous humor and the development of floating opacities in it are of frequent occurrence. It usually runs a protracted course, and does not always respond satisfactorily to treatment. When the tension is above normal the pupil is apt to be dilated rather than contracted, and under such circumstances the supervention of a genuine glaucomatous condition is to be feared.

* Compare Noyes, Diseases of the Eye, p. 203.

All of the varieties of plastic iritis are characterized by a tendency to the effusion of lymph, but this tendency is much more marked in some than in others. It is especially so in sympathetic iritis, in the iritis of herpes zoster ophthalmicus, and, in fact, in all those forms of iritis which appear to be due to "trophic" nerve influence. In syphilitic and in rheumatic iritis this tendency manifests itself by the formation of adhesions between the iris and the capsule of the lens, but they are usually confined to the pupillary margin; in sympathetic and the other allied forms of iritis, however, a felt-like exudation develops upon the posterior surface of the iris, causing it to adhere throughout its whole extent to the lens, and the pupil is occluded by similar material. Under such circumstances, also, projecting portions of the anterior surface of the iris may become adherent (without ulceration) to the inner surface of the cornea (anterior synechiæ). A characteristic, but by no means constant, feature of syphilitic iritis is the development upon the anterior surface of the iris, and occasionally upon its posterior surface in the pupillary zone (Bull), of yellowish or reddish-brown nodules, which project forward into the anterior chamber, and sometimes even press against the cornea. Usually there are not more than one or two present; but they may be so numerous, and of such size, as to fill the anterior chamber. They are of the nature of gummata, and may undergo rapid absorption, or may disappear through fatty or purulent degeneration. The inflammation of the iris-tissue being probably more intense over the area which corresponds to their base, we find here a special tendency to the formation of adhesions to the lens-capsule. All of the varieties of iritis may be complicated by hypopyon, though it is more common in the purulent and syphilitic types. It is due to the deposition from the aqueous humor of flakes of lymph, or pus-globules, and, as a rule, undergoes absorption slowly.

Some authors describe a fourth variety of iritis, which they call "spongy iritis." It is probably only a type of the plastic variety, however, in which there occurs a low form of plastic exudation in the anterior chamber, which presents a cyst-like appearance, and might be mistaken for a dislocated lens.

A chronic form of plastic iritis is occasionally met with, in which the inflammatory symptoms are generally but slightly marked. It is often associated with a rheumatic or gouty diathesis, and shows a disposition to recurrence. Points of adhesion between the iris and lens are apt to take place before the true nature of the attack is discovered, as it develops insidiously, and is unattended by pain or other symptoms calculated to alarm the patient and induce him to seek medical advice.

In examining a case of suspected iritis the use of "oblique illumination" is of great assistance, since it enables us to detect slight changes in the cornea and in the tissue of the iris, and in many cases to discover adhesions between the iris and lens, which could not have been seen by simple inspection. If, however, any doubt remains as to the existence of iritis after this method of examination has been employed, a weak solution of atropia (gr. ss.–j. to ℥ j.) should be dropped into the eye, when, if iritis be present, the pupil will almost certainly dilate in an irregular manner, showing points of adhesion between its margin and the lens-capsule. The character of the vascular injection of the eyeball is not a very trustworthy guide in the differential diagnosis of iritis. When, however, it is most marked around the corneal margin, is of a pinkish rather than a brick-red color, and the vessels involved are for the most part small, and radiate more or less regularly from the margin of the cornea toward the equator of the globe, we may, at least, conclude that some of the structures deeper than the conjunctiva are involved in the inflammatory process, and that the existence of iritis is, at any rate, probable. If, however, the inflammation of the iris be of a severe type, the conjunctival, as well as the pericorneal, vessels will be involved; the injection of the ball will then be diffuse, and even the lids may be hyperæmic and œdematous.

The treatment of iritis depends, of course, in a great measure, upon the nature of the cause which has pro-

voked the attack. As a rule, constitutional, as well as local, measures are called for Among the latter the most important are the instillation of solutions of sulphate of atropia, the application of belladonna or opium lotions, the inunction of the forehead and temples with an ointment of mercury and belladonna, and the local abstraction of blood by leeches or by the artificial leech. Four grains to the ounce (about one per cent.) is the strength of the solution of atropia usually employed. In the different varieties of plastic and suppurative iritis it must be used freely, the frequency of the applications being determined chiefly by the state of the pupil and the amount of ciliary neuralgia and photophobia. When there are recent pupillary adhesions, which we hope to break up (for we can usually accomplish this, unless the bands are firm and broad), an instillation every hour may be required, or even for a short time several instillations an hour may be permissible. Such frequent applications as this, however, cannot be long continued without the constitutional effects of the drug becoming manifest, and, as cases of marked individual susceptibility to the action of belladonna are occasionally met with, due caution should be exercised in prescribing the use of atropia in this manner. Ordinarily, four or five applications a day are sufficient. In serous iritis atropia is commmonly indicated to prevent the possible formation of synechiæ, but it need not be used so frequently or in such strong solutions, since in this affection the pupil generally yields more readily to its influence. There is, moreover, owing to the tendency to increased tension which characterizes this disease, the risk that its too liberal use may precipitate an attack of glaucoma. Occasionally individuals are met with in whom atropia fails to produce any mydriatic effect, and others in whom it greatly irritates the conjunctiva, a few applications producing a conjunctivitis, or even an eczematous inflammation of the lids and cheek. Under such circumstances sulphate of duboisia may be substituted for atropia, and will almost certainly be found to act favorably. As it is much more apt to produce constitutional effects when applied to the eye than atropia, greater caution is required in its use. Two grains to the ounce will usually be a strong enough solution to employ, and this should not be applied more than two or three times a day.

In many cases of iritis no other local treatment than the employment of atropia is required; but, when the inflammation is of a severe type, the application of three or four leeches to the temple may accomplish great good, and, when there is severe pain, much relief is often experienced from the use of a wash of opium (ext. opii, gr. x.–xv. to aquæ ℥ iv.) or of belladonna (ext. belladonnæ, gr. xv. to aquæ ℥ iv.), which should be applied to the closed lids more or less constantly upon a folded linen cloth. The application in the same way, for half an hour at a time, several times a day, of water as hot as can be borne, is also a useful expedient under the same circumstances. In obstinate cases, especially those of syphilitic origin, it is well to supplement the use of constitutional remedies by keeping the forehead and temples constantly anointed with mercurial ointment, with which ext. belladonnæ or ext. opii may be rubbed up, in the proportion of ʒ j.–ij. to ℥ j. A more cleanly, but perhaps less efficacious, preparation is the oleate of mercury and morphia.

Reference has already been made to the use of constitutional remedies in the treatment of iritis, and the opinion has been expressed that the most valuable ones that we possess are mercury, iodide of potassium, and salicylate of soda. If to this list are added quinia, which is especially useful in suppurative iritis; opium, which seems not only to control the pain, but to favorably influence the inflammation; muriate of pilocarpine, which is useful especially when there is increased tension; and some brisk purgative combination which, as a rule, should contain calomel, it will include all the drugs that are likely to be needed in treating any of the varieties of the disease. A supplemental list of less important, but at times useful, remedies might include arsenic, colchicum, chloral, lithia (either the salicylate or the preparation known as "lithiated potash"), iron, and the Turkish bath. In severe acute iritis, whether of specific or non-specific origin, salicylate of soda, given in liberal doses (from ten to fifteen grains every two or three hours, according to the susceptibility of the patient), is, on the whole, perhaps the most promptly efficacious remedy that we have. In many cases it appears not only to relieve the pain very promptly, but to hasten the resolution of the inflammation and promote the absorption of effused material. The writer believes that this drug has not been much employed in syphilitic iritis, but it is in such cases that some of the most striking results which he has observed have been obtained. In serous iritis he has also found it very useful, and, as might be expected, especially so in iritis dependent upon rheumatism.

In most cases of syphilitic iritis, whether the taint be inherited or acquired, mercury in some form is demanded. It is also our chief reliance in sympathetic iritis, and is more useful than anything else—unless it be iodide of potassium—in the iritis of herpes zoster ophthalmicus and in the other "trophic" nerve varieties. In the acute stage of syphilitic iritis it should be administered liberally, and in such shape as to impress the system promptly. Salivation is to be avoided, but in severe cases we must not stop far short of it. Small doses of calomel, frequently repeated (gr. $\frac{1}{10}$ every hour, or gr. $\frac{1}{2}$ every three hours), supplemented, if necessary, by inunctions of mercurial ointment, or a twenty per cent. solution of oleate of mercury, afford the best means of accomplishing the desired result. There seems to be no contra-indication to the administration of salicylate of soda and mercury at the same time, and the writer has obtained good results in this way. Opium may be given if the pain is severe, or if a purgative effect is produced by the mercury. In subacute cases, or when the symptoms are less urgent, biniodide of mercury, in doses varying from gr. $\frac{1}{48}$ to gr. $\frac{1}{12}$, or gr. $\frac{1}{8}$, may be given three times a day. This is a very efficacious and convenient method of administering mercury, and salivation is less apt to occur than when calomel is employed. It should be given in solution in water, a small quantity of iodide of potassium being added to render the mercury soluble. When a prolonged course of mercury is required this is decidedly the best form in which to administer it. It is, therefore, especially useful in the iritis of inherited syphilis, in obstinate cases of serous iritis, and in sympathetic iritis.

Iodide of potassium is valuable in rheumatic iritis, and in the later stages of sympathetic iritis; it may also advantageously supplement the use of mercury in syphilitic iritis. It may be administered in combination with the biniodide of mercury or by itself. In some cases of serous iritis it is most efficacious, but its good effects are not always manifest until it is given in large doses.*

In suppurative iritis, which, as has been said, usually follows wounds of the eye or operations upon it, and is frequently accompanied by purulent infiltration of the cornea, the free administration of sulphate of quinine offers the best prospect, though not a very promising one, of success. Muriate of pilocarpine, which seems to be as efficacious when administered by the mouth as when introduced into the system by the hypodermatic method, is sometimes useful in cases of serous iritis in which the tension of the globe is high; and in any of the other varieties, if this condition obtains, or if there is cloudiness of the vitreous humor, it may be prescribed with advantage. The writer has found it convenient to prescribe it in a solution of the strength of gr. j. to ʒ j. Ten drops of this solution, containing one-sixth of a grain of the salt, is the commencing dose, to be taken by the mouth once a day. According to the effect produced the dose is increased, more or less rapidly, by adding each day two or three to the number of drops administered. In any severe attack of iritis an active cathartic may be given with advantage at the commencement of the treatment.

* The writer has recently met with an extremely obstinate case of this character, which was cured by twenty-five-grain doses of iodide of potassium, administered three times a day, only slight improvement having resulted from the administration, previously, of liberal doses of bichloride of mercury and salicylate of soda.

A very efficacious one is a powder containing from two to five grains of calomel, two grains of scammony, and ten of powdered rhubarb, to be given at bedtime.

When the iritic inflammation is dependent upon a gouty diathesis, colchicum and the preparations of lithia which have been referred to are useful; and in the iritis which sometimes follows malarial attacks, and in that which accompanies ophthalmic shingles, arsenic, in the form of Fowler's solution, may be prescribed with benefit. The daily use of the Turkish bath is commended by Bull as a valuable remedy in arthritic iritis.

In the management of every case of iritis, the question arises whether the patient should be confined to the house during the continuance of the attack.

Undoubtedly, in acute cases, and especially when the inflammation is severe, this should be done if practicable. It is very rarely necessary, however, that he should be shut up in a dark room. With a shade and with dark glasses (London-smoke coquilles), he may safely be allowed the freedom of the house. This makes the treatment much less irksome to the patient, and does not seem in the least to retard the cure. In subacute cases, and even in acute cases where there is but little pain or photophobia, the patient need not be confined to the house unless, of course, the weather be unpropitious. Indeed, most cases of iritis are treated successfully as "out-patients," being seen by the medical attendant either at his office or at his hospital clinic.

Surgical interference is rarely required during the active stage of iritis. There are, however, some exceptions to this rule, as, for instance, in serous iritis, when the supervention of glaucomatous symptoms may demand the prompt performance of an iridectomy, or in suppurative iritis, when paracentesis of the cornea may be required for the relief of hypopyon. To remedy the consequences of iritis, however, and especially to prevent recurrent attacks, operations upon the eye are frequently called for. When, after an attack of iritis, a few slender bands of adhesion between the margin of the pupil and the lens are left, probably no ill consequences will result therefrom, and for such a condition no operation is required. If, however, as happens not infrequently in neglected cases, the margin of the pupil is completely glued to the surface of the lens, an iridectomy should be performed without delay, for soon the iris will be bulged forward by the accumulation of fluid behind it, and will undergo atrophy, while at the same time the deeper structures of the eye will suffer from the consequent disturbance of their nutrition. When, though not completely adherent, the margin of the pupil is attached to the lens by several broad bands, an iridectomy may be required, since recurrent attacks of inflammation are not infrequently induced in consequence of the irritation produced by the traction of these bands during the muscular movements of the iris. When, also, the pupil is closed, or is occluded by lymph, an iridectomy may restore almost normal vision to a nearly blind eye, by yielding a clear artificial pupil. It is also frequently necessary to perform an iridectomy after the more severe types of iritis, when there is complete adhesion of the iris to the capsule of the lens. Under such circumstances it is more difficult to obtain a clear pupil, since it frequently happens that the pigment from the posterior surface of the iris remains adherent to the lens, while only the muscular tissue of the iris yields to the traction of the forceps. There is greater danger, too, under such circumstances, that the artificial pupil may again become closed or occluded. The operations devised by Streatfield and Passavant, for breaking the adhesions between the margin of the pupil and the capsule of the lens, are not often practised at the present day, though in skilful hands they may at times fulfil a good purpose. In sympathetic iritis the condition of the fellow-eye should, of course, be carefully examined, and if it be blind, or nearly so, and still acting as a source of irritation, it should be enucleated without a moment's unnecessary delay. This will probably not arrest the disease which has become established in the second eye, but it will be likely to influence the progress favorably, and will certainly do no harm. *Samuel Theobald.*

IRON. I. General Medicinal Properties of Compounds of Iron.—All iron preparations capable of absorption are qualified, in some degree, to exert a peculiar influence upon nutrition generally. Given to a person in health, the influence appears to be slight, since the clinical symptoms are insignificant. A rather hard and quickened pulse, a feeling of fulness and tension of the head, and dull pains and discomfort, generally constitute about all the obvious derangement. When, however, the mineral is administered to a sufferer from *anæmia* of the ordinary type, or from *chlorosis*, much more marked effects follow. The morbid conditions, in these diseases, that are the expression of deficient hæmoglobin tend to subside with greater or less rapidity; the pale, waxy skin becomes rosy, the flabby tissues firm, weight increases, appetite is gained, and in every way the invalid improves in health and strength. In pernicious anæmia, however, iron is commonly without effect.

The clinical results thus seen to follow the medicinal giving of iron, both in health and disease, obviously suggest that the action of the drug is to determine an increase in the quantity of hæmoglobin present in the circulation, either by enrichment in hæmoglobin of the red blood-corpuscles, or by a quickening in the rate of evolution of these bodies, or possibly by both means combined. Exact observations on the blood of anæmics and chlorotics during a course of iron show that the medicine is indeed capable of producing both the effects described.[1] With large doses, the tendency is first to increase the hæmoglobin-richness of the red corpuscles, and later, the number of the globules; with small doses, to reverse this order of proceeding. Probably, in either case, the essential action of the iron is to determine hæmoglobin-enrichment, the effect on rate of corpuscular evolution being a secondary consequence. How iron accomplishes this feat is, as usual in the matter of the action of a medicine, entirely unknown. It is true that iron is a constituent substance of the very hæmoglobin whose increased rate of manufacture it determines, but that the action is simply the supply of a deficient pabulum is disproved by the well-known clinical fact that, to cure a chlorosis, the iron medicine must be given in great excess of the mere amount required as a constituent of the hæmoglobin to be produced.

This faculty of enriching the red blood-globules in hæmoglobin is essentially the whole of the so-called constitutional effect of iron, and it is one so intrinsically wholesome that iron stands quite apart from the ordinary run of heavy metals in the particular of being, in constitutional effect, practically non-poisonous. Iron compounds, therefore, unless debarred by properties of local irritation, may be given as medicines with a freedom impossible with most other distinctively metallic salts.

So far, next, as concerns local influence, the medicinal compounds of iron are, in the matter of their most important local effect, divided into two fairly-well-defined groups. For, while some iron salts are locally bland, others are decidedly irritant, or, more commonly yet, astringent and irritant both. Of the astringent salts, furthermore, certain ones are not merely astringent, but are possessed also of that enhancement of simple astringency known as *stypticity*—a power to determine a semi-solid coagulum with the coagulable material of blood and tissues. So, between the blandest of iron preparations, on the one hand, and the powerfully styptic, on the other, there is the very widest possible divergence of local action.

The character of an iron compound, *in re* astringency or irritation, is determined in part by the solubility of the salt, and in part by the character of the salt's acid radicle. For, of course, in the first place, all compounds insoluble, or but sparingly soluble, in fluids of aqueous basis are locally bland, so that metallic iron, ferrous carbonate and oxalate, and ferric hydroxide, hypophosphite, and valerianate are bland irrespective of the quality of their several acids. Of aqueously soluble compounds, those that are salts of the so-called organic acids—lactic, acetic, citric, and tartaric—and the mixed salts of the United States Pharmacopœia passing under the names of "phos-

phate" and "pyrophosphate," are more or less comparatively bland—the citrates, tartrates, and phosphates being quite so, the lactate and acetate not so purely. The remainder, which are all salts of the strong so-called mineral acids, are in varying degree astringent, irritant, or both, as follows: Powerfully styptic, are *ferric chloride*, *ferric nitrate*, and the two grades of *ferric sulphate*, normal and basic ("tersulphate" and "subsulphate," respectively); powerfully astringent, but with proportionately less coagulating faculty, *ferrous sulphate* ("green vitriol," "sulphate of iron") and *ammonio-ferric sulphate* ("iron-alum"); decidedly irritant, but not distinctively astringent, *ferrous iodide* and *ferrous bromide*.

Clinically, the respective local effects of the two broad groups thus defined are as follows: The astringent or irritant compounds have a harsh, *puckery*, generally sour and disagreeably inky taste, and, upon frequent taking, tend to blacken and even to corrode the teeth. The blackening is removable by a tooth-brush, but the corrosion is, of course, a serious matter,* and necessitates the clinical rule, to order solutions of astringent chalybeates to be taken through a glass tube set far back over the tongue, and the mouth to be well rinsed after the swallowing. Upon the healthy stomach, small doses of the astringents, in common with most other not over-noxious irritants, tend to excite appetite and quicken digestion, but large doses to derange. Upon a stomach the seat of a decided catarrh—as is unfortunately often the case in the very circumstance of anæmia calling for chalybeate medication—even comparatively small doses act so unkindly that the astringents have to be set aside and a bland chalybeate substituted. Upon the bowels there is a strong tendency to constipate—so strong that in a considerable course of medication with an astringent iron salt the condition of the bowels must be carefully watched and regulated. In overdose the astringents are irritant poisons—fatal, it may be, in sufficient volume and concentration of solution.

Of these various effects there is seen but a shadow, or not even that, among the bland preparations. Some of the soluble ones may taste a little inky and blacken the teeth, but they do not corrode. Some tendency to constipation may be noted, but far less in degree than with the astringent compounds; while severe irritation of the stomach, poisoning, and local stypticity are entirely wanting. Chalybeates of the bland group that are insoluble of course have practically no taste and absolutely no astringency, and do not blacken the teeth. After being swallowed such preparations are attacked by the free acid of the gastric juice, and being changed thereby to soluble form, are capable of absorption, and thus of full chalybeate constitutional power.

All chalybeates, finally, bland and astringent, blacken the stools by their presence therein in the condition of tannate or sulphide. These derived salts thus discharged in the *dejecta* may, in part, represent a certain portion of the iron dose that has entered the blood, and, after a due career in the circulation, has been excreted, as compounds of the heavy metals largely seem to be, by the bowels, and they in part may be, and undoubtedly are, the simple excess of dose above the limit of absorbability that has been passed along the alimentary canal to the rectum. Of course, the blackening of the stools is of no consequence; the only point is that the patient should be forewarned of the circumstance, lest the unusual color of the fæces excite needless alarm.

Therapeutically, the two main applications of iron compounds are their internal administration for the cure of *anæmia*—in which case the medicine is referred to as a *chalybeate*—and the local use of the ferric styptics for the control of hæmorrhage. There are, however, certain special applications of certain compounds, which will be detailed in due place.

II. Medicinal Preparations of Iron.—The preparations of iron officinal in the U. S. Pharmacopœia, and others of common use (such as, notably, "dialyzed iron"), are derived from the following chemical conditions of the metal: 1. The metal uncombined, in state of powder. 2. The metal in ferrous combination, as, severally, *carbonate, oxalate, lactate, sulphate, iodide*, and *bromide*. 3. The metal in ferric combination, as, severally, *hydroxide* ("hydrated oxide"), *oxychloride, acetate, citrate, ammonio-citrate, potassio-tartrate, ammonio-tartrate, sodio-phosphate* ("phosphate"), *sodio-pyrophosphate* ("pyrophosphate"), *hypophosphite, valerianate, chloride, basic sulphate* ("subsulphate"), *normal sulphate* ("tersulphate"), *ammonio-sulphate*, and *nitrate*. These several compounds will be discussed seriatim, together with the preparations of the U. S. Pharmacopœia derived from each, respectively.

Iron Uncombined.

Metallic iron, in the condition of fine powder, is a valuable chalybeate of the bland variety, being characterized by the qualities of richness, tastelessness, and perfect blandness, combined with promptness and efficiency of medicinal action. Because of these qualities metallic iron is obviously peculiarly adapted to the cases of children generally, or of sensitive stomachs and squeamish palates in patients of any age. Iron in powder is easily obtainable by reducing ferric oxide, heated in a reduction-tube, by a stream of hydrogen gas. The product is officinal in the U. S. Pharmacopœia under the title *Ferrum Reductum*, Reduced Iron, also known as *Quevenne's iron*, and *iron by hydrogen*. Reduced iron, pulverulent at the forming, is subjected to further fine pulverization, and then appears as a soft, smooth, heavy powder of a lustreless, blackish-gray hue. It is, of course, insoluble in neutral fluids, such as water, alcohol, or glycerin, but it dissolves, with effervescence of hydrogen, in dilute acids, by entering into saline combination therewith. Its medicinal activity is determined by this reaction, the acids of the gastric juice acting as solvents. Reduced iron should be kept, well dried, in a tightly stoppered bottle, in order to prevent oxidation, a reaction to which the preparation is very prone. Purity is important, since impure specimens give rise to eructations of disagreeable gas after taking. A good sample is a gray-black, and not deep black, and on treatment with dilute sulphuric acid, warmed, dissolves wholly, and the hydrogen gas evolved is nearly without odor. Black specimens, effervescing but slightly with dilute acids, are spurious.

The dose of reduced iron ranges from 0.20 to 0.40 Gm. (three to six grains), given three times a day. Being tasteless, the preparation may be given, even to children, in powder, or it may be ordered in pill, or, convenient for children, in chocolate lozenge. The administration should be at or about meal-times, so as to secure the prerequisite of presence of acid gastric juice; and if digestion be sluggish, it is well even to add an acid from without, for which purpose the innocent acid of lemonade is perfectly efficient.

Ferrous Carbonate: $FeCO_3$.

Ferrous carbonate, also insoluble, closely resembles reduced iron in combined local blandness and chalybeate efficiency. But as the salt is so unstable as to undergo rapid spontaneous decomposition, unless accorded artificial protection, it is available for prescribing only in certain pharmaceutical preparations wherein sugar is present to afford the needed guarding from change. These preparations, in the U. S. Pharmacopœia, are as follows:

Ferri Carbonas Saccharatus, Saccharated Carbonate of Iron. A solution of ferrous sulphate is added to one of acid sodic carbonate; ferrous carbonate forms as a pale, bluish-white precipitate, which is collected, washed, drained, and, while still moist, mixed with sugar. Then the mixture is dried over a water-bath, and the product is pulverized. Such powder is to be kept in small bulk, in

* Since the putting of this article into type there has been published an important paper by George W. Weld, M.D., D.D.S. (read before the Odontological Society of the State of New York, June, 1886), contending that the corrosion of the teeth producible by iron salts is, on the one hand, largely determined by simple aqueous dilution of the solution of the salt, and is, on the other hand, preventable by substituting for plain water an ordinary simple *elixir* or *syrup*, or even a weak alkaline "*mineral*" *water*, such as Vichy water, in order to obtain the necessary volume of fluid to bear the iron salt in solution for use as a medicine.

tightly stoppered bottles. Saccharated carbonate of iron thus made is a dull, greenish-gray powder of a saccharine and faintly ferruginous taste. It is neutral in reaction; in water only the sugar of its composition dissolves, but in dilute acids the entire powder disappears by chemical conversion of the iron salt, the reaction attended by copious evolution of carbonic dioxide. The preparation, by appropriate tests, should show the "presence of at least fifteen per cent. of ferrous carbonate" (U. S. Ph.). The dose is from 0.30 to 2.00 Gm. (five to thirty grains), three times a day, given in powder or pill. But if the pill form be desired, the following preparation is better, since the carbonate therein is more perfectly preserved from change:

Massa Ferri Carbonatis, Mass of Carbonate of Iron, known also as *Vallet's mass*, or *Vallet's ferruginous pills*. Ferrous carbonate is precipitated as in making the foregoing preparation, but now from a syrupy instead of from a simple aqueous solution of ferrous sulphate, and with syrup instead of plain water used for the washings. The protective influence of sugar is thus availed of from the start, with the result of securing a quite perfect preservation of the ferrous salt. After collection, the precipitate of the carbonate is incorporated with honey and sugar, and the mixture evaporated to the attainment of a certain weight. A greenish-black, soft, pilular mass results, of which it must be remembered that no definite weight of pills is ordered by the Pharmacopœia. The mass contains about half its weight of the iron salt, and may be given in doses, thrice daily, of from 0.20 to 0.30 Gm. (three to five grains), of course in pill.

Ferrous carbonate is the salt of iron present in the following preparations of the U. S. Pharmacopœia, designed to afford the association of iron with myrrh for prescription to women, when anæmia is complicated with menstrual debility or an hysterical tendency:

Pilulæ Ferri Compositæ, Compound Pills of Iron, "Griffith's Pills." These pills are compounded of ferrous sulphate, sodic carbonate, syrup, and myrrh. The usual reaction takes place between the two salts, developing ferrous carbonate. The pills are the nearest representative in the U. S. Pharmacopœia of the so-called *Blaud's ferruginous pills*, of great reputation in France, which are compounded of ferrous sulphate, potassic carbonate, mucilage of tragacanth, and licorice. From two to six of the U. S. Ph. pills may be given at a dose.

Mistura Ferri Composita, Compound Iron Mixture, "Griffith's Mixture." In this mixture, rose-water, flavored with spirit of lavender, and charged with the necessary sugar, holds in suspension myrrh and ferrous carbonate, the latter precipitated by mixture of ferrous sulphate and potassic carbonate. The mixture, despite the sugar present, does not keep well, and should be made fresh on prescription. From 30.00 to 60.00 Gm. (one to two fluid ounces) may be given three times a day.

Lastly, ferrous carbonate is the condition in which iron exists, ordinarily, in chalybeate waters, the salt being held in solution by the excess of carbonic acid with which the waters are charged. The rust-colored deposit which these waters yield is due to the ferric hydroxide resulting from the usual spontaneous decomposition of the carbonate.

Ferrous Oxalate: $FeC_2O_4.H_2O$.

Ferrous oxalate was introduced into medicine some years ago, on the strength of an allegation that it constipates less than the average of chalybeates, but the preparation does not seem to have found much favor with prescribers. The salt is officinal in the U. S. Pharmacopœia as *Ferri Oxalas*, Oxalate of Iron, and occurs as a lemon-yellow crystalline powder, practically insoluble in water. It is fairly bland in local action, but is probably feeble in constitutional power. The dose is quoted at from 0.12 to 0.20 Gm. (two to three grains).

Ferrous Lactate: $Fe(C_3H_5O_3)_2.3H_2O$.

Ferrous lactate, also, was proposed as a medicine from theoretical considerations. On the assumption that many chalybeates become lactates in the stomach through the action of lactic acid in the gastric juice, it was thought that the lactate itself would prove exceptionally easy and quick of absorption. Clinical experience, however, fails to show any decided superiority of the salt. Ferrous lactate is officinal in the U. S. Pharmacopœia under the title *Ferri Lactas*, Lactate of Iron, and presents itself in dingy-green crystalline grains or crusts, sparingly soluble only in cold water (in 40 parts at 15° C.). It is a fairly good chalybeate, but is a trifle irritant as compared with reduced iron or the carbonate. It may be given in doses of from 0.12 to 0.20 Gm. (two or three grains) in pill or mixture.

Ferrous lactate is the salt of iron used in preparing the U. S. Ph. officinal syrup entitled *Syrupus Hypophosphitum cum Ferro*, Syrup of Hypophosphites with Iron. This preparation is simply the syrup of hypophosphites (see Hypophosphites), holding one per cent. of ferrous lactate in solution. The lactate is selected for this application solely for the chemical reason that it does not form a precipitate with the hypophosphites. The syrup may be given in teaspoonful doses three times daily.

Ferrous Sulphate: $FeSO_4.7H_2O$.

Ferrous sulphate is the salt so well known as *green vitriol*, and also in the impure state as *copperas*. Medicinally, it is of triple interest, being efficient as a chalybeate, an astringent, and a disinfectant. The salt can be obtained in the condition of large crystals, crystalline grains, and in the powder that results from depriving the crystals, by efflorescence and heat, of the greater part (six molecules) of their water of crystallization. All three conditions are officinal in the U. S. Ph., the crystalline being entitled *Ferri Sulphas*, Sulphate of Iron; the granular, *Ferri Sulphas Præcipitatus*, Precipitated Sulphate of Iron; and the powder of efflorescence, *Ferri Sulphas Exsiccatus*, Dried Sulphate of Iron. The officinal crystals represent a pure form of the article, such as should alone be used if intended for internal giving. The crystals are large monoclinic prisms of a pale bluish-green color, and effloresce slowly on exposure. The crystalline grains—the "precipitated sulphate" of the U. S. Pharmacopœia, or "granulated sulphate" of the British—result from pouring a solution of ferrous sulphate slowly, with constant stirring, into alcohol. The salt then, being insoluble in alcohol, separates in a crystalline powder, which powder is of the same tint as the ordinary crystals, and also effloresces in dry air. The third, the "dried" form, is obtained by heating the previously effloresced salt so long as it yields water of crystallization, and then pulverizing. It is a fine, grayish-white powder, of which three parts are the equivalent in chalybeate value of five of the crystals.

Ferrous sulphate in all its forms dissolves in water, the two varieties of crystals fully and freely, the effloresced powder more slowly and with a small residue. In alcohol it is insoluble. The salt is, without being truly styptic, yet strongly astringent, capable, in overdose, of producing irritant poisoning. Medicinally, it can be used, in the first place, as a chalybeate, and is important in being the only decidedly astringent chalybeate that can conveniently be given in pill form. When prescribed internally, therefore, it is commonly in such form, and for this the dried sulphate should invariably be selected, since the crystals, by efflorescence, would tend to disintegrate a pill mass. The dose is from 0.05 to 0.10 Gm. (about one or two grains), three times a day. If ordered in solution (in which condition, however, ferrous sulphate presents no particular reason for selection), one of the crystalline forms should be prescribed, and care should be taken to avoid in the solution any of the many chemical incompatibles of the salt. These are catalogued as the alkalies and their carbonates, soaps, lime-water, calcic and basic chlorides, sodic borate and phosphate, silver nitrate, and lead acetate and subacetate.

If, furthermore, the iron sulphate contain any of the hydroxide, as it is very apt to do, anything charged with tannic or gallic acids, as are many vegetable infusions, will make ink on admixture. This reaction can, however, be prevented by the addition of a small quantity of any of the pharmacopœial dilute mineral acids—an addition rarely objectionable under the circumstances in which

the chalybeate is likely to be prescribed. Ten drops of diluted sulphuric acid to a 100 c.c. bottleful (about four fluid ounces) of a half-per-cent. solution of ferrous sulphate and tannic acid has been found competent to prevent the usual precipitation.

Ferrous sulphate can, secondly, in the matter of medicinal application, be used locally for the usual purposes of the mineral astringents, but is rarely so employed, since it presents no advantage over the time-honored salts of silver, copper, zinc, etc. If used, it is to be applied in solution, whereof the strength will range from one-fifth per cent. to about two per cent., according to the sensitiveness of the part; or it may be made into ointment of from one per cent. to three per cent. in strength.

Thirdly, ferrous sulphate has an old-time reputation as a so-called "disinfectant." Recent exact experiments have shown that the salt may fail utterly as a germicide, although capable, in 0.5 per cent. solution, to inhibit temporarily the vital activity of certain microzymes. Limitations in the employment are that the salt, not being volatile, is useless for aerial disinfection, and that, because of its staining, it must not be employed to treat textile fabrics, floors, or walls. But for bed-pans, close stools, sinks, drains, cesspools, privies, etc., ferrous sulphate is unobjectionable, and has the positive advantages of being cheap and odorless. For application, the very cheap commercial copperas answers just as well as the pure pharmacopœial salt. A handful of the crystals may be put into a bed-pan or close stool that is to receive offensive or contagious discharges, or, where a solution is more convenient, this may be made of about fifteen per cent. in strength, and should be used liberally. Where large quantities are wanted, a convenient plan is to suspend a basket holding about sixty pounds of copperas in a barrel of water, from which barrel the solution is dipped out as wanted.

Lastly, concerning ferrous sulphate, it is the iron salt present in the officinal preparation of the U. S. Pharmacopœia entitled *Pilulæ Aloës et Ferri*, Pills of Aloes and Iron. (This preparation, being rather one of aloes than of iron, has been discussed under Aloes, which see.)

Ferrous Iodide: FeI_2.

In the medicinal virtues of ferrous iodide, the iodine, because of its small actual quantity in allowable doses of the compound, plays a very subordinate part. The salt is therefore essentially a chalybeate, with but a dash, so to speak, of iodine virtues. Ferrous iodide is irritant, without being much astringent, and is somewhat remarkable for a tendency, in the matter of action upon the bowels, to rather relax than constipate. It is sometimes also diuretic. As a chalybeate it is efficient, and is most commonly selected in cases where the action of iodine is desired along with that of iron—this rather on theoretical grounds. Chemically, ferrous iodide is, like the carbonate, hopelessly unstable, so that the prescriber is again restricted to special pharmaceutical forms for the administration. These in the U. S. Pharmacopœia are as follows:

Ferri Iodidum Saccharatum, Saccharated Iodide of Iron. Iron wire and iodine are brought together in the presence of water; direct union of the elements results, and the ferrous iodide dissolves as it forms in the water. After the reaction is complete the solution is filtered into a vessel holding an appropriate quantity of sugar of milk. The whole is then evaporated to dryness, mixed with an additional portion of sugar of milk, and the final product pulverized. The preparation is then to be put at once into smallwell-dried bottles, tightly stoppered, and is to be kept in a cool and dark place. This saccharated iodide is a grayish powder, very hygroscopic, because of a strong deliquescent tendency of ferrous iodide, is of a sweetish ferruginous taste, and is wholly soluble in water (in 7 parts at 15° C.). It is partially soluble only in alcohol. It contains twenty per cent. of ferrous iodide, and may be administered in doses, thrice daily, of from 0.12 to 0.30 Gm. (two to five grains).

Syrupus Ferri Iodidi, Syrup of Iodide of Iron. Ferrous iodide is formed in solution exactly as in the foregoing instance, and the solution, with proper manipulations of filtering and straining, is charged with cane-sugar and brought to standard strength by addition of water, such strength being the ten-per-cent. presence of ferrous iodide. When freshly made this syrup is of a clear, pale-green color, is odorless, and of a combined sweet and harshly ferruginous taste. Despite the sugar of its composition, it is very prone to change, in which case the color passes from green to yellow, or even brown. This change mainly occurs through exposure to the oxygen of the atmosphere, the iodide being in part decomposed, the iron suffering oxidation, and the iodine being set free. To prevent change the syrup should be kept in small vials, well stoppered, fully filled, and exposed to diffused daylight. If discoloration have taken place, the original clearness and color can be reproduced by treating the syrup with sodic hyposulphite. A four-per-cent. solution of this salt in water is made, of which one cubic centimetre (fifteen minims) may be added to half a litre (one pint) of discolored syrup. If the discoloration have proceeded to a distinct brown, the dose of hyposulphite solution must be increased. Syrup of iodide of iron is a very frequently used and thoroughly efficient chalybeate. It is given in doses, thrice daily, of from 0.50 to 2.00 Gm. (about from six to thirty minims), which doses, because of the extreme chemical vulnerability of the preparation, should never be made constituent of a composite prescription, but always given alone, simply well diluted with water, and even this dilution done only at the time of administration. The medicine, furthermore, being very liable to attack the teeth,* should be taken through a glass tube and the mouth well rinsed after each dose.

Pilulæ Ferri Iodidi, Pills of Iodide of Iron. Iodine and reduced iron, the latter in slight excess, are made to react in presence of water, until all the iodine is converted into iodide. Then certain proportions of licorice, sugar, extract of licorice and gum arabic are added, and the mixture evaporated to pilular consistence. The mass is next cut up into pills, and, to preserve from the decomposing action of the atmosphere, the individual pills are coated with balsam of tolu dissolved in a little ether. These pills are in imitation of the so-called *Blancard's pills*, and are an efficient representative of the virtues of ferrous iodide. Each pill contains about 0.065 Gm. (one grain) of ferrous iodide, and 0.012 Gm. (one-fifth of a grain) of reduced iron, and from one to two pills constitute a dose.

Ferrous Bromide: $FeBr_2$.

Ferrous bromide, as usual with bromides, is nearly related to the corresponding iodide. It is a good, though somewhat irritant, chalybeate, with a trifling suggestion of the specific virtues of its acid radicle. It has been proposed for special use where an antispasmodic and chalybeate are wanted together. The salt is unstable, like the iodide, and is available only in the pharmacopœial *Syrupus Ferri Bromidi*, Syrup of Bromide of Iron—a syrup which in mode of preparation, appearance, behavior, dose, and method of administration, is a twin of the syrup of the iodide just discussed.

Ferric Hydroxide ("Hydrated Oxide"): $Fe_2(OH)_6$.

Ferric hydroxide is peculiar among the medicinally used *ferric* compounds in being insoluble in water. It furthermore seems to obstinately resist the solvent powers of the alimentary juices, for when taken internally, even in quite large quantities, in anæmia, only very trifling effects follow. Locally, as might be inferred, it is absolutely bland. Because of its feebleness, the hydroxide is practically useless as a chalybeate, and its medicinal value is solely because of a peculiar chemical reaction it affords with arsenical compounds, whereby it becomes a possible chemical antidote in poisoning by arsenicals. The reaction is that ferric hydroxide, when freshly made and still moist, attacks arsenical compounds in solution, and forms out of them a ferrous arseniate which is insoluble, and therefore inert. So long as the arsenical is in solid condition there is no reaction, but as fast as solution takes place the hydroxide, if upon the ground, at-

* See foot-note, p. 223.

tacks the dissolved compound as described. For the reaction in full, the estimate is that twelve parts of antidote are needed for each one part of poison ; but the hydroxide being wholly innocent itself, the practice is to give it freely and frequently so long as symptoms of poisoning persist.

Ferric hydroxide is easily obtainable by treating with an alkali a solution of a ferric salt. The salt is decomposed, its acid radicle going over to the alkali, and its basic precipitating as ferric hydroxide. The precipitate thus occurring is brick-red, pulpy, tasteless, and perfectly bland. Washed and mixed with the proper amount of water, it forms a magma, in which condition it is given in teaspoonful doses every five minutes, in application as antidote to arsenic. Two formulæ for procuring the hydroxide are authorized by the U. S. Pharmacopœia, and since, requiring to be freshly made, it may fall to the lot of the physician to do the preparing of the antidote, the formulæ are here reproduced in full :

Ferri Oxidum Hydratum, Hydrated Oxide of Iron. "Solution of Tersulphate of Iron, ten parts [or three fluidounces] ; * Water of Ammonia, eight parts [or three and a quarter fluidounces] ; Water, a sufficient quantity. To the Water of Ammonia, previously diluted with twenty parts [or eight fluidounces] of cold Water, add, constantly stirring, the solution of Tersulphate of Iron, previously diluted with one hundred parts [or two and a half pints] of cold Water. Pour the whole on a wet muslin strainer, and allow the precipitate to drain ; then return it to the vessel and mix it intimately with one hundred and twenty parts [or three pints] of cold Water. Again drain it on the strainer and repeat the operation. Lastly, mix the precipitate with enough cold Water to make the mixture weigh twenty parts [or eight ounces av.]. When Hydrated Oxide of Iron is to be made in haste for use as an antidote, the washing may be done more quickly, though less perfectly, by pressing the strainer forcibly with the hands until no more liquid passes, and then adding enough Water to make the whole weigh about twenty parts [or eight ounces av.]. *Note.*—The ingredients for preparing Hydrated Oxide of Iron as an antidote should always be kept on hand, in bottles holding, respectively, about ten troy ounces, or three hundred grammes, of solution of Tersulphate of Iron, and about eight troy ounces, or two hundred and forty grammes, of Water of Ammonia" (U. S. Ph.). The objection to this process is the time consumed in the washing and straining, and hence the following preparation, where these procedures are not required, is preferable :

Ferri Oxidum Hydratum cum Magnesia, Hydrated Oxide of Iron with Magnesia. "Solution of Tersulphate of Iron, one thousand grains (65.00 Gm.) ; Magnesia, one hundred and fifty grains (10 Gm.) ; Water, a sufficient quantity. Mix the solution of Tersulphate of Iron with twice its weight of Water, and keep the mixture in a well-stopped bottle. Rub the Magnesia with Water to a smooth and thin mixture, transfer this to a bottle capable of holding thirty-two fluidounces, or about one litre, and fill it up with Water. When the preparation is wanted for use, mix the two liquids by adding the Magnesia mixture, gradually, to the Iron solution, and shake them together until a homogeneous mass results. *Note.*—The diluted solution of Tersulphate of Iron and the mixture of Magnesia with Water should always be kept on hand, ready for immediate use" (U. S. Ph.). In this preparation the hydroxide is precipitated by magnesia in excess. The excess of uncombined magnesia is itself of value for some antidotal power, and the magnesic sulphate resulting from the decomposition of the iron salt is, of course, but Epsom salt, whose purgative effect is also of advantage under the circumstances. There is obviously, therefore, good reason for dispensing with all washing and straining in this case.

Ferric hydroxide, dried, is the compound of iron used in obtaining the two following officinal preparations of the U. S. Pharmacopœia :

Trochisci Ferri, Troches of Iron. These are compounded of ferric hydroxide, dried by heat ; vanilla, sugar, and mucilage of tragacanth. Each lozenge contains 0.33 Gm. (five grains) of dried hydroxide.

Emplastrum Ferri, Iron Plaster. This plaster contains ten per cent. of dried ferric hydroxide in admixture with lead plaster, Canada turpentine, and Burgundy pitch. It is commonly known as *strengthening plaster*, but, of course, any specific virtues due to the iron are imaginary.

"Subcarbonate of iron," an impure hydroxide, is no longer officinal in the U. S. Pharmacopœia.

Ferric Oxychloride : Fe_2Cl_6, $12Fe_2O_3$ to Fe_2Cl_6, $95Fe_2O_3$.

Under the name of *oxychloride* chemists recognize the peculiar varying combination in which iron exists in so-called *dialyzed iron*, which is substantially a simple solution of ferric oxychloride in water. This preparation, although extensively tried, has not been deemed worthy of official recognition by the U. S. Pharmacopœia. As a chalybeate it is bland, but feeble, and as an antidote to arsenic—its other possible application—it is considered inferior to the "hydrated oxide with magnesia," on the score that the insoluble compound that it forms with the arsenical is less stable in the presence of acids.

Dialyzed iron is properly made by precipitating an aqueous solution of ferric chloride with water of ammonia, shaking until the precipitate redissolves (formation of oxychloride), and then dialyzing over water, continuing the dialysis, with frequent changing of the water, so long as any traces of hydrochloric acid appear. The product is then assayed, and, by addition of water, brought to the standard strength of ten per cent. of dry oxychloride. Much of the dialyzed iron in market, however, is not made in this way, but simply by adding fresh ferric hydroxide to a solution of ferric chloride so long as it continues to dissolve, and then filtering. Such preparation is, of course, properly, not *dialyzed* iron at all.

Genuine dialyzed iron is a clear, reddish-brown solution, odorless, practically tasteless, and perfectly bland and innocent. Any decidedly ferruginous twang or stypticity of taste probably means a sham specimen. The true article mixes in all proportions with distilled water, alcohol, glycerin, and simple syrup ; but upon admixture with alkalies, many salts—notably sodic chloride—and most organic matters, it suddenly transforms itself into a soft gelatinous mass, in color and consistency much resembling clotted blood. Such reaction must inevitably ensue on swallowing, and in the colloidal state resulting the iron is incapable of absorption. What of dialyzed iron ever gets access to the blood must, therefore, be through some chemical attack upon it by the alimentary juices, with the development of new and soluble iron compounds. The dose of dialyzed iron must be large if any effect at all is to be expected—at least a teaspoonful of the usual ten-per-cent. solution three times a day. As an antidote to arsenic, teaspoonful doses should be given every five minutes ; and since now gelatinizing is of advantage, some common salt should follow each dose.

Dialyzed iron has been injected hypodermatically, but in some instances with the following of abscess at the site of puncture.

Of the next following salts of iron, the acetate and the various citrates, tartrates, and phosphates have so many features in common as to constitute a distinct subclass. These salts are all soluble in water, bland in action, and of little taste ; they decompose spontaneously in aqueous solution, and, obtained in solid form by evaporation of such solution, present the appearance of thin, shining scales, looking like broken bits of thin, colored gelatin. They are valuable, medicinally, as affording bland chalybeates whose solubility and freedom from taste enable them to be given without objection in fluid form. They are common as the iron basis of many fancy fluid pharmaceutical preparations.

Ferric Acetate : $Fe_2(C_2H_3O_2)_6$.

Acetic acid being, for one of the "organic" kind, a pretty sharp acid, ferric acetate has little of a sharp

* The bracketed equivalents are copied from the U. S. Dispensatory, 15th edition.

quality, is not so purely bland as the citrates and tartrates. It is an excellent chalybeate of its type, and is officinal in the U. S. Pharmacopœia, not in solid form, but in the three following pharmaceutical preparations only:

Liquor Ferri Acetatis, Solution of Acetate of Iron. "An aqueous solution of ferric acetate, containing 33 per cent. of the anhydrous salt" (U. S. Ph.). It is made by saturating glacial acetic acid with freshly precipitated ferric hydroxide, and bringing the solution to standard strength by the addition of water. Like most of the solutions of the present series of compounds, this preparation is a deep reddish-brown fluid of mild ferruginous flavor only. It may be given as a medicine in doses of from 0.12 to 0.65 Gm. (two to ten minims), diluted with at least an equal bulk of aqueous or syrupy vehicle, but is made officinal more as the basis for the next-named preparation.

Tinctura Ferri Acetatis, Tincture of Acetate of Iron. This is a preparation evidently designed in imitation of the "ethereal tincture" of the German Pharmacopœia. It consists of fifty parts of the foregoing solution, with admixture of thirty parts of alcohol and twenty of acetic ether (ethyl acetate). It is a clear, dark fluid, with a decided odor and flavor of acetic ether, mixed with the mildly inky and slightly astringent taste of the iron salt. Dose, anywhere up to a teaspoonful, diluted considerably with water, with which fluid this tincture mixes in all proportions.

Mistura Ferri et Ammonii Acetatis, Mixture of Acetate of Iron and Ammonium, Basham's Mixture. This so-called mixture, really a solution, is an elegant elixir, containing a weak charge of iron in condition of acetate. It is compounded of tincture of chloride of iron (two per cent.), diluted acetic acid, solution of acetate of ammonium, elixir of orange, syrup, and water. By reaction the iron becomes the acetate, and part of the ammonic acetate becomes ammonic chloride, but the greater part of the ammonium salt remains unchanged. The preparation is a beautifully clear, reddish solution of agreeable elixir-taste, with scarcely a trace of ferruginous flavor. For its strength it is efficient, and may be given in doses of a tablespoonful three or four times a day.

Ferric Citrate: $Fe_2(C_6H_5O_7)_2.6H_2O$.

Normal ferric citrate is peculiar, among the group under consideration, in that it dissolves quite slowly, although fully, in cold water, and when once in solution, is comparatively stable. Because of slow solubility it is peculiarly fitted for prescription in pill. The salt is officinal as follows:

Liquor Ferri Citratis, Solution of Citrate of Iron. "An aqueous solution of ferric citrate, containing about 35.5 per cent. of the anhydrous salt" (U. S. Ph.). Fresh and moist ferric hydroxide is mixed with citric acid, and the mixture heated, with stirring, until a solution results. Such solution is then evaporated, at a gentle heat, until reduced to standard strength. In this procedure ferric citrate forms by direct union of the radicles, and dissolves in the water entangled in the magma of the hydroxide. This solution may be used medicinally, given in doses of about 0.65 Gm. (ten minims), corresponding very nearly to 0.32 Gm. (five grains) of the scaled preparation next to be described, but its essential purpose is to afford this same preparation, as follows:

Ferri Citras, Citrate of Iron. The above solution is evaporated, at a temperature not exceeding 60° C. (140° F.), to the consistence of syrup, and the syrupy fluid is then spread upon plates of glass and allowed to dry. A film of solid matter results, which breaks up into transparent garnet-red "scales," constituting the preparation in question. Such scales have the properties of ferric citrate as already described, and may be given in doses, three times daily, of 0.30 Gm. (about five grains), being specially selected for administration in pill.

Ferri et Quininæ Citras, Citrate of Iron and Quinine. The above scaled preparation and quinine—the alkaloid, dried till it ceases to lose weight—in the proportion of eighty-eight of the former to twelve of the latter, are dissolved together in water, and the solution then evaporated for the yielding of scales, as described in the foregoing example. The product is in transparent, reddish or yellowish-brown scales, bitter and mildly ferruginous in taste, and dissolving, as does the simple citrate, completely but slowly in cold water. The scales should be kept in the dark, in well-stopped bottles. They represent the ingredients probably in simple mixture only. The preparation affords a means of giving a chalybeate in conjunction with quinine; convenient where the indication fits the one proportion between the constituents which these scales provide, but otherwise not. The dose averages 0.30 Gm. (about five grains), representing rather less than 0.06 Gm. (one grain) of quinine, given, by natural selection, in pill.

Ammonio-ferric Citrate.

If the officinal solution of citrate of iron be charged with one-fourth of its weight of water of ammonia, and the mixture then evaporated in the usual manner (see *Ferri Citras*, above), scales will be obtained identical in characteristics with the scales of the citrate already described, except that they dissolve rapidly instead of slowly in cold water. Such scales are regarded as representing a double citrate of the two bases, but the exact chemical constitution, as is the case with all the composite scale preparations, is difficult to determine. The preparation is officinal as *Ferri et Ammonii Citras*, Citrate of Iron and Ammonium, and is medicinally convenient as a substitute for the simple citrate when the chalybeate is desired in solution. Pharmaceutically, it is the basis of the following:

Vinum Ferri Citratis, Wine of Citrate of Iron. Four per cent. of the ammonio-citrate scales is dissolved in a mixture of tincture of sweet orange-peel, syrup, and stronger white wine. This wine makes a weak chalybeate elixir, to be given in doses of a teaspoonful, representing about 0.20 Gm. (three grains) of the iron compound.

Liquor Ferri et Quininæ Citratis, Solution of Citrate of Iron and Quinine. Scales of the ammonio-citrate are dissolved in water, and then, severally, citric acid and quinine are added. These latter bodies, combining, form citrate of quinine, so that the pharmaceutical product is a joint solution of ammonio-ferric and quinine citrate. For practical purposes it represents an aqueous solution of the pharmacopœial "citrate of iron and quinine" already described (see above), of the strength that two parts of the solution equal one part of the solid preparation. This solution is convenient when citrate of iron and quinine is wanted for administration in solution. Dose, 0.65 Gm. (ten minims).

Vinum Ferri Amarum, Bitter Wine of Iron. Eight per cent. of the solution of citrate of iron and quinine just described is added to a mixture of tincture of sweet orange-peel, syrup, and stronger white wine. This wine, both in composition and strength, is the exact analogue of the simple wine of the citrate already described, and amounts to a weak chalybeate elixir with the association of a small proportion of quinine. It is given in teaspoonful doses.

Ferri et Strychninæ Citras, Citrate of Iron and Strychnine. A joint solution of ammonio-ferric citrate and strychnine citrate is formed by precisely the same procedure as in making the solution of citrate of iron and quinine (see above), and the solution is then evaporated to the yielding of scales by the usual process (see *Ferri Citras*, above). The composite scales thus derived are indistinguishable in appearance and solubility from those of the plain ammonio-citrate, but declare themselves by their bitter taste. They contain two per cent. of the citrate of strychnine, equivalent to one per cent. of the alkaloid itself. The average dose is about 0.30 Gm. (about five grains), representing 0.003 Gm. of strychnine (one-twentieth of a grain), given in pill, or, having due regard to the bitterness, in solution.

Potassio-ferric Tartrate.

Although not selected for the making of fancy preparations, the potassio-tartrate of iron is a valuable chalybeate,

being of little taste, perfectly bland, and, perhaps because of the potassic tartrate of its composition, less disposed to constipate than the average of iron salts. The salt is officinal under the title of *Ferri et Potassii Tartras*, Tartrate of Iron and Potassium, as a scale preparation, gotten in the usual way (see *Ferri Citras*, above), from a solution resulting from admixture, in water, of fresh ferric hydroxide and acid potassic tartrate ("bitartrate"). The scales are garnet-red, similar in appearance to the scales of the citrate, and probably represent a double tartrate of the contained bases. The preparation is so bland that it may be given in comparatively large doses, ranging from 0.65 to 2.00 Gm. (ten to thirty grains), most naturally in solution.

Ammonio-ferric Tartrate.

Ammonio-ferric tartrate is substantially a duplicate of the potassio-tartrate just described. It occurs in scales, derived from a solution wherein the salt is made by a process analogous to the foregoing. The preparation is officinal as *Ferri et Ammonii Tartras*, Tartrate of Iron and Ammonium, and in appearance, solubility, and dose conforms to the example of the potassio-tartrate.

(Sodio-) Ferric Phosphate.

Considerable confusion is likely to exist now for some years in regard to the phosphate of iron, so called, of the U. S. Pharmacopœia, for the reason that the compound now officinal under that name is a totally different thing from the incumbent of earlier revisions. Formerly the "phosphate" was the slate-colored, insoluble ferroso-ferric phosphate that precipitates from reaction of ferrous sulphate and sodic phosphate in solution; whereas now it is a composite scale preparation—soluble, of course—obtained by the usual process (see *Ferri Citras*, above) out of a joint solution of sodic phosphate and ferric citrate. These scales, entitled *Ferri Phosphas*, Phosphate of Iron, differ from those of the citrates and tartrates in being of a bright-green color instead of garnet-red. They are bland, of little taste, and make an excellent chalybeate of their kind. Dose, from 0.30 to 0.65 Gm. (about from five to ten grains), in pill or solution.

Compounded from these scales and from quinine, strychnine, and phosphoric acid is an officinal syrup entitled *Syrupus Ferri, Quininæ, et Strychninæ Phosphatum*, Syrup of the Phosphates of Iron, Quinine, and Strychnine. The dose is limited by the presence of strychnine to a teaspoonful, which quantity contains about 0.06 Gm. (one grain) each of the iron compound and of quinine, and 0.002 Gm. (one thirty-second of a grain) of strychnine.

(Sodio-) Ferric Pyrophosphate.

Under the title of *Ferri Pyrophosphas*, Pyrophosphate of Iron, a scale preparation is officinal in the U. S. Pharmacopœia, which is a twin brother of the "phosphate" described above, the mode of preparation being identical, except that sodic pyrophosphate is substituted for the ordinary orthophosphate. The present scales are apple-green in color, freely soluble, of little taste, and perfectly bland. They constitute, therefore, a favorite form for giving iron. Chemically, here, as also with the other "phosphate," the exact relation between the two acid and basic radicles represented in the two salts conjoined in the preparation is not known. Dose, from 0.12 to 0.30 Gm. (two to five grains) three times a day, in pill or solution.

Ferric Hypophosphite: $Fe_2(H_2PO_2)_6$.

The salt is officinal as *Ferri Hypophosphis*, Hypophosphite of Iron. It is a grayish-white powder, of little taste, permanent in air, sparingly soluble only in water, and insoluble in alcohol. It was introduced into medicine as a means of combining the virtues of a hypophosphite, as such, with those of iron. From the point of view of its qualities as a chalybeate, it is mild in operation, but feeble in effect. Dose, from 0.30 to 0.65 Gm. (five to ten grains) three times a day, in powder or pill.

Ferric Valerianate: $Fe_2(C_5H_9O_2)_6$.

This salt is officinal as *Ferri Valerianas*, Valerianate of Iron. It occurs as a tile-red, fine powder, insoluble in cold water, decomposed by boiling water, freely soluble in alcohol. It has little taste, but smells faintly of valerianic acid. It is designed to yield the double virtues of a valerianate and a chalybeate, but so far as the latter purpose is concerned it is feeble. Dose, from 0.06 to 0.20 Gm. (one to three grains).

The remainder of the iron salts, again form a natural group. They are all ferric salts of the stronger so-called mineral acids, and are characterized by free solubility in water, and the possession of intensely strong astringent, or even, most of them, styptic, qualities. Their taste is harsh and puckery, with a combined, strong, inky, and acidulous flavor—on the whole, very decidedly disagreeable. With the exception of the ammonio-sulphate, they yield solutions of a color ranging from a golden yellow to a deep orange or reddish brown. They comprise the most powerful representatives, both of the chalybeate and hæmostatic virtues of iron, and in overdose are capable of producing irritant poisoning.

Ferric Chloride: $Fe_2Cl_6.12H_2O$.

Ferric chloride, commonly called, also, *sesquichloride* and *perchloride*, is the most powerful known combined chalybeate and styptic, and has the qualities mentioned above developed to the highest degree. It is officinal as follows:

Ferri Chloridum, Chloride of Iron. Iron wire is treated with dilute hydrochloric acid, whereby ferrous chloride forms, with effervescence of hydrogen. The solution of the ferrous salt is then treated with additional hydrochloric acid, followed by nitric acid, by which means the ferrous is converted into the ferric chloride. The resulting solution, which under the details of the process is hot and concentrated, becomes a crystalline mass on cooling. Ferric chloride, thus derived, is in lumps of crystalline texture, orange-yellow in color, without smell, but of a harsh, chalybeate, and sour taste. It deliquesces with great readiness, dissolves freely in water, and is also soluble in alcohol and ether. The salt is convenient for ordering in solution for styptic purposes; it is a powerful but harsh hæmostatic. Applied to a bleeding part it forms a reddish, slimy, pultaceous slough with the coagulable elements of the part—an operation entailing a good deal of irritation. Because of such irritation, the so-called subsulphate of iron, which irritates much less, while hardly inferior in styptic power, is commonly preferred. If the chloride be used, and the bleeding area is small, as in the case of hæmorrhage from a tooth-socket, a concentrated application may be made by taking a drop or two of a deliquesced sample, or by mixing a small fragment of the solid stuff into a paste with a very little water. For more extended applications, solutions may be ordered of strengths ranging from five to twenty per cent. or so. Strong solutions, even so strong as fifty per cent., have been used to inject varicose aneurisms, but in some instances with fatal consequences.

Liquor Ferri Chloridi, Solution of Chloride of Iron. This is an original solution wherein ferric chloride is formed exactly as described above. It contains 37.8 per cent. of anhydrous salt, with some free hydrochloric acid, and is a dark-reddish fluid. It may be used as a strong solution for styptic purposes, or in doses of a few drops, very largely diluted, as a chalybeate medicine, but its essential purpose is to afford the preparation next to be described.

Tinctura Ferri Chloridi, Tincture of Chloride of Iron, "Muriated Tincture of Iron." The above solution of the chloride is mixed with alcohol in the proportion of thirty-five parts of the former to sixty-five of the latter, and the mixture is ordered to be kept before dispensing for at least three months. The object of the latter requirement is to afford time for a slow reaction that takes place between the free hydrochloric acid derived from the original iron solution and the alcohol, whereby an ethereal body is formed, which imparts the peculiar flavor to the tincture, and is commonly accredited—perhaps justly—with having something to do with the somewhat peculiar effects of this preparation in medicine. Tincture of chloride of iron is a clear, yellowish-brown fluid, of a

rough, astringent, acid, and ferruginous taste. It is decomposed by alkalies, alkaline earths and their carbonates, astringent vegetable infusions, and mucilage of acacia. In its effects it is strong enough in ferric chloride to be locally styptic, and, if swallowed in considerable quantity, to set up irritant poisoning. Its almost sole application is as a chalybeate medicine, in which rôle it is unsurpassed. Besides being of avail in anæmia and chlorosis, it often shows marked power in the individual diseases—acute tonsillitis, diphtheria, scarlet fever, and erysipelas—if given boldly in full doses. Moderate doses, furthermore, will often seem to oppose, so far as medicines can, the progress of kidney-degeneration. In prescribing this tincture it must be borne in mind that it is a powerful medicine; that even in moderate doses it tends to blacken, if not to injure, the teeth, to irritate the stomach and constipate the bowels, while in large doses it may cause, in addition, headache and urino-genital irritation. Yet in the acute diseases mentioned above, in which large doses are so commonly prescribed, the medicine is remarkably well borne. The dose of the tincture ranges from about 1.00 Gm. (fifteen minims) three times a day, in anæmia, to a teaspoonful, or more even, every hour or two, in the grave diseases requiring full dosage. The medicine must be well diluted, at least fourfold, with water,* and the addition of some glycerine—about twenty-five per cent. of the potion as swallowed—remarkably disguises the harsh, unpleasant taste of the draught without affecting its efficiency. The dose should be sucked through a glass tube and the mouth well rinsed after the swallowing, and the administration should preferably be a while after meals rather than before.

Basic Ferric Sulphate: $Fe_4O(SO_4)_5$.

This salt closely resembles the chloride in intense styptic quality, yet differs from the same in the advantageous way of being decidedly less irritant. It is officinal in the U. S. Pharmacopœia only in an original solution, as follows:

Liquor Ferri Subsulphatis, Solution of Subsulphate of Iron, "Monsel's Solution." Ferrous sulphate in a fixed proportion is added to a mixture in fixed proportion of sulphuric and nitric acids, at the boiling temperature. Conversion of the ferrous to the ferric sulphate results, but, by virtue of the proportion of sulphuric acid taken, it is here the basic salt that forms. After the reaction is complete the solution is brought, by the addition of distilled water, to the standard strength—the strength of 43.7 per cent. of the iron salt. This solution is a deep ruby-red fluid, analogous in all general characteristics to the solution of the chloride. It is especially intended and used as a hæmostatic, and of the substances commonly used for the medicinal control of bleeding is the most efficient.

Solution of the subsulphate may be applied clear to parts within reach; may be swallowed in ten-drop doses, well diluted, in hæmatemesis, and inhaled in atomized spray, in a two-per-cent. aqueous dilution, in hæmoptysis. The solution is also, of course, a possible chalybeate medicine, but, having no especial advantage over the tincture of the chloride, is rarely used for its medical virtues. The dose would be ten drops or so, largely diluted.

Normal Ferric Sulphate: $Fe_2(SO_4)_3$.

The normal sulphate differs, medicinally, from the basic only in being more irritant in its local effects. It is officinal in the U. S. Pharmacopœia for pharmaceutical purposes only, and in the following original solution:

Liquor Ferri Tersulphatis, Solution of Tersulphate of Iron. This solution is made in precisely the same manner as the foregoing, only with such proportion of the ingredients as to yield the normal, instead of the basic, sulphate. It is of the strength of 28.7 per cent. of the iron salt. It is important as the preparation out of which ferric hydroxide is made, both when this compound is called for as an antidote to arsenic, and also when it is required for the making of the scale preparations of iron, as already seen. This solution is efficient as a chalybeate, and as a hæmostatic, but, having no advantages for such application, is rarely so used.

Ferric Nitrate: $Fe_2(NO_3)_6$.

This salt is substantially a duplicate of its congeners just considered. It has no peculiarities to call for it as an additional chalybeate to the many already described. Like the ferric sulphates, it is officinal in the U. S. Pharmacopœia only in an original solution, as follows:

Liquor Ferri Nitratis, Solution of Nitrate of Iron. Fresh and moist ferric hydroxide is treated with nitric acid, and the resulting solution of ferric nitrate is brought to standard strength (six per cent. of anhydrous salt) by the addition of distilled water. The solution is a clear, amber or reddish-colored liquid, sour and styptic in taste. It has been given as a chalybeate, in doses of from ten to twenty-five drops.

Ammonio-ferric Sulphate: $Fe_2(NH_4)_2(SO_4)_4 . 24H_2O$.

The salt is officinal under the title *Ferri et Ammonii Sulphas,* Sulphate of Iron and Ammonium, "Iron Alum." It has the chemical structure and, physiologically, the peculiar strong astringency, without excessive irritation, of the true alums. It occurs in octahedral crystals of a delicate lilac or violet color, which dissolve freely in water, but are insoluble in alcohol. It is used in strong solution, as a styptic, or internally, as a combined astringent and chalybeate, in cases of anæmia with passive discharges. Dose, from 0.30 to 0.65 Gm. (five to ten grains) three times a day.

III. General Therapeutics of Iron Compounds.—Excepting certain special applications of individual compounds, the therapeutics of iron comprises the internal use, for the cure of anæmic conditions, and the local employment, for astringent or styptic purpose. Concerning the two applications, the following practical points are to be made:

Anæmia.—1. Except in pernicious anæmia, iron proves so serviceable that, given an anæmic state, the medicine is commonly held to be indicated, unless there be either fever or a tendency to active hæmorrhage—conditions apt to be aggravated by iron. 2. In the matter of choice of preparations, in general, the astringent chalybeates are more powerful than the bland, but yet it will be wiser to try the latter kind first if either the stomach be over-irritable, the bowels strongly prone to constipation, the teeth fragile, and the patient of careless habits; or if, as with children, the disagreeable taste of the astringent preparations be particularly obnoxious. On the other hand, the astringent chalybeates are especially advantageous when the appetite is poor and yet the stomach not unduly sensitive, or when there is general laxity of tissue, or a tendency to passive fluxes or hæmorrhages. 3. In particular, concerning the preparations, if an astringent be wanted, the tincture of the chloride answers every purpose as a fluid form, and the dried sulphate (ferrous) as one for giving in solid form in pill. If a bland compound be required, there may be prescribed, in powder, reduced iron and the saccharated carbonate; in pill, reduced iron, mass of the carbonate, and the citrate; and in solution, the potassio-tartrate or the pyrophosphate, with the others of the scaled preparations as substitutes. For the rest, the various compound salts and the fancy pharmaceutical preparations are often convenient, but are never indispensable. 4. The frequency of dosage is most conveniently fixed at three times a day, and the doses, as already given, are intended for such frequency. But in exceptional uses of iron, as of the tincture of the chloride in diphtheria, the frequency will be far different—according to the severity of the case, even to hourly administration, day and night. 5. The timing of the doses is best arranged to be at meal-hours, the administration to be rather after than before eating. This certainly with the astringent chalybeates, but with the very bland the rule need not be insisted on.

To Arrest Hæmorrhage.—1. In general, it must be remembered that arterial hæmorrhage belongs by right to the domain of surgery, and that medicinal hæmostatics are

* See foot-note, *ante*, p. 223.

only proper when the vessel is either too small for mechanical measures, or is inaccessible. This rule needs especial observance in connection with the iron styptics, for if they fail to stop the bleeding the surgical search for the bleeding-point, through the indiscriminately slough-obscured tissue resulting from the styptic application, is made exasperatingly difficult. Furthermore, this same slough caused by the styptic seriously interferes with speedy healing of the wound. 2. Of the styptic preparations the officinal solution of the subsulphate is generally the best, because the least irritant; but if extreme power be required, and the area to be subjected to the application be small, a drop or two of the deliquesced chloride may be allowed.

The individualized applications of iron compounds are of the hydroxide, as an antidote to arsenic; of ferrous sulphate, as a disinfectant; of the tincture of the chloride as a medicine of peculiar virtues; of the solution of the "tersulphate," for purposes of pharmacy, and of the ammonio-sulphate, as a pure astringent.

Edward Curtis.

[1] Willcocks: The Practitioner, vol. xxxi., pp. 7 and 94.

IRONDALE SPRING. *Location,* Irondale Furnace; *Post-office,* Independence, Preston County, W. Va.

ACCESS.—By Baltimore & Ohio Railroad to Grafton six miles, or Independence three miles from the spring, thence by carriage.

ANALYSIS (Professor Breneman).—One gallon contains:

	Grains.
Chloride of sodium	1.361
Sulphate of potassium	6.764
Sulphate of calcium	60.417
Sulphate of magnesium	4.335
Sulphate of aluminum	11.337
Sulphate of manganese	2.857
Silicic acid	1.445
Vegetable and volatile substances	8.239
Sulphate of iron, cobalt, and free nitric acid	traces
	96.755

THERAPEUTIC PROPERTIES.—This water contains an astonishing amount of lime sulphate, and a very appreciable proportion of manganese. From very reliable sources I learn that it is of great value in chronic catarrh of the stomach and intestines.

There is no accommodation at present at the spring for visitors. The water is bottled and shipped throughout the country. There are several strong sulphur springs on the grounds. *Geo. B. Fowler.*

IRON, POISONING BY. Metallic iron and those compounds of iron which are insoluble in water are not poisons. The soluble salts, however, though not active poisons, have an irritant action, and are capable of destroying life when taken in large doses and in a concentrated state. The continued administration of medicinal doses even produces, after a time, decided gastric disturbance. It is probable that all the soluble preparations may act as irritant poisons when administered in large doses. The most important, however, from a medico-legal point of view, are ferrous sulphate (copperas, green vitriol), ferric chloride (perchloride), which is used medicinally in the form of tincture, and the tannate in the form of ink.

The salts of iron are rarely administered for criminal purposes. Most of the reported cases of poisoning have been the result of accident, or of the use of the sulphate or the tincture of the chloride of iron in attempts at abortion. The symptoms which follow the administration of large doses of the preparations named are essentially similar to those produced by the irritants in general. There is a styptic taste in the mouth, nausea, vomiting, pain in the stomach and intestines, and purging. The evacuations are black, owing to the conversion of the iron salt into a tannate by the tannic acid of the food, or into a sulphide by the sulphuretted hydrogen resulting from decomposition in the intestines. Irritation of the genito-urinary passages is sometimes observed. The tincture of the chloride of iron is more corrosive in its action than the sulphate, by reason, apparently, of the free hydrochloric acid which it frequently contains. Its injection into the cavities of the body, for the purpose of arresting hæmorrhage, has proved fatal.

The amount of any of the preparations of iron required to endanger life is not accurately known, but appears to be quite large. In most of the cases in which the sulphate has been taken, the amount was unknown. Recovery has taken place after a dose of thirty-one grams (1 ounce) of the sulphate (Christison). A case is reported in which forty-eight grams (1.5 fluidounce) of the tincture of the chloride of iron proved fatal in about five weeks (Christison). Recovery has taken place after doses of thirty-two to ninety-six grams of this preparation. The favorable issue is probably due, in many cases, to the early occurrence of vomiting.

The results of experiments on animals are not uniform. Gmelin states that 7.7 grams (2 drachms) of the sulphate of iron administered to dogs by the mouth caused vomiting only; that 2.6 grams (40 grains) administered to rabbits produced no injury; and that 1.3 gram (20 grains) injected into the veins of a dog produced no symptom whatever. Dr. Smith, however, states that 7.7 grams will prove fatal to dogs when administered by the mouth or applied to a wound.

The post-mortem appearances are those of a simple irritant, and are confined, so far as has been observed, to the stomach and upper part of the intestines. In acute cases the contents of the intestines will probably present a black appearance, owing to the presence of the tannate or the sulphide of iron.

Iron is eliminated to some extent in the urine. A small amount only is absorbed in any event, the greater part escaping in an insoluble form with the fæces.

Treatment consists in the use of the stomach-pump, or of emetics if necessary. Magnesia or dilute solutions of alkaline carbonates should be administered as antidotes, and these should be followed by demulcents.

William B. Hills.

ISCHL is one of the most frequented spas of Austria, being often visited by the emperor and many of the nobility. It is situated in the centre of the "Salzkammergut," in a beautiful Alpine valley, at the point where the little river Traun empties into the Ischl. Its elevation is about fifteen hundred feet above the level of the sea. It possesses a mild, moist climate, the average temperature from May to the end of September being 61° F. Showers are very frequent during the early part of the summer, but the sandy soil absorbs the water quickly, so that the walking is seldom rendered unpleasant. In the neighborhood of the salt-works the atmosphere is very similar to that of the seashore.

The salt-hills of Ischl and Hallstädt contain natural salt veins, consisting of saliferous clay mixed with gypsum, resting upon limestone seamed with marl and clay. Pure water is conveyed hither in pipes, becomes saturated with the salts, and the brine then flows into the salt-houses in Ischl and Ebensee. The following is the composition of the brines coming from the Ischler and Hallstädter hills, calculated in parts per 1,000:

	Hallstädter brine.	Ischler brine.
Sodium chloride	255.26	236.13
Magnesium chloride	4.94	0.93
Magnesium bromide	0.16	0.06
Potassium sulphate	4.62	0.69
Sodium sulphate	3.25	3.84
Calcium sulphate	3.40	3.84
Total solids	271.63	245.49

The baths are prepared by mixing these two brines in the proportion of one-third Ischl and two-thirds Hallstädt, to which is often added a decoction of pine-needles. There are also facilities for mud-baths and for inhalations of salt spray.

There are also several mineral springs at Ischl. The following is their composition, computed in parts per 1,000:

	Schwefel-quelle.	Klebelsberg-quelle.	Maria-Louisen-quelle.
Calcium carbonate	0.092	0.015	0.197
Magnesium carbonate	....	0.011	0.010
Calcium sulphate	0.459	0.244	0.078
Potassium sulphate	0.024	0.018	....
Sodium sulphate	4.125	0.274	0.071
Magnesium chloride	0.732	0.406	0.098
Sodium chloride	17.005	5.118	5.580
Total solids	22.437	6.086	6.034

In the sulphur spring (Schwefelquelle) there is a considerable amount of free sulphuretted hydrogen gas.

In addition to its being a fashionable watering-place, Ischl enjoys a well-deserved reputation as a health-resort. The climate and the waters combine to render it admirably adapted for the treatment of nervous and irritable individuals, and of those debilitated by disease, dissipation, or too rapid growth. Children suffering from scrofulous troubles are often much benefited by a visit to the place. Inhalations of the brine spray are used in the treatment of chronic catarrhal affections of the air-passages, and many female disorders are relieved by brine-baths.

The accommodations at Ischl, at least up to within a few years, have been rather inadequate for the large number of visitors; the cost of living is in consequence somewhat high. There are many private villas in the place, and the scenery in the valley is charming. *T. L. S.*

ISINGLASS (*Ichthyocolla*, U. S. Ph.; *Ichthyocolle, ou Colle de poisson*, Codex Med.). The swimming-bladder of *Acipenser Huso* Linn., and of other species of *Acipenser* (Class, Pisces; Order, *Sturiones*).

Isinglass is prepared from these fishes by opening and removing their air-reservoirs, splitting or slicing them, macerating them to remove their mucous surfaces, and drying; the tripe-like membranes are then rolled in cylinders (staple isinglass), folded in folios (leaf or book isinglass), or done in some other more or less fantastic shape. Its ordinary form in this market is that of "sheets," of irregular size and shape; it is stiff, of a horny or pearly appearance, whitish color, semi-transparent, somewhat iridescent, tough, and flexible. No taste or odor. Isinglass almost completely dissolves in boiling water, the structural character disappearing completely. Besides this, which is generally known as Russian Isinglass, and is in this country very expensive, the swimming-bladders of the hake and other fishes are manufactured into sheets and ribbons of thin, light-brownish, gelatinous tissue, known as American Isinglass. Its properties are similar to those of the above, but it is darker colored and not so absolutely free from taste and odor.

Isinglass consists of about ninety-nine per cent. of pure, white, fine, and adhesive gelatine, which forms a jelly with twenty-four parts of water. Its medical and dietetic qualities are identical with those of other pure gelatines, which are frequently substituted for it. Its only medical use is in the preparation of Water plasters (Isinglass plasters, Court plasters, etc.), which are essentially silk or linen cloth, varnished with a thin layer of the Isinglass, and backed with some waterproof varnish, like that of Gutta-percha or Tolu. *W. P. Bolles.*

ISSUES. This name is given to artificial ulcers induced for therapeutic purposes. They may be established by any of the following methods: 1. The actual cautery. 2. The potential cautery. 3. The knife. 4. Setons.

1. The actual cautery is mentioned first, because it seems preferable in every way. It is more rapid and more easily applied than the potential cautery, and certainly is not more painful. If cocaine be used hypodermatically, the subsequent burning is easily borne. Paquelin's cautery is best for this purpose, because the degree of temperature is here most easily controlled. A glass rod or a poker sufficiently heated will, however, accomplish the same result. A white heat is least painful, but causes a wide-spread scorching of the surrounding skin, unless this is protected, as by a layer of wet cotton.

Under the head of the actual cautery should be included the moxa. This was originally used by the Chinese, who burn upon the skin a cone made of the leaves of *Artemisia moxa*. Any easily inflammable substance may, however, be used instead of this, and the term has been employed to designate actual cautery in any form. It possesses no advantage over the metallic cautery; and the heat of the latter can be so regulated as to produce as deep and as wide-spreading an eschar as that which results from the use of the moxa. For further information regarding moxæ, see Vol. II., article Cauterization.

2. By the potential cautery we mean caustics; substances escharotic otherwise than by heat. Of these there are many—acids and alkalies being, however, most frequently employed. The nitric-acid issue is a favorite one. A piece of cardboard is soaked in the acid and then applied to the skin and kept there for ten minutes, or longer if a deep ulcer is desired. After removal, any excess of acid is neutralized by washing the spot with an alkali.

Of alkalies, a piece of caustic potash strapped upon the part, or—less spreading—Vienna paste, or London paste, is much used. Vienna paste is composed of equal parts of caustic potash and quicklime; London paste, of equal parts of caustic soda and quicklime. They may be left on from a few minutes to several hours, according to the severity of effect desired. The skin surrounding the part which it is desired to cauterize should be protected by a circle of adhesive plaster; and, finally, it is well to wash the slough with vinegar, in order to neutralize the remaining alkali.

The slough produced by either the actual or the potential cautery is often at least double the size of the surface area of the caustic employed; with spreading caustics it may be more. To aid the separation of the eschar, poultices are of value. Thereafter the question arises how best to prevent cicatrization of the ulcer. If the ulcer has been produced by (3) simply removing a portion of the skin and subcutaneous tissue with a knife, this indication is somewhat difficult of accomplishment. A sore the result of a cautery is more easily kept open.

In any case, the application of some irritant is always needed. Simple adhesive plaster is sometimes sufficient to maintain a discharge. Sometimes an irritating ointment, such as the officinal Ung. Mezerii, is required. An ounce of lard rubbed up with five to ten drops of nitric acid may be applied for this purpose. Instead of these, some hard foreign body may be kept, by means of adhesive plaster, in contact with the raw surface. A glass bead, a small pebble, a dried pea, are examples of such substances.

4. Regarding setons: These are strips or strands of some more or less irritating fabric—as rubber, silk, linen, etc.—drawn through artificial fistulæ and kept there to maintain the issue. When the discharge is insufficient, the seton is to be coated with some irritant.

In inserting a seton, the incision through which the foreign substance is drawn should be rather deeply subcutaneous, in order that the skin above the tract may not be cut off from its vascular supply, and slough in consequence. It is almost unnecessary to say that a seton should neither be placed close to important vessels or nerves, nor over a bone lying close to the surface.

The therapeutic uses of issues may be divided into two heads: First, as irritants; second, as emunctories.

In very many chronic diseases the maintenance of persistent counter-irritation by an issue at some point—generally over the organ affected—is of established value, and is to be recommended after less unpleasant means have failed to give relief. The issue seems to act as a permanent balance-wheel to the nervous mechanism. It cannot be denied, for example, that there are cases of organic heart-disease in which the subject is free from annoyance, the viscus performing its work regularly as long as an issue is kept open upon the præcordium; but whenever the ulcer is allowed to heal, the heart begins to become irregular in rhythm, and to fail in the performance of its function.

It seems to the writer that there is some truth in the old idea of "constitutional ulcers," and that it is not invariably wise to heal a chronic sore. The writer has noted a few instances in which the patient stated that an

ulcer of many years' duration was accompanied by excellent health; while the occasional healing of the same was always coexistent with nervous disorders.

Setons are often used as a means of local irritation when it is desired to excite adhesive inflammation, as, for instance, when a thread is passed through a hydrocele, bursa, or ranula.

Regarding the second therapeutic indication mentioned, the probability of the escape of a *materies morbi* through this channel is, perhaps, to be taken with reserve. Nevertheless, as an example of such a belief, we may refer to the explanation of the cure of syphilis, by the now obsolete method of syphilization, given by Gross ("System of Surgery," vol. i., p. 298): "It was shown, long before the downfall of syphilization, as a practical matter, by Mr. Lee, of London, and Dr. Lindwurm, of Munich, that the alleged beneficial effects of the operation were due, not to any specific influence of the inoculation, but to the *depurating* effects of the resulting ulcers upon the system, the continuous suppuration serving as a salutary drain."

Robert H. M. Dawbarn.

IVANDA is a small spa in the southern part of Hungary, not far from Temesvar, in which there is a spring of strong bitter water. The following is the composition of the water per thousand parts:

Sodium sulphate	15.279
Potassium sulphate	0.014
Calcium sulphate	3.385
Calcium carbonate	0.029
Magnesium carbonate	0.027
Nitrates	0.372
Magnesium chloride	0.902
Ferrous phosphate	0.001
Silicic acid	0.023
Organic and extractive matters, etc.	1.420
Total solid constituents	21.452

T. L. S.

IVY, GROUND (*Lierre terrestre,* Codex Med. Gill.), *Nepeta Glechoma* Benth., *Glechoma hederacea* Linn., order *Labiatæ,* is a small, creeping herb, with opposite, petiolate, round-kidney-shaped leaves, with crenate margins and few-flowered axillary clusters of smallish, light-blue, labiate flowers. It is a native of Europe, but has been introduced here, and grows spontaneously in rich waste places.

Ground Ivy has an unpleasant, bitterish odor and a bitter, aromatic taste. The whole herb, taken at the time of flowering, is collected as a domestic remedy, and is reported to be "stimulant, diuretic, antiscorbutic, and tonic." It undoubtedly is, like horehound and boneset, a stimulant bitter tonic. Dose, three or four grammes in infusion (ʒ ss. ad ʒ j.).

Allied Plants.—The only other species of this genus suitable for mention here is *Nepeta Cataria* Linn., the common catnip, or catmint, which is much more fragrant and less bitter than the Ground Ivy. For the order, see Peppermint.

Allied Drugs.—Aromatic bitters in general.

W. P. Bolles.

IVY, POISON (*Rhus Toxicodendron,* U. S. Ph.; "Poison Oak"). The leaves of this plant, *Rhus Toxicodendron* Linn. (including *Rhus radicans* Linn.), order *Anacardiaceæ,* have always been recognized by the Pharmacopœias of this country as a medicine, from that of the Massachusetts Medical Society of 1809 to the last revision of the United States Pharmacopœia. In previous editions of this work the small esteem in which it was held is shown by its presence in the "secondary" instead of the principal lists; but in the last one the consolidation of the secondary list with the primary one removes this distinction. It is, however, so useless as a medicine that it might better have been removed altogether from that work.

The plant has, however, considerable medical importance as the cause of many cases annually of well-marked and troublesome cutaneous poisoning. And being a common American plant, everyone should be familiar with its appearance. It is a woody vine, or shrub, of varied habit and size, from a slender, close-clinging, ivy-like vine, running over rocks and fences or along the ground, to a bushy, branching shrub a metre or so high. There are all forms of intermediate gradations. It sometimes climbs and covers good-sized trees. The running branches develop innumerable rootlets, by which they adhere most tenaciously to the surfaces on which they lie. The stems are tough, the bark is gray or brownish-gray, with corky spots; on old stems it is quite thick and rough. The leaves are long-petioled, deciduous, three-parted, smooth, and shining—at least above—of a rather light but variable bright-green color; leaflets ovate or rhombic ovate, generally pointed, with entire or variously notched or cut borders. In the early fall these leaves change to most brilliant yellow, orange, and scarlet hues, and are conspicuous and tempting objects to persons collecting autumn leaves for house decoration. Most of the cases of ivy-poisoning, occurring in cities and towns, are contracted by gathering and pressing them for this purpose. Upon being broken, the fresh leaves and the stem exude a rather thick, yellowish, resinous, milky juice, which inspissates and blackens upon exposure. Dr. Jacob Bigelow found it capable of making an indelible ink, which nothing but boiling ether will remove. Poison Ivy blossoms in early summer and ripens its fruit in early autumn; flowers minute, in loose, axillary panicles, polygamous or diœcious, regular, greenish-white; sepals, petals, and stamens, five each; ovary single, one-celled and one-seeded; styles two. Fruit as large as pepper or cubeb, round, clayey- or bluish-white, one-seeded.

It is a native of Canada and most parts of the United States. Several different varieties, and even species, have been made of its different forms without any permanent or substantial grounds. It appears to have had considerable employment from fifty to a hundred years ago in this country, and even a little in England, but may be regarded now as obsolete among regular practitioners. The leaves are the part used; they probably lose most of their activity in drying.

The dried leaves, besides the characters given above as to shape and appearance, are thin and papery, very brittle, inodorous, and pale green. Their taste is astringent and slightly acrid. The active principle of Poison Ivy is contained in the milk-juice, and is said by Professor Maisch to be a volatile, vesicating, peculiar acid—*toxicodendric acid*—resembling formic and acetic acid in some of its reactions. It also contains a *tannic acid* of the green-precipitating variety, besides wax, mucilage, and other common vegetable products.

Action and Use.—The latter can be pretty quickly dismissed; it probably has none. A previous generation has employed it in paralysis, nocturnal incontinence, and in some skin diseases. It may occasion irritation of the stomach. The interest of its action is mainly confined to the skin, which it inflames to a violent degree, producing an intensely uncomfortable acute eczema. This may be produced by direct contact, as where the patient has been handling the plant either by gathering leaves or tearing up the stems, or indirectly, as by fumes given off in the sunlight or when it is being burned in the stove or fireplace. It may even be received from a person suffering from it, as when two boys sleep in the same bed one of whom has rhus-poisoning. The other will be very apt to take it. The first symptoms may begin a few hours after the contact, or they may be delayed one or two days. There is a great difference in the susceptibility of different persons; some are apparently proof against it.

Ivy-poisoning first appears as minute, clustered, itching papules, which soon become surrounded by a bright erythema, in part produced by the inevitable scratching. The papules have by the next day become minute, deep-seated, eczematous blisters. For several days this appearance is not much changed, nor are the burning and itching diminished. Then the surface of the blisters gets rubbed off, the watery exudation moistens the surface affected, and often spreads the disease to other parts. The blisters finally become pustular, and then crusts and scabs cover the surface. The first appearance is always local, and if contracted in any of the usual ways is on

either the hands or wrists or the face. In the latter situation the swelling is always great, the eyelids generally becoming completely closed by it. From the hands it easily extends to the breasts or male genitals, on the latter of which the burning is exceedingly hard to bear; occasionally it becomes universal. The course of the affection in a single spot covers usually five or six days, but it may often spread over twice that time when different parts of the body are successively invaded. It heals without a scar, but is a little apt to return on successive summers. Numerous remedies and specifics are in use against it; still its course, when fairly begun, is not often really aborted. But the usual surgical means of preventing scratching and the rubbing of the poison from one part of the body to another, as well as protecting the denuded surface by means of vaseline or some simple fat or oil, will appreciably shorten it. Alkaline washes—limewater, black wash, lead wash, etc.—are among the best. As the eczema dries away, zinc ointment should take the place of the washes. Oxalic acid in saturated solution is recommended to be painted on the affected parts; very great relief and shortening of the disease is claimed for it. Of course, when one suspects having touched Poison Ivy, he should carefully wash the suspected parts; any obstinately remaining resinous spots may be removed with a litle ether on a sponge or cloth. Internal medicines, further than salines, refrigerants, or anodynes, are not indicated.

The dose of Poison Ivy is from one-half to two grams (grs. viij. ad grs. xxx.). A fluid extract—not officinal—may be employed if desired.

Allied Plants.—The relations of the present *Rhus* are full of interest; no less than three other species in the United States are equally or more poisonous. *Rhus venenata* D. C., poison sumach, is far more deleterious, poisoning nearly everyone who comes in contact with it, and many who merely stand near it. It is a large, handsome shrub, looking like a small ailanthus-tree, only more graceful. Its leaves are pinnate, like those of other sumachs. *R. pumila* Michx., of the Southern States, and *R. diversiloba*, of California, are also poisonous. Then come the non-poisonous sumachs, which are simply astringent and acid—*R. glabra* Linn., and *R. copallina* Linn. Of foreign *Rhoes* of economic value there are many. *R. cotinus* Linn., whose wood yields "fustic" yellow; *R. succedanea* Linn., the source of "Japanese wax"; *R. vernicifera* Linn., which yields the wonderful Japan varnish, or lacquer; *R. metopium* Linn., of the West Indies, is a source of "hog gum;" and *R. semiolata* Murray, of Asia, has remarkable galls, which are a source of tannin. Besides these, several species supply an abundant and cheap astringent bark for tanning. Cashew nuts and Chian turpentine, the latter derived from the *Pistacia Terebinthus*, are products of the order.

Allied Drugs.—Numerous vesicating substances, especially Cardol, Chrysarobin, Tartar Emetic, Cantharides, Mustard, etc. *W. P. Bolles.*

IWONICZ is situated in Galicia, in a pleasant, well-wooded valley at the foot-hills of the Carpathian Mountains, lying at an elevation of nearly one thousand feet above the sea. There are several springs, two containing iodine and bromine, one iron, and another sulphur. The following is the composition of the two most important springs. In one thousand parts of water are contained:

	Karlsquelle.	Amalienquelle.
Sodium iodide	0.0164	0.015
Sodium bromide	0.023	0.022
Sodium chloride	8.376	7.884
Potassium chloride	0.095	0.091
Sodium carbonate	1.783	1.624
Magnesium carbonate	0.085	0.076
Calcium carbonate	0.242	0.225
Ferrous carbonate	0.004	0.019
Manganous carbonate	0.007	0.007
Lithium carbonate	0.0108	0.010
Barytum carbonate	0.019	0.018
Strontium carbonate	0.0009	0.0008
Silicic acid	0.018	0.019
Organic and extractive matters	0.0158	0.0148
Total solid constituents	10.6959	10.0256

The gases are carbonic acid, light carburetted hydrogen, and nitrogen. The iron spring (Eisenquelle) contains 0.033 parts per thousand of ferrous bicarbonate and 0.005 of manganous bicarbonate. In the sulphur spring (Schwefelquelle) are 0.016 parts of sodium sulphate and 0.002 of sodium hyposulphite. Iwonicz is frequented chiefly by sufferers from scrofula, gout, and uterine disorders. The marsh-gas arising from extensive marshes in the vicinity is conducted by pipes to a building, where it is used for inhalations. *T. L. S.*

JABORANDI (*Pilocarpus*, U. S. Ph.). *Pilocarpus pennatifolius* Lemaire, order *Rutaceæ*, is an erect, moderately branched shrub, from one to three metres (three to ten feet) in height, with very large pinnate leaves of from

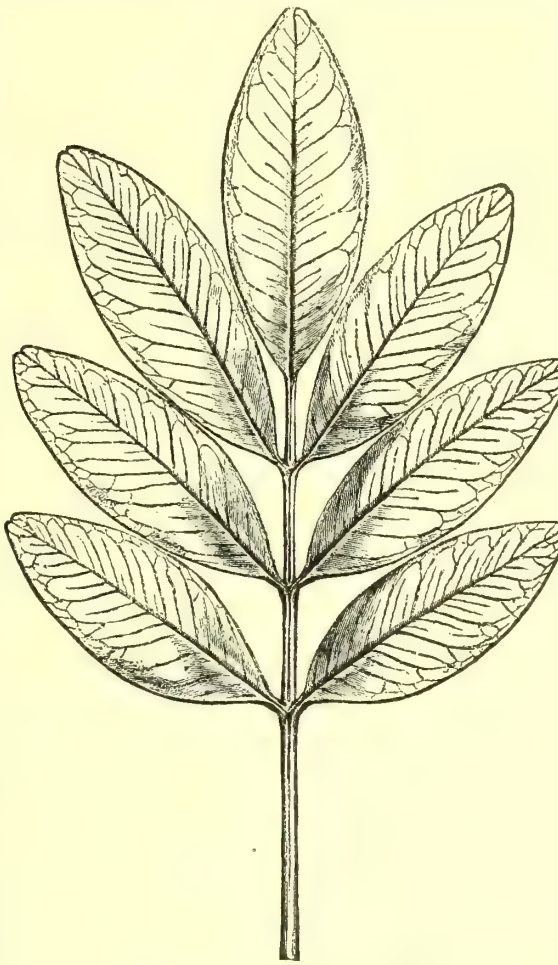

Fig. 1890.—Leaf of Jaborandi. (Baillon.)

five to eleven leaflets. The flowers are small, regular, and completely pentamerous, arranged along a very long and narrow, spike-like raceme. Fruit of five carpels, one or two of which are usually suppressed. The plant is a native of Brazil and probably of other parts of South America.

The name Jaborandi is applied by the Indians of South America to several sudorific drugs besides this one, especially to one or two *Piperaceæ* and *Scrophulariaceæ* of local reputation; but in our commerce it is entirely restricted to the plant above described, or to some closely connected species. Jaborandi is comparatively new to civilized medicine, having been first sent to Europe in 1874 by Dr. Coutinho, of Pernambuco. The identification of the plant

as the probable source of the drug did not take place until some years later. Even now it is to be questioned whether at least some Jaborandi is not the product of a different species.

The large alternate leaves of *P. pinnatifolius* have long petioles and rather distant leaflets. These are in from two to five pairs, with an odd one at the end. The following description, from the Pharmacopœia, refers of course to dried leaflets: "About four inches (ten centimetres) long, short-stalked, oval or ovate-oblong, entire and slightly revolute at the margin, obtuse and emarginate, unequal at the base, coriaceous, pellucid-punctate, mostly smooth; when bruised, slightly aromatic; somewhat pungent and bitter." They have conspicuous midribs, and are sometimes pubescent beneath.

Jaborandi owes its activity to one or two alkaloids, the most important of which, *pilocarpine,* was discovered by Hardy in 1875. It is an amorphous or scarcely crystalline substance, easily soluble in the usual pharmaceutical liquids. It is somewhat deliquescent. The sulphate, nitrate, and hydrochlorate are crystalline, the two latter official and much employed forms. The second alkaloid, *jaborine,* which is possibly a decomposition product or derivative of the other, is an amorphous, strongly basic substance, with a physiological action like atropine. Jaborandi also contains an *essential oil.*

Action and Use.—The peculiar property of jaborandi of stimulating the secretion of saliva and perspiration is due to its pilocarpine. Pilocarpine appears both to directly stimulate the peripheral extremities of the secreting nerves, and also to stimulate the centres governing these nerves. The result, at least, of its administration is an increase of secretion from the mouth and skin which may become enormous. Several pounds of water may be exuded from the skin, or one or two pints of saliva secreted in a few hours after taking it. The result appears to be sometimes vicarious, either the skin or the mouth responding to it mostly, while the other may be comparatively unaffected; more often both yield to its action. The sweating of pilocarpus is one of debility and languor. It is not accompanied by a feeling of warmth or comfort at first, but is cold, clammy, and disagreeable from the start; chilly sensations and chills frequently accompany it, and depression sometimes amounting to collapse may follow it. It depresses the heart's action. Many other effects of this alkaloid on various organs have been observed, but as they do not bear upon its usefulness in medicine they are not mentioned. The use of pilocarpine is a logical outgrowth from its action upon the sweat-glands, and is almost entirely confined to producing copious perspiration. Chronic nephritis with dropsy, or with suppression of urine, for instance, calls for it. Its action upon the uterus, bladder, and intestines does not appear to be well defined. It is somewhat antagonistic to both atropine and morphine.

Administration.—The alkaloid salts have wholly replaced the crude drug in medical practice, and, as they are tolerably uniform, should do so completely. The nitrate is official in Great Britain, the hydrochlorate in this country. Both are easily soluble. Dose, from one-half to one centigram, preferably given subcutaneously.

Allied Plants.—The genus is a large one, mostly inhabitants of South America. Several of them probably might be made sources of jaborandi. For the order see Rue.

Allied Drugs.—Various aromatic sudorifics associated with heat and moisture. Warm baths, vapor and water, and the perspiration of the collapsed stage of antimonial impression may be compared with. As a sialagogue compare Pellitory. *W. P. Bolles.*

JACKSONVILLE. [For detailed explanation of the accompanying chart, and for directions as to the best method of using it, see Climate.]

The city of Jacksonville, Fla., stands upon the left bank of the St. John's River, at a distance of about twenty-five miles from its mouth. The population of the town in 1880, according to the United States Census Report, was 7,650. Jacksonville is one of the favorite winter-resorts of Florida, and its hotel accommodations are ample.

According to "Appleton's Handbook of Winter Resorts" (1884–85): "A system of water-works, draining excellent water from artesian wells, and also a system of sewerage, have been constructed; and the unwholesome marshy ground west of the city has been thoroughly drained and laid out in gardens."

In addition to the data presented in the accompanying chart, a few others, together with brief comments upon the climate of the St. John's River section of the State, will be found given in the general article entitled "Florida." *H. R.*

Climate of Jacksonville, Fla.—Latitude 30° 20′, *Longitude* 81° 39′.—*Period of Observations, October* 1, 1871, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 5 *feet.*

	A			AA	B		C	D	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature.
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January ...	50.7	62.7	54.1	55.8	62.5	50.6	64.9	48.2	80.0	72.0	45.0	24.0	19	26
February ..	52.8	65.1	56.5	58.1	64.3	53.9	68.5	52.1	83.0	74.0	42.0	32.0	22	22
March	57.5	70.0	60.6	62.7	68.1	59.0	73.6	56.2	88.0	79.0	47.0	31.0	24	23
April.......	65.6	75.8	65.7	69.0	71.2	66.5	78.4	61.5	91.0	85.0	56.0	37.0	20	24
May........	73.7	80.6	71.7	75.3	78.2	73.8	83.4	67.3	98.5	89.5	64.0	48.0	18	16
June	79.8	85.2	77.3	80.7	82.5	79.4	88.6	73.0	100.5	95.0	70.0	62.0	16	24
July........	81.3	87.2	79.1	82.5	84.7	80.0	91.6	75.5	104.0	93.0	75.0	68.0	20	24
August.....	79.6	85.8	77.7	81.0	82.8	78.8	89.8	74.8	100.0	94.5	74.0	66.0	23	25
September .	75.0	82.6	75.8	77.8	79.9	76.3	85.4	71.6	98.0	90.0	70.0	56.0	24	20
October	66.3	75.7	68.1	70.0	74.7	65.7	79.5	66.2	92.0	83.0	59.0	40.0	21	28
November..	57.2	67.9	60.0	61.7	65.6	56.5	70.9	55.3	84.0	80.0	43.0	30.0	20	23
December..	50.4	62.7	54.3	55.8	62.2	48.4	66.4	49.4	81.0	71.0	41.0	19.0	31	25
Spring	......	......	......	69.0	71.6	67.4	......	......	......	......	......	......	......	......
Summer ...	......	......	......	81.4	82.6	79.8	......	......	......	......	......	......	......	......
Autumn ...	......	......	......	69.8	73.4	67.3	......	......	......	......	......	......	......	......
Winter.....	......	......	......	56.5	61.9	52.7	......	......	......	......	......	......	......	......
Year	......	......	......	69.2	70.6	67.1	......	......	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind, in miles, per hour.
						Inches.	From	
January....	56.0	74.6	12.8	9.0	21.8	3.28	N.E.	5.8
February ..	51.0	70.6	10.4	9.7	20.1	3.45	N.E.	6.9
March	57.0	65.4	13.0	12.7	25.7	3.13	S.W.	7.9
April.......	54.0	67.2	11.8	12.0	23.8	3.55	S.W.	7.6
May........	50.5	68.3	14.8	10.7	25.5	3.80	N.E.	6.7
June.......	38.5	70.8	14.7	8.8	23.5	5.39	S.W.	6.9
July	32.4	71.8	16.0	10.2	26.2	5.18	S.W.	6.3
August	34.0	74.4	16.3	9.7	26.0	7.19	N.E.	6.2
September.	42.0	77.4	12.5	8.9	21.4	7.27	N.E.	6.4
October....	52.0	74.9	11.3	11.5	22.8	6.60	N.E.	6.9
November.	54.0	74.8	11.1	9.8	20.9	2.95	N.E.	6.5
December .	62.0	73.7	12.0	10.2	22.2	2.89	N.E.	6.0
Spring.....	67.5	67.0	39.6	35.4	75.0	10.48	S.W.	7.4
Summer ...	42.0	72.3	47.0	28.7	75.7	17.76	S.W.	6.5
Autumn ...	68.0	72.0	34.9	30.2	65.1	16.82	N.E.	6.6
Winter.....	64.0	73.0	35.2	28.9	64.1	9.62	N.E.	6.2
Year.......	85.0	72.0	156.7	123.2	279.9	54.68	N.E.	6.7

JALAP. (Jalapa, U. S. Ph.; Br. Ph.; *Tubera Jalapæ* Ph. G.; *Jalap tubéreux ou officinal,* Codex Med.). The

Fig. 1891.—Jalap Plant. (Baillon.)

tubers of *Exogonium purga* Benth. (*Ipomea Purga* Hayne, etc.). Order, *Convolvulaceæ.*

This is a perennial, herbaceous twiner with numerous slender, twisted and furrowed, moderately-branched stems, arising from ovoid, or pear-shaped, or subspherical tubers, these often clustered or tangled together by roots and rhizomes. Leaves alternate, long-petioled, large, cordate, or with pointed lobes, or sagittate entire, smooth, thin. Flowers pentamerous, large and handsome, salver-shaped, with rose-colored corolla. The whole plant above ground recalls in habit, leaf, and flower, the "morning glories," to which it is in all respects a near relative. It is a native of Eastern and Central Mexico, from one town of which it has received its name (Jalapa). Jalap was known and brought to Europe as early as the beginning of the sixteenth century, if not before. Its botanical source was demonstrated first in the early part of this century, by Dr. Coxe, of Philadelphia.

The collection of Jalap is carried on without much regard to season. The tubercles are dug up and dried by artificial heat, the smaller ones entire, the larger scored (usually lengthwise), or split or sliced. The heat employed is often sufficient to break the starch-granules, and

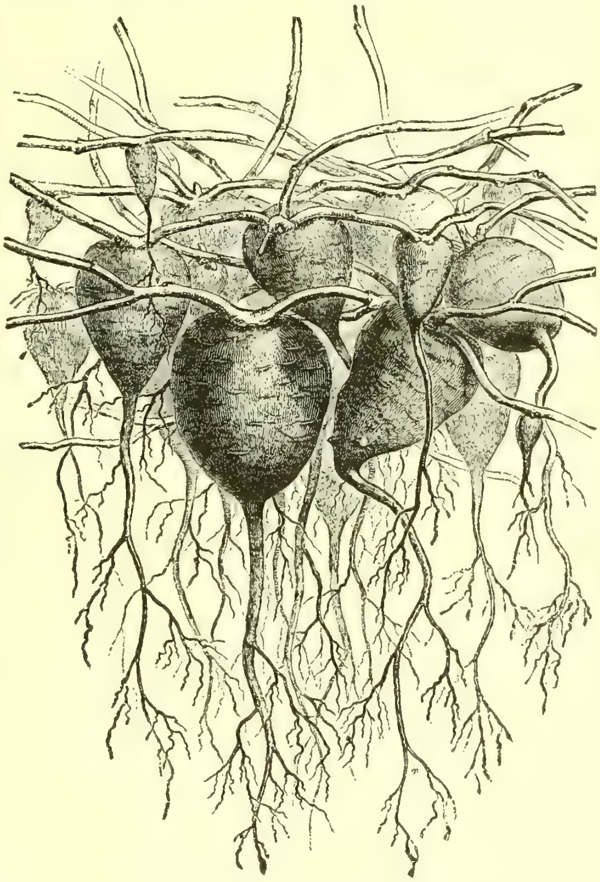

Fig. 1892.—Jalap Roots. (Baillon.)

so, when dry, the texture is often horny, on account of the hardened starch mucilage, irrespectively of the amount of resin contained. The cultivation of Jalap is in its infancy.

Description.—The Jalap turbercles are in part described above; the Pharmacopœial description is as follows: "Napiform, pyriform, or oblong, varying in size; the larger roots incised, more or less wrinkled, dark brown, with lighter colored spots, and short, transverse ridges; hard, compact, internally pale grayish-brown, with numerous concentric circles composed of small resin-cells; fracture resinous, not fibrous; odor slight, but peculiar, smoky and sweetish; taste sweetish and acrid." Jalap should contain not less than twelve per cent. of resin, of which at least ten should be soluble in ether. The dried tubercles of the market have shrunken and shrivelled

considerably, and are much more acute than represented in the above cut of living roots.

Composition.—Jalap contains a large amount of sugar and of starch, substances which contribute to its taste and texture, but have no further value. Its active principle is a composite *resin*, the quantity of which determines the value of the article. There should be from twelve to eighteen per cent. This crude substance consists of two resins, both of which are soluble in alcohol, but only one of which (but that the most considerable) is also soluble in ether; the insoluble portion is called *convolvulin*.* The crude resin of Jalap is officinal (*Resina Jalapæ*, U. S. Ph.), and in common use.

Action and Use.—Jalap is one of a considerable number of active cathartics whose energy either lies in their resinous contents or is at present inseparable from them. Of these, however, it is one of the mildest and most uniform, and probably, in consequence, one of the most frequently employed. In full doses it produces free hydragogue catharsis, with more or less, but generally not excessive, nausea and griping.

It has been traditionally used as an adjuvant to calomel for several generations. Of its action upon other organs than the stomach and bowels but little can be said. It is doubtful whether much of it is absorbed.

Administration. — Powdered jalap is frequently given, and contains so little woody tissue that it is a very good form. Dose, from half to one gramme; as a drastic purgative sometimes twice as much. The resin is about five or six times as active as the crude powder. There is also an abstract made in the usual way (*Abstractum Jalapæ*, U. S. Ph.); strength, $\frac{2}{1}$. The compound powder of jalap (Pulvis Jalapæ Compositus) is frequently of use in anasarca, when a combined effect upon the kidneys and intestines is desired. It consists of jalap, 35 parts, and cream of tartar, 65. Dose, a gramme or so twice a day.

Allied Plants.—Several other *Ipomeæ* and convolvuli have purgative qualities. *Ipomea simulans* Hanbury, of Mexico, is the source of a jalap called Tampico Jalap. It resembles true jalap quite closely. *I. orizabensis* Ledanois, is the source of Orizaba or Lightwoody Jalap, much larger than the tubers of *I.* (*Exogonium*) *purga*. *I. nil* Roth Kaladana, of India, furnishes purgative seeds. *I. Turpethum* R. Br., of India, has a purgative scammony-like root. *I. Jalapa* Pursh, of the Southern States, is also a false jalap. The tubers are not always resinous and cathartic, since *I. Batatos* Lam., so closely related botanically, is the edible "sweet potato." Convolvulus Scammonia Linn. is the source of scammony, and *Ipomea purpurea* Lam., is the favorite morning glory; and there are a variety of other species in cultivation for ornament.

Allied Drugs. — Besides those mentioned above, Podophyllum, Gamboge, and Elaterium. Less nearly, Croton-oil, Colocynth, Senna, etc.; Hellebore, Leptandra, Wahoo, etc. *W. P. Bolles.*

JAMAICA DOGWOOD. This is a large West Indian tree, *Piscidia Erythrina*, order *Leguminosæ*, yielding a valuable wood, whose bark has been used for many years to poison fish in the streams by dragging it, after it has been crushed and prepared, through the water in baskets. The fish are stupefied by it and easily caught. It has also had for a long time a local reputation for relieving pain, especially toothache, which was treated by applying it, or some preparation of it, locally, in the carious cavity. Its introduction to the medical profession of this country is of the last ten years or so, since when it has been used for various conditions, generally including pain of so-called nervous character, with uncertain, but on the whole favorable, results. Judging from the published reports it has been more used in the Western and Southern States than in the East.

The bark is usually in quills, but may be thicker and "flat;" it is in brittle pieces from five to ten or more centimetres long, and from one to three millimetres in thickness, grayish or yellowish-brown, often mottled externally, dark-brown and fibrous next the wood. Upon fracture the central tissue is seen to be dark-green. Odor narcotic, taste disagreeable and acrid. The accounts of its chemistry are not yet satisfactory—a glucoside and a probable "alkaloid" mentioned by one investigator need further isolation; the yellow "resinoid" powder, *piscidin*, is probably a composite substance.

Jamaica dogwood appears to have decided narcotic powers over most animals, it certainly does in a marked degree upon fish, as its original use shows, and in case of frogs and several kinds of higher animals it exhibits the same qualities. The following summary is from experiments by A. C. Nagle: "It is a narcotic to higher as well as lower animals. It dilates the pupil, it causes an increase in the respiration, followed by a sudden decrease. Produces salivation and profound diaphoresis. Reduces the action of the heart, producing general paralysis and death by asphyxia. It has little effect upon the temperature."[1] In therapeutics it has been tried with good results in neuralgia, headache, hysteria, "phantom tumor," "nervousness," melancholia, prodromic labor pains, neurasthenic pains of various places, etc., as well as for some inflammatory pains, such as iritis. It also serves a good purpose as a hypnotic in restlessness, alcoholic wakefulness, etc. For certainty and uniformity of action it is not to be compared with opium or chloral, and disagreeable feelings sometimes follow its administration as well as that of these more powerful drugs; but it undoubtedly has some value, and may prove much better when its hypnotic principle is separated, and its dose is better established.

From two to four cubic centimetres (2 to 4 c.c. = ʒ ss. ad ʒ j.) is the usual dose.

Allied Plants.—Another species of *Piscidia*, *P. Carthagruensis* Linn., of Brazil, has similar qualities; for the order see Senna.

Allied Drugs.—Opium, Lupulin, Cannabis indica, Lettuce (Lactucarium), Viburnum, etc. *W. P. Bolles.*

[1] Proc. Am. Pharmaceutical Association, 1881, p. 221.

JASMINE, YELLOW (*Gelsemium*, U. S. Ph.; Br. Ph.; Codex Med.). *Gelsemium sempervirens* Artois (*G. nitidum* Michx. Order, *Loganiaceæ*. The Yellow Jessamine (rather than Jasmine) of the Southern States is a pretty climbing shrub, with a large woody rhizome, and numerous fine roots, and slender, smooth, climbing, and tendril-bearing, purplish stems. It has shining, dark green, glossy, lanceolate, entire, evergreen leaves, growing opposite to each other, and bearing in their axes solitary or clustered flowers. The latter are large, sweet-scented, bright yellow, and slightly irregular. Calyx small, of five pointed sepals; corolla funnel-shaped, with a slightly oblique, five-lobed border; stamens five, perigynous. Fruit an oblong, flattened, drooping pod; seeds margined. This is one of the most attractive flowers in the Southern States. It grows abundantly from Virginia southward, in woods, and mounts to the top of tall trees. The flowers, which appear in the spring, load the air with their sweet odor.

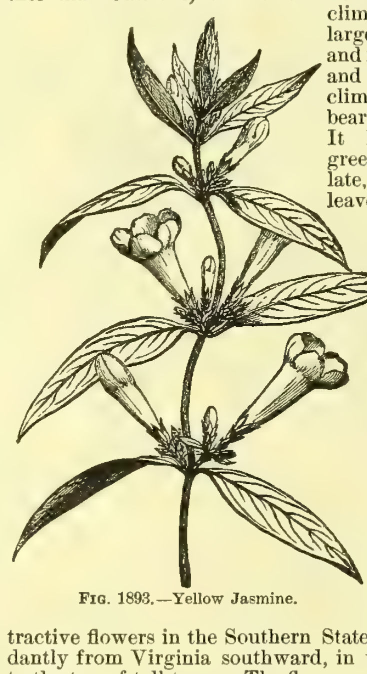

Fig. 1893.—Yellow Jasmine.

* The term *Jalapin*, as at present used, is misleading, as it designates a resin found in Scammony, and not in Jalap.

Of course, so conspicuous a plant was early noticed; in fact, it was carried to England as an ornament in the first half of the seventeenth century. Its poisonous properties were also early known, but its medicinal employment is of rather recent date. The rhizome and roots are used; their bark contains most of the active principles. The rhizome may be two or three centimetres (one inch) or more in diameter, the roots generally much smaller, and all alike in appearance. Bark thin, yellowish-brown externally, with dull purplish stripes, closely adherent to the light-yellow, tough, porous wood. Roots without pith. The inner bark is composed of silky liber cells, the fracture of the wood is tough and splintery. Gelsemium is generally cut in shortish pieces, and the larger stems are split. Odor slight, taste bitter.

Composition.—Its activity is due to a peculiar alkaloid, *Gelseminine*, discovered by Kallock in 1855, and afterward verified by Wormley and others. It is an amorphous, yellowish-white, bitter, very poisonous powder, soluble in ether and chloroform, less so in alcohol and water. Associated with this is what Wormley called *gelseminic acid*, but which has all the properties of *æsculin*, and is generally conceded to be such. Besides these are oil, resin, coloring matter, and other commonly distributed substances.

Action and Use.—The active principle, *gelseminine*, represents the entire value of the drug; the gelseminic acid (æsculin) is also said to be poisonous, but possibly because it was not entirely freed from traces of the alkaloid. Gelsemium is an active paralyzing poison, capable of killing both animals and man in small doses, expending its action upon the nervous system. It does not affect consciousness until near the end of fatal cases; sometimes, but not always, it produces convulsions, pretty well ascertained to be of spinal origin. Reflex excitability is increased at first, afterward diminished, while its paralyzing effect upon the motor columns steadily increases to the end. Death takes place by asphyxia. The following symptoms are observed in man after moderate doses: languor, debility, dizziness, disturbances of vision, dilatation of the pupils, paresis, especially of the flexors of the arm, and drowsiness. The poison appears to be quickly absorbed and promptly eliminated. This root, whose medicinal value is said to have been discovered by accident, has been considerably used in the South and West in the treatment of malarial and other fevers. It is occasionally employed in pneumonia and pleurisy, as a depressant; in asthma, whooping-cough, etc., it is also indicated, but is not, in the East at least, very frequently given. In neuralgias it holds, perhaps, its place most firmly. It has also been useful when dilatation of the pupil is desirable, differing from atropine in the transientness of its effects.

Administration.—From twenty-five to thirty centigrams (0.25 to 0.30 Gm. = gr. iv. ad gr. v.) of the powder, or the same measures of the fluid extract (*Extractum Gelsemii Fluidum*, U. S. Ph.) are suitable doses. Of the tincture one gramme.

Allied Drugs.—Veratrum Viride, Aconite.

Allied Plants.—See Nux Vomica. *W. P. Bolles.*

JAUNDICE (Fr. *jaunisse*, jaundice, from Fr. *jaune*, yellow); Icterus (L., from Gr. ἴκτερος, a yellow bird, or ἴκτις, a yellow-eyed or yellow-breasted bird or animal). A term originally applied to the yellow discoloration of the skin and conjunctivæ, presumed to be due to the deposition of bile-pigment in the tissues. It now also designates a like discoloration of the tissues and fluids attributed to blood-pigment. This distinction is expressed by the terms hepatogenous and hæmatogenous jaundice.

The original significance of the word was thus extended for the following reasons:

First.—The occurrence of cases of yellow skin, tissues, and urine, the latter containing bile-pigment, in the absence of the usual causes of jaundice, and with the presence of bile in the intestine.

Second.—The absence of bile-acids in the urine of such cases.

Third.—The effect of the introduction into the circulation of certain agents which destroyed red blood-corpuscles and produced bile-pigment in the urine, with the frequent association of a cutaneous jaundice. Also the experiments of Tarchanow and Ponfick, who found that bile-pigment, as well as blood-pigment, appeared in the urine after the injection of hæmoglobin into the blood.

Fourth.—The probable identity of bile-pigment and blood-pigment.

Hammarsten has found that the coloring matter of human bile is composed of bilirubin and urobilin or hydrobilirubin. The former is considered by most authorities to be derived from the same source (hæmoglobin) as hæmatoidin, if not actually identical with the latter.

Two compounds are included under this term, one of which is identical in crystalline form and chemical reactions with bilirubin. Maly has obtained urobilin from bilirubin, and Hoppe-Seyler has shown that the former may be obtained from blood-pigment.

Two varieties of jaundice are thus to be recognized. The one, a cholæmia, results from the presence in the blood of the acids and pigments of the bile. This is the cholæmic or hepatogenous jaundice.

The other is the hæmatogenous, anhepatogenous, or hæmoglobinæmic jaundice, due to the presence of free blood-pigment in the blood. According to Ponfick (*Berliner Klinische Wochenschrift*, 1883, xx., 389), this may be as granular, disintegrated red blood-corpuscles, or as dissolved hæmoglobin. The granules are accumulated in the spleen and become decomposed within a few weeks. The dissolved hæmoglobin is eliminated by the liver with the copious secretion of a very dark bile. If more than one-sixtieth of the hæmoglobin of the body is set free, the excess over this quantity is eliminated by the kidneys, a hæmoglobinuria resulting. The cutaneous jaundice is the result of the transformation in the blood of hæmoglobin into bilirubin. It occurs when more blood-pigment is set free than can be disposed of by the spleen, liver, and kidneys.

The most important constituents of the bile are the acids (taurocholic and glycocholic), and the pigment. It is probable that under normal circumstances both are produced in the liver, and that the acids always arise in this gland. Neither of these is found normally in the blood of the portal vein or hepatic artery, the circulation of which, especially of the former, is necessary for the production of bile. Stein ("Arch. f. Exp. Path. und Pharm.," 1885, xix., 59) has most recently shown that, when the supply of blood to the liver (of pigeons) is completely cut off, there is no accumulation of biliary constituents in the tissues and fluids of the body. Hence, there can be no jaundice from a suppression of secretion.

The flow of bile into the ducts, according to Heidenhain, is mainly dependent upon the activity of the liver-cells. The mechanism of their action is unknown. But within certain limits the rapidity of the flow corresponds to that of the blood-current within the liver. The flow is accelerated by respiratory efforts, especially by the action of the diaphragm. At the best it is under a low degree of pressure, although this is higher than that of the portal blood-current.

If the bile is prevented from leaving the liver by a ligature of the common duct, within three or four days the skin becomes stained yellow and the urine contains the acids and pigment of the bile. After this operation, the lymph in the thoracic duct holds bile-acids and pigment at a time when neither is to be found in the blood. It is thus obvious that the absorption of the bile from the ducts takes place through the lymphatics, and not through the blood-vessels.

Under normal circumstances, when the bile is poured into the intestine, its chief functions are considered to be the promotion of the digestion of fats and the retardation of putrefaction. Whatever portion is not decomposed in the intestine is probably absorbed, as the fæces contain neither bile-acids nor bilirubin, although hydrobilirubin is present in them. The absorbed constituents of the bile are probably again eliminated from the liver as bile, or form a part of the urinary constituents, bile-acids having been found in normal urine.

Causes of Jaundice.—The causes of jaundice are those producing:

1. Stagnation of the bile, either from obstruction, enfeebled diaphragmatic action, or excessive secretion.
2. Lowered vascular tension, inducing a reversed current.
3. Increased intestinal absorption.
4. Prevented renal elimination.
5. Excessive destruction of red blood-corpuscles, hæmoglobinæmia.

The first four give rise to a jaundice from the absorption of bile. The result is a cholæmia, the presence of bile in the blood. The fifth includes what is called a hæmatogenous jaundice. Several of these causes may act in common.

The following table illustrates in detail the above causes:

Jaundice from Stagnation.

- Obstruction of the common bile-duct or cystic duct.
  - Internal causes.
    - Inflammation.
      - Catarrhal.
      - Suppurative.
    - Stenosis.
      - Congenital.
      - Acquired.
    - Tumors.
      - Fibroma.
      - Lipoma.
      - Cancer.
    - Foreign body.
      - Gall-stone.
      - Cherry stone.
      - Parasite.
        - Distomum.
        - Lumbricus.
        - Echinococcus.
  - External causes.
    - Cicatricial tissue.
      - Duodenal ulcer.
      - Peripylephlebitis.
    - Fæcal retention.
    - Aneurism.
      - Hepatic artery.
      - Mesenteric artery.
    - Tumors.
      - Duodenum.
      - Colon.
      - Pancreas.
      - Portal lymph-glands.
      - Omentum, mesentery.
      - Kidney.
      - Uterus, including pregnancy.
      - Ovary.
- Obstruction of the hepatic ducts.
  - Internal causes.
    - Inflammation.
      - Catarrhal.
      - Suppurative.
    - Calculi, concretions, inspissated bile.
  - External causes.
    - Fatty infiltration.
    - Chronic passive congestion.
    - Parenchymatous degeneration.
    - Inflammation of liver.
      - Suppurative.
      - Chronic interstitial.
    - Tumors.

Enfeebled Diaphragmatic Action.
- Pneumonia.
- Pulmonary œdema.
- Atelectasis.
- Hæmorrhagic infarction.
- Pleurisy.
- Hydrothorax.
- Perihepatitis.

Excessive Secretion.
- Poisoning.
  - Toluylendiamin.
  - Arseniuretted hydrogen and other agents producing hæmoglobinæmia.
- Disturbed innervation. [Menstrual jaundice (?)]

Lowered Vascular Tension.

Obstruction or obliteration of the portal vein.
Hæmorrhage from the portal radicles.
Open ductus venosus (icterus neonatorum).
Feeble heart and deficient cutaneous anastomoses of umbilical vein.
Vaso-motor disturbance (?) (Menstrual and emotional jaundice.)

Increased Intestinal Absorption.

Polycholia.
Absence of putrefaction.
Starvation.
} Icterus neonatorum.

Prevented Renal Elimination.

Icterus neonatorum.
Jaundice with urinary suppression.

Excessive Destruction of Red Blood-corpuscles, Hæmoglobinæmia.

Acute yellow atrophy.
Paroxysmal hæmoglobinuria.
Pernicious anæmia.
Infectious diseases.
Burns.
Internal hæmorrhage.
Transfusion with lamb's blood.
- Poisons.
  - Snake.
  - Fish.
  - Mushroom.
  - Phosphorus.
  - Arsenic.
  - Chloral.
  - Chlorate of potash.

Results.—Jaundice, whether cholæmic or hæmoglobinæmic, is usually associated with a variety of symptoms. Only those will be especially considered which result from the abnormal distribution of bile-pigment and bile-acids on the one hand, and an excess of free blood-pigment on the other.

Pigmentation.—The skin and conjunctivæ are yellow, varying from a pale lemon-color to a dark yellowish-brown. Shades of green and blue may be recognized, and a bronzed appearance may suggest the existence of Addison's disease. These differences in color depend upon the quantity of pigment in the tissues, the thickness of the superjacent epithelium, and the quantity and quality of the blood in the superficial vessels. The pigment in the skin is deposited in the deeper layers of the epidermis, and is uniformly distributed throughout the surface of the body. The connective tissues are stained, also muscle, bone, blood-vessels, and glandular structures, especially the liver and kidneys. Nerve-tissue, cartilage, and the teeth are but little pigmented. Certain of the fluids of the body, as serum, sweat, milk, and urine are discolored, while others, as mucus, tears, and saliva, are free from pigment.

The urine which contains constituents of the bile may be of a dark-brown color. It foams when shaken, and a yellow froth appears on the surface. It is clear, but frequently contains hyaline casts and renal epithelium, both of which are stained yellow.

A similar color may result from the use of rhubarb and santonin, but the urine does not foam, and becomes red when a caustic alkali is added.

The usual test for bile-pigment in the urine is that of Gmelin. It is applied most simply by allowing a like quantity of urine to flow down the side of the glass (test-tube or sherry wine-glass) about one-fourth full of nitric acid. In a few minutes a play of color arises at the junction of the two fluids, from green through blue to violet, red, and yellow.

A negative result does not indicate that bile-pigment is absent.

Bile-acids are to be found in the urine, but only by a method which involves too much detail to be of general clinical value. In most cases it is necessary that the acids should be isolated. Their nature is then readily determined by Strassburg's modification of Pettenkofer's test. This is a color-reaction, the production of a violet or purple-red color with concentrated sulphuric acid.

In hæmoglobinæmic jaundice the urine is more red than yellow, and may be so dark as to resemble porter. The coloring matter is hæmoglobin, according to Hoppe-Seyler, in the form of methæmoglobin. It may be readily recognized by the spectroscope.

When the urine is boiled the hæmoglobin separates into albumen and hæmatin. The former appears as a large clot, stained brown by the latter, and lies upon the surface of the fluid. If the hæmatin is precipitated with the phosphates by Heller's method, boiling the fluid made strongly alkaline with potash, the chloride of hæmatin crystals may be isolated by salt and boiling glacial acetic acid.

In hæmoglobinuria the sediment contains no red blood-corpuscles, but is composed of globules and granules of hæmoglobin, perhaps resembling fragments of red blood-corpuscles. These may form casts or be attached to the latter. They may be associated with yellow, hyaline, or fatty casts.

The fæces, when deprived of bile-pigment, are pale, usually clay-colored, dense, and offensive. They may be pale when a milk-diet is taken, yet contain bile. They may be dark-colored and free from bile when iron or bismuth is taken, or when intestinal hæmorrhage has occurred.

Indigestion.—The absence of bile from the intestines interferes with the absorption of fat and favors putrefaction. The tongue is coated, and there is a bitter taste in the mouth. Nausea, loss of appetite, and a disgust for fatty food are present. Flatulence and constipation exist. There is a sensation of epigastric fulness after eating, and of emptiness before meals. The region of the

liver may be sensitive or painful, and the gall-bladder may be found greatly enlarged. The area of splenic dulness may be increased, all the more the greater the intensity of the jaundice.

But the person whose skin is darkly pigmented may have, at intervals, a normal appetite and freedom from digestive disturbances. The great frequency of the latter is due to their presence as a result of the cause of the jaundice, as well as the effect of the absence of bile from the intestines, and its presence in the blood.

Nausea and vomiting, with sensitiveness in the region of the liver and spleen, may be present in hæmatogenous jaundice.

Nervous Disturbances.—The central apparatus, as well as the peripheral distribution, may show disturbance of function. There may be grades of mental inactivity, from dulness to coma; also of irritability, from fretfulness to delirium. Dizziness is frequent, and sleeplessness may be serious.

The vision may be curiously affected. White objects, even all objects, appear yellow—xanthopsia, a rare symptom, and, therefore, not due to a yellow staining of the tissues or fluids of the eye. Some patients see better when the light is lessened, nyctalopia; while the vision of others is unusually obscured when darkness approaches, hemeralopia.

Itching of the skin is a frequent symptom and, at times, almost intolerable. It may be present everywhere, or be limited to, or intensified in, the palms and soles. It is usually observed after the skin has become pigmented, and is worse at night. The presence of bile-pigment has been regarded as the cause, although the cutaneous discoloration may follow the itching by an interval of several days. Leyden and Eichhorst suggest that bile-acids are the cause, either by irritating the sensory nerves, or by the production of vaso-motor disturbances. Darting pains in the skin may be found in hæmoglobinæmia.

Cutaneous Eruptions.—Severe scratching frequently results in the presence of papules, pustules, and ulcers. Patches of herpes are frequent, and urticaria may be present. The latter affection has also been observed in hæmoglobinæmia. Boils and carbuncles may occur. Legg calls attention to the appearance of xanthelasma after jaundice has existed for a long time.

Respiration, Circulation, and Temperature.—Although the injection of small quantities of bile-acids into animals produces a slowing of the respiration, this feature is not an accompaniment of simple cases of jaundice. In acute yellow atrophy of the liver, toward the close of the disease, the breathing becomes stertorous, or the Cheyne-Stokes phenomenon may be observed.

A slow pulse is sometimes noticed; it may be even as low as twenty-one beats in the minute. It is rarely below sixty, and increases when the patient walks about. When fever and jaundice are associated, the pulse does not rise in the usual proportion to the elevation of the temperature. The modification of the pulse is attributable to the action of the bile-acids upon the cardiac ganglia.

Hæmorrhages in the skin and retina, and from the mucous membranes are not uncommon. The last may represent a very serious complication in the course of the jaundice.

The temperature in jaundice is usually unaffected. The action of bile-acids upon the temperature is like that on the pulse. A febrile elevation of temperature in cases of jaundice is lower than that from a similar cause in the absence of jaundice. In paroxysmal hæmoglobinuria, a chill followed by fever occurs during the period of discolored urine.

Anatomical Changes.—The general discoloration of the tissues and fluids has already been mentioned. In the examination of the body it is important that attention should be directed to a possible cause of obstruction. If present, the bile-ducts may be dilated, tortuous, with thickened or thinned walls. Their contents, at first a thick, dark bile, may become thin, pale, and watery. The liver may be enlarged or atrophied, brittle or tough, with a color as varied as that of the skin. Abscesses may be found on section, or an abundant fibrous tissue. A microscopic examination is particularly necessary in cases of doubtful obstruction. The presence of inspissated bile, as casts of the capillary ducts, or of plugs of epithelium in the larger ducts, are evidence of an intra-hepatic source of obstruction. The liver-cells, in jaundice from obstruction, contain granular pigment or are diffusely stained. Their protoplasm may appear normal, or granular, or fatty, with disintegration of the cell, according to the cause of the jaundice. Similar degenerative changes in the renal epithelium may be observed. Hyaline and epithelial casts, both stained yellow, may be found within the tubules.

Diagnosis.—The diagnosis of jaundice is readily made from the color of the skin and urine. Although the former may suggest Addison's disease, the distribution of the pigment differs. In the latter malady the sclerotic is white, and the cutaneous discoloration appears gradually. The parts exposed to the air are first affected, then those liable to friction or pressure.

The presence of bile-pigment in the urine indicates a cholæmic jaundice. If corroborative evidence is demanded, an excess of bile-acids will be found.

In hæmatogenous jaundice the urine, if pigmented, contains blood-pigment. The fæces are normally colored. The symptoms of cholæmic jaundice are absent. Under conditions favoring a rapid destruction of red blood-corpuscles a hæmatogenous jaundice is to be expected, and is to be differentiated from a cholæmic jaundice by the absence from the urine of bile-pigment.

With the recognition of a cholæmic jaundice arises the necessity of determining its cause. As the obstructive causes are the most numerous and the most frequent, the seat of a possible obstruction should be sought for. If the gall-bladder is dilated and the fæces discolored, an obstruction of the common duct is probable. With fæces of a normal color and dilatation of the gall-bladder, the obstruction is probably at the cystic duct. If the gall-bladder is not dilated, and the fæces are colorless, the obstruction is of the hepatic duct or ducts. The paler the fæces and the more acute and intense the jaundice, the more likely is the obstruction of the hepatic duct to lie outside the liver.

An acute, uncomplicated, cholæmic jaundice is probably catarrhal.

An acute, cholæmic jaundice, complicated with febrile affections, is probably catarrhal, but may possibly be due to other general causes of jaundice.

An acute, cholæmic jaundice, with intense pain in the region of the gall-bladder, is probably from gall-stones; the probability is greater if the attacks are recurrent. Chronic cholæmic jaundice, if mild, is most likely to result from chronic interstitial hepatitis, malignant disease of the liver, or chronic passive congestion of this organ. The coexistence of ascites favors the first of these causes, of hepatic enlargement the second, and of chronic mitral disease the last.

Prognosis.—The significance of jaundice depends almost entirely upon its causes.

If they are not necessarily fatal, and are capable of removal, with their disappearance the jaundice will fade away. First, the color returns to the fæces, and last of all, disappears from the urine.

In the majority of cases the attack lasts about six weeks. It may continue for years, Fagge having reported a case which persisted for seven years.

Symptoms which threaten a fatal result are profuse gastro-intestinal hæmorrhages, a rise of temperature, affections of vision, and the occurrence of delirium or coma. An apparently mild case may suddenly develop the severest toxic symptoms, and terminate as a case of acute yellow atrophy of the liver.

Treatment.—The treatment of jaundice should have reference to the removal of the cause and to the relief of symptoms. The former is possible but to a limited extent, and practicable only in cases of jaundice from obstruction.

Gerhardt has recommended that the gall-bladder be compressed from without, and that a faradic current be sent through it in the direction of the common duct.

Such treatment seems of doubtful expediency. The good it may accomplish is likely to come in time, while the danger of rupture of the dilated, perhaps ulcerated, biliary tract is imminent. If immediate removal of the obstructing cause is necessary, as in actual or threatening perforation of the gall-bladder, laparotomy with cholecystotomy is the only method which promises success. The seat of obstruction may then be found and the cause removed, if recovery or relief is to be anticipated. Severe hæmorrhage from the jaundiced tissues is likely to prove a dangerous complication.

The symptoms which demand relief are the disturbances of digestion and those affecting the nervous system.

A diet free from fat, and not readily putrescible, is important. Hence skim-milk, strained broths, with or without rice, and but little farinaceous food, will be found suitable. With an improved gastric digestion, chicken, lean meat, and fish may be added. Water, lemonade, selters, apollinaris, or soda-water, may be used as a drink. Sweet fruits are to be avoided, but cooked acid fruits may be taken.

The tendency to constipation is best relieved by small daily doses of saline laxatives, Epsom and Carlsbad salts being useful for this purpose. Rectal irrigations with cold water, from one to two pints at a temperature of about 60° F., have been recommended by Krull, and recently by Loewenthal (*Berliner Klin. Woch.*, 1886, ix., 139).

When the obstruction to the flow of bile into the intestine is removed, the use of measures to displace the coloring matter from the tissues is indicated. For this purpose remedies which increase the secretion of bile and accelerate its elimination are demanded, as aloes, colocynth, rhubarb, podophyllin, the sulphate of potash, the sulphate or salicylate of soda. This last drug is particularly indicated in hepatogenous jaundice, when an unusually thick bile may be expected. As much bile-pigment escapes by the kidneys, the free use is indicated of the drinks above recommended, also of the bitartrate or acetate of potash. Warm baths will promote desquamation, and thus the removal of pigmented epidermis.

Itching may be relieved by external applications, as calomel ointment or lotions of carbolic acid, lead-water and glycerine, or dilute hydrocyanic acid. Internal remedies may also be necessary, as bromide of potassium or morphia.

If sleeplessness is not due to itching, urethan or chloral should be used.

Catarrhal Jaundice.—This is the most frequent variety of jaundice, and results from a catarrhal inflammation of the biliary tract, a cholangitis or cholecystitis.

The catarrh is usually continued inward from the intestine in consequence of a gastro-duodenal catarrh. It may originate within the liver from the action of poisons, the extension of inflammation, or the obstruction of circulation through the hepatic vein.

The catarrh may arise within the gall-bladder, or in one of the larger bile-ducts in consequence of the presence of a foreign body.

The catarrhal element is conspicuous in the causation of jaundice in the infective diseases, from emotional disturbance, and when associated with menstruation. Epidemics may occur, as well as sporadic cases.

The obstruction to the escape of bile may be the result of a plug of secretion, or of a swelling of the mucous membrane. As these mechanical disturbances are seated in the common duct or within the liver, so the jaundice is more or less complete and more or less intense.

Catarrhal jaundice is usually simple and uncomplicated, terminating favorably within a few weeks.

The symptoms may suddenly become grave, with extreme nervous and circulatory disturbances, and death may rapidly follow. The jaundice is then called malignant, a term which includes fatal cases other than those primarily of a distinctly catarrhal origin. The most remarkable lesion frequently found in malignant jaundice is acute yellow atrophy of the liver. Chauffard (*Rev. de Méd.*, January, 1885) suggests that in most cases of catarrhal jaundice a general disease exists, of which the jaundice is a symptom. The milder stages of this disease are represented by a catarrhal, the severer by a malignant, jaundice. He regards the disease as a toxæmia, the patient perhaps poisoning himself with ptomaines elaborated in the intestine.

The treatment of catarrhal jaundice, as well as its symptoms, are essentially those already stated in the general consideration of the subject. The digestive disturbances usually precede the jaundice when the catarrhal cholangitis is secondary to a gastro-duodenal catarrh.

Jaundice of the New-born.—*Icterus neonatorum.* This term is usually applied to the simple, benignant, yellow discoloration of the skin frequently observed within two or three days after birth, and disappearing at the end of the first week. The fæces and urine are normally colored, and bile-acids are absent from the latter. It is a harmless affection, requiring no treatment.

Its origin is obscure, but has been attributed to an excessive destruction of red blood-corpuscles after birth (Virchow). It has also been considered cholæmic, resulting from an obstruction to the flow of bile in consequence of an œdema of Glisson's capsule (Birch-Hirschfeld). Finally, although regarded as cholæmic, it has been thought to be independent of obstruction. Its method of origin is then assumed to be from lowered vascular tension in the liver, due to a diminished flow of blood immediately after birth (Frerichs), to a patency of the ductus venosus (Quincke), or to a weak heart and deficient cutaneous anastomoses of the umbilical vein (Henry: *Arch. of Med.*, x., 97, 1883).

In the preparation of the above article the writer acknowledges his obligations to the following authorities, in addition to those whose names are directly referred to in the text:

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Reginald H. Fitz.

JAWS, INJURIES AND DISEASES OF. Injuries and Diseases of the Upper Jaw.—The upper jaw is peculiar from the fact of its possessing a large cavity, the antrum of Highmore. This cavity is situated in the body of the bone, and is lined with mucous membrane continuous with that of the nasal cavity through a small orifice opening into the middle meatus.

On account of its structure the upper jaw is more subject to diseases than the lower. The affections of the bone calling for surgical interference are injuries, inflammation and abscess, cystic diseases and tumors.

Fractures of the Upper Jaw.—Owing to the position of the upper jaw, protected on all sides by its outlying processes of bone—the malar bone externally and the nasal bones internally—fracture of the upper jaw is not a very frequent accident. Almost invariably, fracture of this bone is associated with fracture of the more prominent bones of the face, with which it is articulated. Direct violence, such as blows upon the face, falls from great heights, etc., is usually the cause of the fracture.

The fracture may be of the penetrating variety, consisting of a small opening into the antrum made by a sharp-pointed instrument, which may enter by way of the orbit, the palate, the nostril, or the anterior wall of the cavity. Such wounds, as a general rule, heal rapidly, and require but little attention on the part of the surgeon.

Fracture may involve any part of the bone—the nasal, palatal, or alveolar process, or the body of the bone. As the result of falls upon the face from great heights, the fracture, in a few recorded cases, has been vertical in the median line, constituting a diastasis or separation of the two superior maxillary bones.

Comminuted fractures, attended with the most fright-

ful deformity, as the result of gunshot wounds, are occasionally met with.

When the alveolar process is separated from the body of the bone, there is usually marked displacement.

The anterior wall of the antrum of Highmore is sometimes crushed in by fragments of the malar bone driven down upon it by the force of blows.

The soft parts overlying the fracture are nearly always extensively involved. Hæmorrhage from wounds of branches of the internal maxillary artery is occasionally very profuse—sometimes even requiring the ligation of the common carotid artery, or the application of the actual cautery to the bleeding point.

When a fracture of the nasal process of the upper jaw is complicated with a fracture of the nasal bones in which the mucous membrane of the nose has been more or less lacerated, extensive emphysema of the face may take place.

If the line of fracture runs through the infra-orbital foramen, causing contusion or laceration of the infra-orbital nerve, temporary paralysis of the parts supplied by that nerve may ensue.

Obstruction of the lachrymal duct, with a constant overflow of tears upon the cheek, may follow fracture of the upper jaw.

Symptoms.—In the majority of cases recognition of fracture of the upper jaw is not difficult. Deep-seated pain, increase of saliva, hæmorrhage from the mouth, and the special signs of fracture, viz., crepitus, preternatural mobility, and deformity, are all present in greater or less degree. The accessible position of every part of the bone makes it usually an easy matter to detect a fracture of the upper jaw.

Treatment.—In the treatment of fractures of the upper jaw the indications are to replace, by manipulation, the fragments as accurately as possible, and, by suitable appliances, to render them immovable. Pressing the lower jaw firmly against the upper with a bandage will in most cases suffice.

If the tendency to displacement is great, as in fractures of the alveolus, it may be necessary to wire the teeth of opposing fragments together, or to adjust a gutta-percha or vulcanite interdental splint.

When the fracture is comminuted and compound, great care should be taken to preserve every fragment, however loosely attached, as the experience of a great many surgeons has shown that such fragments reunite very readily. Another point to be observed in the treatment of fractures of the upper jaw is not to extract loosened teeth, as, in addition to the fact that they most frequently become firm again, their extraction is attended with some danger of removing fragments of bone that might have been preserved.

Inflammation, either acute or chronic, may attack the mucous membrane of the antrum or the periosteum of the bone. The cause of the inflammation is most commonly irritation set up by carious teeth, though it may originate from mechanical injury, from the poisonous effects of syphilis, scrofula, the exanthematous fevers, mercury, or phosphorus. Its tendency is to run rapidly on to suppuration, and in the majority of cases this process has been already established when the surgeon is called.

When the mucous membrane of the antrum is inflamed, the symptoms are by no means clear. Aching of the molar teeth is present, there is more or less puffy, œdematous swelling of the cheek, and occasionally there may be observed a discharge of mucus from the nostril of the affected side.

In periostitis there is always severe pain of a throbbing, tensive character, aggravated at night; swelling of the cheek, often so great as to distort the features; the teeth are raised in their sockets, and the least pressure upon them gives rise to the sharpest pain.

Treatment.—In order to avert suppuration the treatment should be prompt and active. All decayed teeth should be at once removed as the most probable causes of the mischief. Saline cathartics should be exhibited, and local depletion by means of leeches applied to the gums or free incisions, together with hot fomentations, should be employed.

Alveolar Abscess, the immediate effect of inflammation at the root of a tooth, may be superficial or deep. When superficial it is commonly known as gumboil, which is recognized as a puffy swelling of the gums, usually small in volume, but often exquisitely tender and painful. This form of abscess, after a brief period, ruptures spontaneously or upon slight pressure with the finger, and recovery speedily ensues.

The deep alveolar abscess, which more directly results from diseased teeth, commences in the substance of the bone. The abscess cavity, at first very small, rapidly increases in size, the alveolar process becoming carious and undergoing absorption. The pus may find an outlet for itself by the side of a tooth, or, if resistance in that direction is too great, the alveolar process may be perforated and the pus burrows beneath the mucous membrane. Occasionally the pus burrows beneath the periosteum of the palate, afterward pointing in the roof of the mouth.

Treatment.—The treatment of alveolar abscess is free incision and extraction of the peccant tooth. This should be done early, as delay may lead to extensive necrosis, or to the formation of a long sinus, most difficult to heal.

Suppuration in the Antrum.—Accumulation of pus within the antrum—erroneously termed abscess, more properly empyema of the antrum—is most frequently caused by irritation set up by diseased fangs of teeth which normally project upward into the cavity and form prominences upon its floor. The teeth most usually involved are the first and second molars, though it may be the bicuspid or canine. Only a thin partition of bone separates the roots of these teeth from the cavity, and not infrequently the root of one or more of these teeth penetrates the cavity and lies in contact with the antral mucous membrane. The disease may also depend upon a catarrhal inflammation of the lining membrane, may follow violent blows upon the face, or arise by extension of inflammation from the nasal cavity, or from suppurative degeneration of cysts of the antrum.

Symptoms.—If very rapid in its formation, the symptoms of suppuration in the antrum are pain in the head and face, aching of the teeth on the affected side, swelling of the face and gums, and the discharge of an offensive pus into the nose when the patient is recumbent or forcibly blows the nose. The constant discharge of fetid pus through the nose often occasions the mistake that the disease is ozæna, but the character of the matter and the fact that the fetor is most perceptible to the patient, are sufficient marks of distinction. Digestion is much disturbed by the constant entrance of pus into the stomach, and the general health of the patient is on that account often very much impaired.

If the suppurative process has been very slow and gradual, the symptoms are hardly sufficient to attract attention until the disease has made considerable progress.

The pus most usually finds an exit for itself through the opening from the antrum into the nose, or into the mouth along the side of diseased teeth. Expansion of the bone rarely occurs, except when no outlet for the escape of pus is afforded. When there exists no means of escape for the pus and it accumulates in the cavity, the bone becomes expanded, the cheek is pushed forward, and the walls of the antrum become so thinned by absorption, that when pressed upon a peculiar crackling sensation is felt. The bone may be expanded upon any or all of its surfaces, orbital, buccal, palatal, or nasal. In several recorded cases the pressure upward has caused protrusion of the eyeball with permanent amaurosis. Obstruction of the lachrymal duct by the expansion of the bone frequently brings about a constant overflow of tears upon the cheek.

Treatment.—The treatment of suppuration in the antrum consists in providing a free opening for the pus to escape before extensive destruction of the walls of the cavity has taken place. This may be effected by the extraction of a tooth on the affected side, preferably the first molar, and enlarging the opening through the socket

by means of a trocar or drill. In edentulous jaws, attempts to penetrate into the antrum through the alveolus should never be made, as under these circumstances the bone is greatly thickened and consolidated. The most effectual method of evacuating the pus is to make the opening above the alveolar process by means of a drill, a carpenter's gimlet, or an ordinary trocar, care being taken that the instrument is not driven upward with such force as to pierce the orbital plate.

If the opening has been made through the socket of a tooth, the passage should be kept closed with a plug of cotton, or a gutta percha or metallic plate adjusted over the teeth to prevent the entrance of food into the cavity.

The cavity should be frequently syringed out through the opening with an antiseptic solution—corrosive sublimate, 1 to 2,000, or carbolic acid, 1 to 30.

The most assiduous attention is necessary to bring about a perfect cure, and often months elapse before the disease may be said to be at an end.

Cystic Disease of the Antrum.—In this disease the antrum becomes distended by a dark-colored, glairy, and in some instances gelatinous fluid, which frequently contains cholesterine in considerable quantity. The old name applied to the disease was *hydrops antri*, or dropsy of the antrum, and it was supposed to depend upon the retention of the natural secretion of the mucous membrane lining the sinus, the escape of which had been prevented by the closure of the opening between the antrum and the nose; but modern research has shown that such a view was not correct. The cysts most likely depend upon cystic degeneration of the glandular follicles thickly aggregated over the mucous membrane lining the cavity.

Fig. 1894.—Cystic Tumor of Antrum. (Erichsen.)

Symptoms.—The disease is of painless growth and the expansion of the bone gradual. In course of time it leads to marked deformity—the cheek becomes prominent and round; the eye protrudes from the orbit; the nose is pushed to the opposite side; the nostril becomes occluded; and the palate is depressed, often to such an extent as to seriously embarrass deglutition. The enlargement presents itself as a rounded tumor, soft and elastic at some portions of its surface, hard and resisting at others. Pressure upon the swelling often elicits the peculiar eggshell crackling characteristic of those conditions in which the bone is greatly expanded and thinned. The general appearance of the disease closely resembles that of solid tumors of the upper jaw, which fact has caused surgeons, in a number of instances, to excise the entire upper jaw unnecessarily. In all doubtful cases of swelling of the upper jaw, therefore, exploratory punctures should be made before resort is had to the more serious operation of excision.

Treatment.—Acting upon the false belief that the enlargement consisted of the pent-up secretion of the antral mucous membrane, surgeons formerly attempted to reestablish the normal opening between the sinus and the nose, but naturally such a procedure never met with success.

The proper treatment consists of the evacuation of the contents of the cyst by means of free incisions, and the establishment of efficient drainage until the tendency to recurrence no longer exists. This may be easily accomplished by incising the most prominent part of the tumor, usually beneath the cheek, evacuating the contents through the opening, and dilating the passage thoroughly with the finger. If the cyst is large, a portion of the bone or of the cyst-wall should be cut away. The cavity should be thoroughly washed out, several times daily, with some stimulating or antiseptic solution until all discharge ceases. The deformity occasioned by the distention of the bone will eventually entirely disappear.

Polypus of the Antrum.—This form of morbid growth in the antrum is rare. Like polypus of the nasal cavity, to which it is similar in pathology, it takes its origin from the mucous membrane, and may be either fibrous or gelatinous, most frequently the latter.

When small its presence is unsuspected, and it is only after it has attained considerable volume and has, by its size, led to absorption of the thin internal wall of the antrum, and protruded into the nostril, that the real nature of the disease is manifested.

Until this form of growth reaches large dimensions, surgical interference is rarely called for. Thorough removal, by opening up the anterior wall of the antrum, or through the nose if possible, is the proper method of treatment.

Dentigerous Cysts develop in the jaw in consequence of some error in the growth and eruption of a tooth, most frequently a permanent one, though Heath mentions a case in which the tooth involved was of the temporary set. Tomes believes that dentigerous cysts are the result of the gradual increase of the small amount of fluid left in the tooth-sac after development of the enamel. This form of cysts most frequently occurs in young adults. In the upper jaw they nearly always occupy the antrum.

In general appearance dentigerous cysts strongly resemble simple cysts, described above. They cause a slow, painless enlargement of the jaw, which, after it has reached a considerable size, crackles upon pressure, though this symptom is not constant, on account of the thick and highly organized wall of the cyst.

Treatment.—The treatment of dentigerous cysts is the same as that of simple cysts, namely, free incision and evacuation of their contents. The contained tooth, which is usually found imbedded in or lying loose upon the cyst-wall, should be removed, and a portion of the sac cut away. The operation should, if possible, be performed from within the mouth. Entire recovery, without deformity, usually follows the operation.

Solid Tumors of the Upper Jaw—Fibromata.—Fibrous tumors of the upper jaw may be either endosteal or periosteal in origin, and may occupy the antrum of Highmore or grow from the alveolar process, the latter variety being known as fibrous epulis.

In structure, fibromata are similar to fibrous tumors of other parts of the body, and are liable to the same kinds of degenerative changes.

The upper jaw is not so often the seat of fibrous tumors as the lower.

Frequently these growths contain spicula of bone or nodules of cartilage, either of which may be present in large quantity.

Inflammation resulting from the irritation of decayed teeth or mechanical injury may be the starting-point of the disease. More frequently, however, the cause is not apparent.

Though usually of slow growth, fibromata occasionally reach enormous dimensions. When originating within the antrum, a fibroma may extend in every direction. The bony walls of the cavity give way before it, and undergo absorption. Processes of the growth may extend into the mouth, the nasal cavity, and the orbit, and distend the cheek, giving rise to the most hideous deformity. The health of a patient who is the subject of fibroma of the upper jaw usually remains unimpaired.

Fibrous Epulis is a small, firm tumor of fibrous structure, which grows from the periosteum of the alveolar process close to the junction of the gum with the teeth, or even between the teeth. It grows slowly and painlessly, and seldom reaches a large size, though a few cases have been reported in which such outgrowths have attained sufficient volume to cause considerable deformity. As the tumor increases in size the adjacent teeth become loosened, and eventually drop out. It bleeds when manipulated, and is not infrequently ulcerated on account of the pressure of the teeth of the lower jaw. As

in fibromata of the body of the jaw, epulis frequently contains bony spicula, which radiate into its substance from the attachment of the tumor to the jaw.

Fibromata may be distinguished from malignant tumors of the upper jaw by their slowness of growth, their hard and resisting consistence, the absence of pain, their independent growth, and the immunity of the lymphatic glands.

Treatment.—When the tumor is located within the antrum and is of moderate size, it may be possible to enucleate it from within the mouth without disfigurement of the face. This may be accomplished by dissecting the cheek from the bone and entering the antrum through its anterior wall.

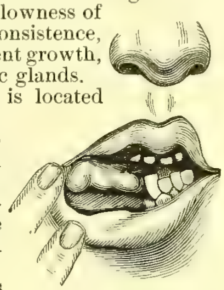

FIG. 1895.—Epulis of Lower Jaw. (Erichsen.)

If the growth is large, and has in a measure substituted itself for the upper jaw, nothing less than complete excision of the bone will suffice. In the treatment of epulis thorough removal of the growth, with a portion of the bone from which it sprung, should be done to insure against a return of the disease.

ENCHONDROMATA.—Pure cartilaginous tumors of the upper jaw are extremely rare. They may grow from the surface of the bone or from within the antrum. They usually appear early in life, and grow more rapidly than fibrous tumors. Enchondromata may reach immense size, as in the case reported by O'Shaughnessy, who removed a tumor of this kind, together with the upper jaw, which weighed four pounds.

In general appearance and in progress the enchondroma differs so little from the fibroma that during life it is impossible to differentiate between them. Ossification of the growth is a very frequent occurrence, and it is not unlikely that nearly all osseous tumors were originally cartilaginous. The tendency to recur is much greater than is the case of fibrous tumors, and for this reason extirpation of enchondromata should be most thorough. Eight operations for the removal of enchondroma of the upper jaw were performed upon a patient whose case has been reported by Ferguson. It is not unlikely that the disposition of enchondromata to recur has been greatly exaggerated, as, no doubt, in many cases sarcomatous tumors which have undergone chondrification have been considered as originally cartilaginous.

Treatment.—The treatment of enchondromata should be the same as applies to fibromata, except that the surgeon should be even more careful to go wide of the disease, in order to guard against recurrence.

OSTEOMATA are more frequently met with in the lower than in the upper jaw. This form of tumor in its structure possesses all the characteristics of true bone. It may be cancellous in structure, enclosed in a thin casing of compact bone, or of denser consistence, hard and compact throughout like ivory.

Hyperostosis is a disease of the jaw which consists of a diffused hypertrophy of the bone, with frequently total obliteration of the antrum. Partial hyperostosis may take place in the alveolar process as the result of irritation proceeding from a misplaced or diseased tooth.

Osteomata of the upper jaw have been known to become loose in their attachments, and finally to become spontaneously detached.

It is not an easy matter to distinguish an osteoma from an enchondroma, or even from a fibroma, but its slow growth, extreme hardness, and irregular, nodulated, or tuberous surface will be of service in making a diagnosis.

Treatment.—Osseous tumors of the upper jaw should be removed with the part of the bone from which they grow, or if large and the source of great deformity, the entire jaw should be excised.

SARCOMATA of the upper jaw are tumors of connective-tissue origin, made up chiefly of embryonic cells. They are met with most frequently in early and middle life. Sarcomata are essentially malignant in nature, being almost certain to recur after removal, and in their growth infiltrating the neighboring tissues. The sarcomata are very vascular and grow rapidly, often reaching immense volume. They are conveniently divided into three classes, according to the kind of cells that enter into their composition—namely, the spindle-celled, the round-celled, and myeloid or giant-celled.

The spindle-celled sarcoma is most frequently found in the antrum. It is made up of spindle-shaped cells of varying size, closely packed in a homogeneous basis substance, held together by a scanty fibrous tissue. It closely resembles the fibroma in general appearance.

The round-celled sarcoma, as its name implies, is composed principally of large, round cells, very greatly resembling leucocytes. Both spindle-shaped and round cells are occasionally found in the same tumor. Both varieties frequently undergo osseous or cartilaginous transformation, often to such an extent as to mask the real nature of the neoplasm. When the tumor occupies the antrum it pursues the same course as other solid tumors of that cavity, causing enlargement of the bone, bulging of the cheek, etc., but differs from them in that it grows more rapidly, is more prone to ulcerate, is very vascular, is of soft consistence most usually, and the lymphatic glands frequently become secondarily affected.

The myeloid sarcoma occurs at an early age, and most usually grows from the alveolar process, where it is known as myeloid epulis. In structure it is composed of large polynucleated cells. This form of sarcoma grows rapidly, is extremely vascular, and is soft and elastic to the touch.

Treatment.—No matter how thoroughly sarcomata of the upper jaw are removed, their malignancy is manifested by the fact that in the majority of cases they recur. Occasionally they have been removed, together with a large portion of the bone from which they grew, with perfect success; and in exceptional cases, when the growth is small and in a measure isolated, it may be expedient to excise it with a portion of the bone; but when the nature of the tumor is clearly apparent, and when it has reached a large size, nothing short of complete excision of the entire upper jaw will be of any avail.

EPITHELIOMA is the only form of carcinomatous growth connected with the jaws.

There are two distinct varieties of epithelioma of the upper jaw: the squamous, which grows from the gums, or from the mucous membrane of the palate, and the columnar, which always commences in the nasal cavity or the antrum. Epithelioma is rarely met with before the age of forty.

The squamous epithelioma usually commences as a small ragged ulcer of the gum or the palate. As the ulcerative process extends, the bone gives way before it, and the antrum is invaded. This cavity soon becomes filled with the epitheliomatous deposit, and the surrounding tissues are rapidly infiltrated. The antrum becoming overdistended with the mass, the external walls yield, the cheek bulges, the nostril is occluded, the orbital plate is encroached upon, and the eye protrudes. The skin over the tumor is stretched, and eventually becomes livid. Later on, the skin gives way and an irregular ulcer is formed, through which protrudes a fungous mass, from the surface of which a fetid, thin, muco-purulent fluid is constantly discharged. Profuse hæmorrhages are not infrequent.

The lymphatic glands beneath the jaw, behind the ear, and at the temple, become involved in the advanced stages of the disease.

The progress of the disease is variable, being sometimes very rapid, at other times slow.

The columnar epithelioma grows either from the mucous membrane of the palate or from that of the antrum. It is invariably of rapid growth. It is usually softer than the squamous variety. When growing from the antrum, it pursues the same course and presents the same symptoms as squamous epithelioma.

When the tumor occupies the nostril, it is liable to be mistaken for nasal polypus.

Treatment.—When epithelioma attacks the upper jaw,

complete excision of the bone should be the rule, and the earlier in the course of the disease it is done the greater the chance of preventing its return or the longer the immunity from recurrence.

Thorough eradication of the disease should be the object of the surgeon. Even when there can be no hope of removing all the disease, an operation is nearly always advisable, as it may prolong life and render the patient more comfortable.

OPERATIONS UPON THE UPPER JAW.—The nature of the operation is determined by the character and extent of the morbid growth. If the tumor is innocent, care should be taken to disfigure the face as little as possible, and to sacrifice no more of the bone than is absolutely necessary.

Very often, when the tumor is small and confined to a limited portion of the bone, it may be removed from within the mouth after dissecting up the cheek from its attachments.

If it is impossible to effect this by reason of its position and attachments, a tumor of considerable size may be sufficiently exposed, by means of an incision through the lip in the median line, carried into the nostril of the affected side alongside the septum nasi, and the cheek then dissected from the bone. When the growth is confined to the antrum—a polypus, for example—it may be reached and removed by means of this incision through the anterior wall of the antrum, or from within the mouth, without external incision through the palatal process.

FIG. 1896.—Line of Incision in Excision of the Upper Jaw by External Flap. Fergusson's Method. (Erichsen.)

When the growth is of great size, or when it belongs to the malignant or rapidly growing sarcomatous class of tumors, nothing less than excision of the entire upper jaw should be undertaken.

Professor S. D. Gross gives the credit of the first removal of the upper jaw to Dr. Jameson, of Baltimore, Md., who successfully performed the operation in 1820; but the honor is by other writers given to Gensoul, of Lyons, whose case occurred in 1827. Lizars, Liston, Syme, Mott, Dupuytren, Heath, and others have repeatedly extirpated the upper jaw successfully, but the established position of the operation is, in great measure, due to important modifications suggested by Sir William Fergusson.

The special instruments required for excision of the upper jaw are strong, angular bone-forceps, a small, strong saw with a movable back, chisels, gouges, and a Fergusson lion-forceps.

The patient is placed in a recumbent position, and fully anæsthetized. An incision is carried in the median line through the lip to the nostril; thence around the ala and along the side of the nose to near the inner canthus of the eye, where it is joined by a curved incision begun over the zygoma, near the outer canthus, and carried along the lower margin of the orbit. The large flap of integument thus marked out is rapidly dissected up and reflected outward. This incision, proposed by Fergusson, is preferable to that originally employed by Gensoul and Lizars, as it divides the facial arteries and nerves where they are of smallest size, and the resulting cicatrix is not nearly so unsightly. The tumor having been thoroughly exposed, an incisor tooth of the affected side is extracted, a small saw carried into the nostril corresponding to the growth, and the palatal process nearly or wholly divided. The nasal and malar processes, in the order named, are divided or deeply notched with the saw.

If the orbital plate is not involved in the disease, it should be preserved by making a section of the bone below the orbit by the saw horizontally applied. If the disease involves the upper part of the bone, it may be expedient to leave the alveolar process.

The bony attachments of the jaw are completely severed by the bone-forceps; the jaw is firmly grasped by the lion-forceps, and forcibly depressed. The remaining attachments are thus brought into view, and their division effected with the knife or the forceps. The infraorbital nerve should be cleanly divided, and as much of the soft palate preserved as possible.

The jaw having been taken away, any remains of the growth should be removed with the gouge, and roughened points of bone cut off with bone-forceps. Hæmorrhage during the operation is usually trifling, in many cases not a ligature being required. The entrance of blood into the larynx may be effectually prevented by placing a small sponge, with string attached, in the back part of the mouth, and by frequently removing the accumulations with sponge and fingers. Preliminary ligation of the common carotid artery, or the performance of tracheotomy, together with the use of the trachea tampon as practised by Trendelenburg, are entirely unnecessary measures.

After the removal of the jaw all bleeding points that can be should be ligated, and Paquelin's thermo-cautery

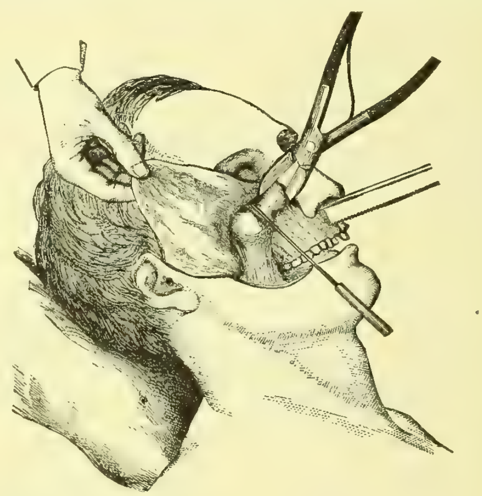

FIG. 1897.—Excision of Upper Jaw by Liston's Method. (Erichsen.)

applied to vessels beyond the reach of the ligature. The cavity left by the removal of the jaw should be dusted over with iodoform and filled with cotton pledgets packed in with moderate tightness, so as to support the cheek and repress the tendency to oozing of blood. The pledgets should be provided with strings, so as to facilitate removal.

The tegumentary flap is brought accurately into place, the wound closed with harelip pins at the lip, and in the rest of its extent with fine catgut or carbolized silk interrupted sutures. The dressing is completed by a compress of carbolized tow or absorbent cotton placed over the wound and retained by a few turns of a bandage. After the second or third day the cotton packing may be removed, and the cavity thoroughly cleansed daily with an antiseptic solution.

Results.—No operation of equal magnitude is followed by as great success as excision of the upper jaw. Erichsen says: "Of 17 consecutive cases collected by Hutchinson as having been practised in the London hospitals, it was successful in 14; and of 16 cases (10 of total and 6 of partial) done by Esmarch, 13 were successful (viz., 8 of the former and 5 of the latter)." ("Science and Art of Surgery," vol. ii., p. 585.) In the practice of Professor

W. T. Briggs and the author, of 26 cases of total extirpation of the upper jaw (24 by the former, 2 by the latter) there has not occurred a single death.

The recurrence of the disease, after removal of the upper jaw, depends upon the character of the growth. When the operation is done for the removal of benign tumors, recurrence is rare; but when done for the removal of malignant tumors, epithelial or sarcomatous, recurrence is almost invariably the rule, no matter how thoroughly the operation may have been done, though the lapse of time between the operation and the reappearance of the growth varies within wide limits.

Osteo-plastic Section of the Upper Jaw is the term applied to an operation devised by Langenbeck, in 1859, for the removal of tumors situated behind the upper jaw without involving that bone. The operation consists of the division of the attachments of the jaw in such a manner that the bone can be displaced downward or to the outer side sufficiently to expose tumors growing from the sphenoid or ethmoid bones, or from some of the fossæ between these bones and the palate bone. After removal of the tumor the jaw is replaced in its normal position, so that union of the divided bones will take place. The operation has been performed a number of times, with gratifying results, both in this country and Europe.

Removal of both Upper Jaws.—Excision of both upper jaws was first successfully performed by Heyfelder in 1844, since which time the operation has been occasionally repeated. It may be performed by carrying incisions from each commissure of the lips to the external angles of the eyes on both sides, and reflecting the flap, together with the nose, upon the forehead. The bony attachments of the jaws, the malar processes on each side, and the junctions of the bone with the nasal bones and vomer, are divided with the saw and forceps. The bones are then grasped with lion-forceps and forcibly wrenched from their position.

Injuries and Diseases of the Lower Jaw.

The principal injuries and diseases of the lower jaw are dislocation and fractures, abscess, periostitis, necrosis, and the various kinds of tumors.

Dislocation of the Jaw.—This accident, not infrequent in middle age, is rarely met with in the extremes of life. It occurs more commonly in women than in men. Though in the majority of cases bilateral, the dislocation may be confined to one side. On account of the peculiar configuration of the joint, the displacement is almost invariably forward, though, when complicated with a fracture of the vaginal process, backward or outward dislocation may occur.

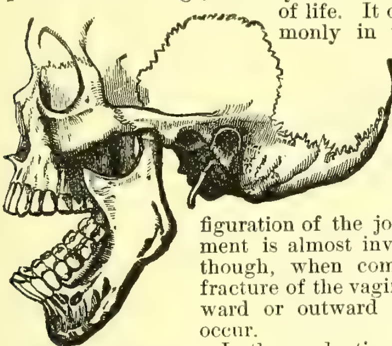

Fig. 1898.—Dislocation of the Jaw. (From Heath.)

In the production of dislocation of the jaw, as in all other accidents of the kind, muscular action plays an important part, though violence, applied either from without or within the mouth, is usually the immediate cause. The dislocation may be the result of muscular action alone, as when it occurs in yawning, vomiting, or immoderate laughter. Sometimes it occurs during a general convulsive seizure, as in epilepsy. When the result of violence, the force is generally received upon the chin at a time when the mouth is stretched widely open. The accident is occasionally produced during operations performed within the mouth, as extraction of teeth, taking an impression, the use of the laryngoscope, etc.

The mechanism of dislocation of the jaw is simple. When the mouth is opened to its fullest extent, the condyle leaves the glenoid fossa proper and, carrying with it the interarticular fibro-cartilage, rests upon the articular eminence. This relation of the bones is peculiarly favorable to the production of the accident, and the slightest violence applied to the chin, or a sudden spasmodic contraction of the muscles of the jaw, is all that is necessary to cause the condyle to slip over the articular eminence, and the dislocation is complete. As soon as the condyle has taken up its new position in the zygomatic fossa, the internal pterygoid and masseter muscles forcibly contract and thus fix the jaw in the position so characteristic of the accident.

The capsular ligament is stretched, but not often torn; the lateral ligaments are tense, and the temporal muscle is put on the stretch, and occasionally some of its fibres are torn. The coronoid process does not rest against the malar bone, but, as shown by Heath, some distance below it, so that the position of this process can have little or nothing to do toward maintaining the fixed position of the jaw, as contended by a number of observers.

Symptoms.—When the dislocation is bilateral, the symptoms are most marked. The mouth is stretched open to its widest extent, and immovably fixed in that position, so that both deglutition and articulation are very much impaired. The chin is pushed forward, so that the lower teeth project beyond the upper. The saliva, which is increased in quantity, dribbles constantly from the mouth.

Immediately in front of the ear is a marked depression. The coronoid process can be felt beneath the malar bone. A prominence above the zygoma, caused by contraction of the temporal muscle, is usually present.

In the unilateral form of dislocation the symptoms are not so manifest, and may be so little marked as even to be overlooked. The mouth is held open, but not near so widely as in the double form; the chin is usually directed to the side opposite the displacement, the parallelism of the teeth is lost, and speech and deglutition are interfered with. The depression in front of the ear is perceptible only on one side.

Fig. 1899.—Dislocation of the Jaw. (From Heath.)

When the dislocation remains unreduced, the jaw after a time recovers its functions to a great extent, the patient becoming able to close the lips and eventually to approximate the jaws sufficiently to masticate food. Speech and deglutition are fully restored, and much of the deformity is overcome.

Subluxation of the Jaw.—Sir Astley Cooper described a condition of the temporo-maxillary articulation which he called subluxation of the jaw, in which the condyle slips before the interarticular cartilage so that the mouth cannot be at once closed. This accident generally occurs in delicate persons whose ligaments and muscles are greatly relaxed. The exciting causes are yawning, biting upon some hard substance, etc. Most usually the subject of the accident is able to overcome the trouble by making a lateral movement of the jaw, or by pressing the chin upward. The reduction is announced by an audible snap.

Congenital Dislocation.—Mr. R. W. Smith was the first to call attention to congenital dislocation of the jaw, of which a small number of cases have been reported. The condition is characterized by great deformity, the lower jaw being atrophied to such a degree that the upper teeth project beyond the lower. This form of dislocation is invariably unilateral.

Treatment.—Reduction of dislocation of the jaw is usually easily accomplished.

The force is to be applied so as to depress the angle of the jaw while the chin is raised toward the upper jaw. This manœuvre, however accomplished, has the effect of depressing the displaced condyle below the level of the eminentia articularis, so that the external pterygoid muscle may draw it back into the glenoid fossa.

The usual method is as follows: The surgeon stands in front of the patient, who is seated in a chair or upon the floor, with his head thrown back and supported. The operator, having wrapped the thumbs with a towel or bandage to protect them, introduces them into the mouth and carries them back to the ramus on each side, at the same time grasping the body of the bone with the fingers. Pressure with the thumbs upon the teeth is then made downward and backward, while the chin is forcibly elevated by the fingers, and the condyle having by this movement been liberated, is suddenly drawn back into the glenoid fossa by the contraction of the muscles.

Occasionally it may be expedient to reduce one side at a time, care being taken that the condyle first reduced does not, while the other is being manipulated, slip out again.

When the dislocation is unilateral, efforts at reduction should be applied only to the affected side.

Another method, especially applicable to cases in which the above-described treatment has failed, consists in the employment of wedges of cork, soft pieces of wood, or the handles of case-knives placed far back upon the teeth between the jaws. The surgeon, standing behind the patient, draws the chin forcibly upward so as to make the jaw act as a lever upon the wedges as fulcrums; the condyles are thus forced below the level of the articular eminence and readily slip back in place.

In Nélaton's method the force is brought to bear directly upon the coronoid processes. The operator, standing in front of the patient, grasps the back of the head on each side by the outstretched fingers, and endeavors, with his thumbs pressing against the coronoid processes, to press the condyles in place.

When the dislocation has been allowed to remain unreduced for any length of time, the reduction becomes more difficult. Reduction has been accomplished, however, at as late a period as the fourth month. The process employed for the reduction of ancient dislocations is the same as described above, though anæsthesia may be required, as much greater force is necessary in order to break up adhesions.

Recurrent dislocation of the jaw is seldom met with. It depends upon the existence of a rent in the capsule, or some change in the form of the eminentia articularis, or an unusual laxity of the ligaments.

The treatment after reduction is simple, the object being to limit the movements of the jaw for a week or ten days. The chin should be fixed by a bandage and talking and mastication of food prohibited, the patient being fed upon liquid diet for a number of days.

To prevent displacement in persons who are subject to recurring dislocations, the chin should be supported by a small silk cap held in place by elastic straps passing over the head or attached to a skull-cap. This apparatus should be worn until the tendency to dislocation no longer exists.

Fracture of the Lower Jaw is a very common accident. It may be caused by either direct or indirect violence, though the former is by far the most frequent cause. Blows upon the jaw, falls from great heights, and kicks from horses may be mentioned as the most common causes of the accident.

When the alveolar border is involved in the fracture, as it nearly always is, the mucous membrane gives way and the fracture is, therefore, compound. It is the exception, however, for a wound in the skin to communicate with the fracture.

Not infrequently the bone is broken into two or more pieces, but comminuted fracture, in which the bone is shattered into many small fragments, is rare.

The jaw may be broken in any part of its extent, though, on account of its more exposed position, the body of the bone is the part most liable to the accident. Of 55 cases of fracture of the lower jaw, recorded by Hamilton, 52 were through the body.

Partial fractures, in which portions of the alveolar process are torn loose from the body of the bone, occasionally occur from extraction of teeth.

When the body of the bone is broken, the line of fracture is most generally in the vicinity of the canine tooth, where the jaw is naturally weakest, owing to the depth of the socket of that tooth and the proximity of the mental foramen.

The ramus of the jaw is less often fractured, on account of the direction of its axis, its great strength, and its protected position.

Fractures through the symphysis are very uncommon, because of the great thickness of that part of the bone.

The coronoid process may be occasionally broken by extreme violence directly applied.

A fracture of the neck of the condyle is of very rare occurrence.

When the jaw is broken near the symphysis, the line of fracture is almost vertical; when nearer the angle of the jaw, it is more oblique and, as pointed out by Malgaigne, the fracture occurs at the expense of the internal plate of the anterior fragment, and of the external plate of the posterior fragment.

Symptoms.—The symptoms are usually very obvious. The special signs of fracture—crepitus, preternatural mobility, and deformity—are all well marked. Pain, which is greatly increased by movements of the jaw, is invariably present. Irregularity in the line of the teeth is readily detected by the finger introduced in the mouth. The teeth which adjoin the fracture are loosened, often detached, and, in a case reported by Erichsen, a tooth became separated and lodged between the fragments. The mucous membrane is nearly always torn, giving rise to more or less hæmorrhage. Saliva is secreted in excessive quantity, and, mingling with the discharges of the wound, decomposes, and gives rise to an offensive fetor most difficult to control, even by the most careful attention. When the fracture is double, the bone being broken on each side of the symphysis, the central fragment is displaced very much downward by the depressor muscles.

In single fractures near the symphysis the displacement of the fragment is usually great, while it is less the nearer the fracture is placed to the angle of the jaw. Fractures of the ramus are attended with very little displacement, owing to that part of the bone being covered and protected by the masseter muscle.

In fractures of the neck of the condyle the symptoms are pain at the seat of fracture, crepitation and displacement forward by the action of the external pterygoid muscle, as a result of which the chin is deflected to the injured side.

Considerable inflammation generally follows fractures of the jaw—the face and neck are swollen and infiltrated, and not infrequently troublesome abscesses form.

As possible complications of fractures of the lower jaw may be mentioned, hæmorrhage from wound of the inferior dental artery, temporary paralysis of the lower lip and integument of the chin from laceration or contusion of the inferior dental nerve, necrosis, salivary fistula, and abscesses.

Simple fractures of the lower jaw heal in from thirty to forty days. Instances of non-union are extremely rare. The prognosis, both as regards deformity and the restoration of function, is good, for even in cases in which it has been impossible to obtain perfect apposition of the fragments, and union with some deformity has taken place, ultimately the deformity almost disappears, and but little evidence of the fracture may be detected.

Treatment.—Reduction in simple fracture is usually easily accomplished by conjoint manipulation, acting within the mouth upon the teeth and externally upon the border of the jaw.

When the line of fracture is very oblique and the fragments overlap and become locked, reduction is occasionally difficult, and, in a few recorded cases—one reported

by Buck, of New York—it became necessary to expose the bones at the seat of fracture by external incision, and to make a resection of the fragments before proper apposition of the broken segments could be accomplished.

When the fracture is simple and the tendency to displacement is slight, in many cases it is only necessary to maintain the fragments in place after reduction by means of a four-tailed bandage, which is so adjusted as to fix the lower jaw against the upper, thus utilizing the latter as a splint.

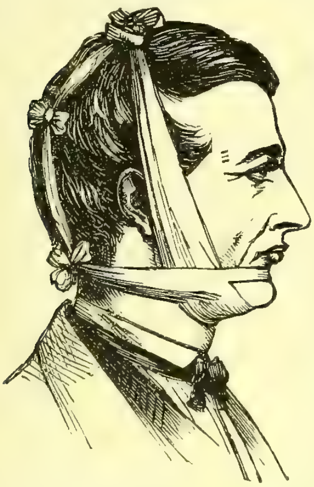

FIG. 1900.—Four-tailed Bandage as Applied in the Treatment of Fracture of the Lower Jaw. (From Heath.)

In addition to this bandage or the other forms of bandage used for this purpose, as Barton's figure of eight, or Gibson's bandage, a cup-shaped splint of pasteboard or gutta-percha moulded to the chin, may sometimes be advantageously used. During the process of repair mastication and talking should be forbidden. Nourishment in fluid form should be administered, either by being sucked into the mouth between the teeth, or through a tube carried into the mouth behind the last molar tooth.

This simple method of treatment is most effectual when the fracture is uncomplicated.

Hamilton has devised an apparatus for the treatment of simple fractures which is admirably adapted to the purpose.

In regard to the management of loosened teeth, the idea formerly held, that they should be extracted as foreign bodies is no longer entertained; they should be allowed to remain, as they soon contract new adhesions and become as firm as before. It may even be advisable to tie them with wire or silk to adjacent firm teeth, until they have contracted new adhesions.

When the fracture is comminuted, or the tendency to displacement is very great on account of the obliquity of the line of fracture, this simple plan of treatment will prove ineffectual, and recourse must be had to one of the numerous ingenious mechanical supports that have been devised for such cases.

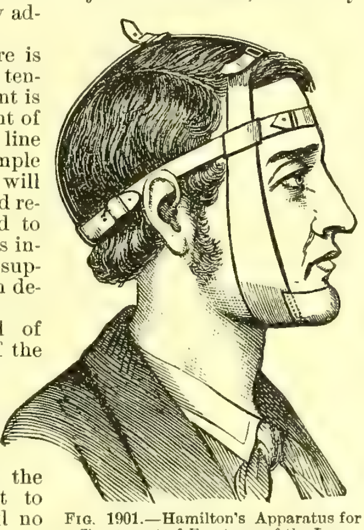

FIG. 1901.—Hamilton's Apparatus for Treatment of Fractures of the Lower Jaw. (From Heath.)

The old method of binding the teeth of the fragments together with wire or thread is objectionable, from the fact that the teeth soon become loosened by the strain thus brought to bear upon them and no longer afford adequate support.

An ingenious contrivance for wiring the teeth together, which in skilful hands is capable of achieving a certain amount of success, is Hammond's wire splint, which consists of a frame of strong iron wire made to surround the teeth, to a number of which it is fastened by smaller pieces of wire carried between the teeth. To insure accurate adjustment, the wire frame should be shaped upon a plaster cast of the teeth.

Various forms of interdental splints, made of gutta-percha, vulcanite, or metal, and moulded to fit over the teeth for some distance on each side of the fracture, are sometimes used. They are either intended to act as a lateral support while the lower jaw is firmly held against the upper, or they are fastened to the teeth or the bone

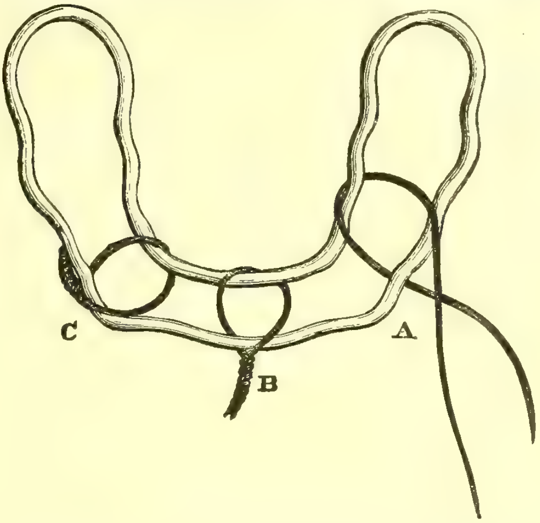

FIG. 1902.—Hammond's Wire Splint. (From Heath.)

by means of screws or metal wire, or they may be attached to an outside support by means of rods passing from the mouth to the outside.

Hamilton's method of making an interdental splint of gutta-percha is to take pieces of the gum of the proper size, and render them soft and malleable by dipping them in hot water. The pieces are then worked into the shape of wedges and carried between the teeth on each side, care being taken that the wedge extends on both sides of the fracture. The jaws are then pressed together until the lower border of the bone at the fractured point is smooth and held in position until the rubber hardens. Accurately fitting caps of the teeth are thus obtained.

Of this splint Hamilton says: "The 'clasp' applied over the crowns and sides of the teeth is not intended to act as an interdental splint; but by its lateral pressure it is expected to hold the fragments in apposition upon nearly the same principle as the ligature." [1]

Gunning and Kingsley, of New York, Bean, of Atlanta, Moore, Lonsdale, and Hill, of England, have all devised interdental splints consisting of a clasp for the teeth attached to an external support. These appliances have, in many difficult cases of fracture of the lower jaw, been of great service; but, on account of their complex mechanism and the necessity of considerable manipulative skill in adjusting them, they have never come into general use.

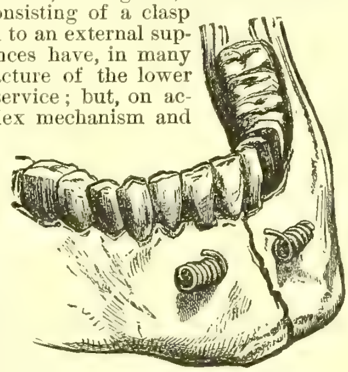

FIG. 1903.—Thomas' Method of Suturing the Fragments in Fracture of Lower Jaw. (From Heath.)

When the fracture is very difficult of management, as, for example, when the bone is broken in two places, and the middle fragment is drawn downward and cannot be maintained in place by any of the above methods; when the fragments overlap each other and are difficult to reduce, or when the fracture has a wound in the integument communicating with it, a more

rational and certain mode of treatment consists in exposing the bone at the seat of fracture by an external incision, drilling holes in the fragments on each side of the fracture, and wiring the fragments firmly together (Fig. 1903).

This method of treatment, advocated by H. Thomas, of Liverpool, as especially suited to compound fractures of the lower jaw, is equally appropriate to all fractures of that bone that present obstacles to the ordinary and more simple modes of treatment.

Thomas' method of operation is to expose the bone at the seat of fracture, bore holes through the fragments below the alveolus, on each side of the fracture, about one-eighth of an inch from the broken edges; a strong, pliant wire is passed through the holes thus made from one side to the other, and the ends of the wire firmly twisted by means of a special instrument (Fig. 1904), called a key, devised for the purpose.


FIG. 1904.—Key for Tightening Thomas' Wire Suture. (From Heath.)

ABSCESS OF THE LOWER JAW may be acute or chronic. The symptoms, course, and termination of acute abscess of the lower jaw differ in no respect from those of acute abscess of the upper jaw, given in a preceding portion of this article.

Chronic abscess of the lower jaw may be caused by injury, by irritation of carious teeth, or it may result from suppuration of a dentigerous cyst.

The symptoms are obscure, there being slow, steady enlargement of the bone, sometimes with a dull, aching pain; more frequently, however, there is entire absence of pain. The accumulation of pus occurs between the osseous plates of the jaw, but it is seldom that the expansion is so great that the peculiar egg-shell crackling can be elicited by pressure. The slow increase in the size of the bone, and the firm consistence of swelling in chronic abscess have, in a number of cases, led surgeons to remove portions of the jaw under the impression that they were dealing with solid tumors.

Treatment.—The treatment of chronic abscess is to evacuate its contents, which may usually be easily accomplished from within the mouth; but it is sometimes necessary to expose the swelling by raising a flap of skin, and then to apply the trephine to the bone.

PERIOSTITIS OF THE LOWER JAW may be either acute or chronic. The acute variety may be caused by the irritation of diseased teeth, mechanical injury, exposure to cold, or the action of certain medicines, as mercury and phosphorus. It may also arise, independently of any extraneous cause, in children of the scrofulous diathesis, or after the exanthematous fevers.

Acute periostitis of the lower jaw is very rapid in its course, terminating in necrosis of the bone if not arrested promptly.

Symptoms.—The symptoms are swelling of the gums and the side of the face, a severe tensive pain in the part, worse at night; the teeth are raised in their sockets, and, when pressed upon, the most exquisite pain is elicited. Very frequently there is spasmodic closure of the jaw. The swelling often extends into the neck, and, when pus forms, pointing takes place beneath the jaw.

Treatment.—If the condition is recognized early, active treatment—such as the extraction of carious teeth, leeching the gums, free incisions, and hot fomentations by holding hot water in the mouth, may prevent the formation of pus.

When the process has become suppurative, the earlier the pus is evacuated the better.

When practicable the opening should be made from within the mouth, but most generally the evacuation can be better accomplished by external incision, as, aside from the fact that the abscess most frequently points in the neck, better drainage is thus afforded. Detergent injections into the cavity should be constantly employed. If necrosis occurs complete separation of the dead part must be awaited before removing it.

CHRONIC PERIOSTITIS OF THE LOWER JAW is usually the result of syphilis. It is almost painless in its course, and manifests itself in the nodes which appear upon the palate and the alveolar border. This form of periostitis yields readily to large doses of iodide of potassium.

NECROSIS OF THE LOWER JAW is more frequently met with than is that of the upper, a fact most likely due to the greater vascularity of the latter.

Necrosis is the effect of unchecked suppurative periostitis, the accumulation of pus separating the periosteum from the bone, and in this way cutting off the vascular supply. Death of the bone ensues very rapidly after the establishment of the suppurative process, often in a few hours.

Necrosis may be complete, involving the entire thickness of the bone, or partial, when it is limited to the alveolar process.

It happens quite frequently that the external plate of the alveolar process becomes necrotic and is removed, while the internal plate remains intact and serves as an adequate support for the teeth.

Symptoms.—The symptoms of impending necrosis are severe pain, increased heat in the part, and rapid swelling of the gum and cheek. At this stage much may be done to arrest the death of the bone, or at least to limit the destructive process, by free incision of the gums, the extraction of carious teeth, leeching, hot fomentations, etc.

After necrosis has been established the pus finds an outlet by the side of loosened teeth, or wells up between the bone and the gum, which, during the process, become separated from each other; or it may burrow its way through the soft tissues to points beneath the body and near the angle of the jaw, where it points and is evacuated either spontaneously or by the surgeon. The discharge has the characteristic fetor of pus from dead bone, and in consequence of its constant entrance into the stomach, digestion is seriously interfered with. A probe introduced through a fistulous orifice readily comes in contact with denuded bone.

Treatment.—This consists, as in necrosis of the long bones, in the removal of the sequestrum, which, however, should never be undertaken until the separation of the dead from the living bone has taken place. It is especially important that this rule be observed in children before the permanent teeth have made their appearance, as a premature operation may not only seriously damage surrounding healthy bone, but also prevent the eruption of teeth that might otherwise have been saved.

If there are no external openings, and the ends of dead and detached fragments of bone project into the mouth, they may frequently be removed with the fingers or the forceps, only a small incision being required to enlarge the opening in the mucous membrane.

When the sequestrum is too large to be removed entire, it should be divided with bone-forceps into two or more pieces, which can be taken away separately.

If at all practicable, the extraction of dead bone should be invariably effected through the mouth; but when the disease is extensive and a number of fistulous openings exist, or when it is impossible to operate within the mouth on account of the fixity of the jaw, the sequestrum may be reached and removed by an external incision so placed as to avoid disfiguration of the face as much as possible.

NECROSIS of the jaws in children sometimes occurs upon the subsidence of the exanthematous fevers, especially scarlatina and small-pox. It comes on with aching of the teeth, swelling of the gums, and fetid breath; suppuration speedily ensues with all the symptoms of necrosis. A peculiarity that has been observed of this form of necrosis is the symmetrical manner in which it affects the bone. The disease is most generally limited to the alveolar process. The treatment differs in nowise from that of necrosis from other causes.

Necrosis of the jaws from severe mercurial salivation was formerly a common occurrence, when in the treatment of syphilis or other diseases it was thought necessary to induce ptyalism in order to obtain the best effects of mercury. Many supposed cases of this kind in children,

Jaws.

however, really owed their origin to a scrofulous taint of the system, to cancrum oris, or to the poisonous effects of an exanthem. Fortunately, nowadays necrosis as the effect of the abuse of mercury is rarely seen.

The symptoms of necrosis from mercurialization are those of necrosis of the jaws from other causes, but aggravated in degree and with more constitutional disturbance. Large portions of the bone, not infrequently the entire bone, with portions of the cheek, were in many cases thrown off as a slough, giving rise to the most frightful deformity. To add to the pitiable condition of the patient, the jaws often became immovably fixed, so that deglutition was rendered very difficult.

Phosphorus Necrosis, arising from the injurious effects of the fumes of phosphorus upon the jaws, is a form of the disease to which the attention of the profession was called by Lorinzer in 1845. In this country the late Professor J. R. Wood published an account of a case treated by him in Bellevue Hospital, New York, in 1856, remarkable from the fact that, after removal of the entire lower jaw, complete reproduction of the bone took place.

The disease occurs most frequently among workmen in lucifer-match factories, who are constantly exposed to the fumes of phosphorus. The disease is now seldom encountered, owing to precautionary measures adopted in the manufacture of matches.

The fumes of the phosphorus were supposed to gain access to the bone through carious teeth, so that persons with sound teeth enjoyed an immunity from the disease. Langenbeck and others held a different view, however, maintaining that the effects were produced through the system. Both jaws are about equally liable to the disease; but while in the lower jaw the entire body is generally involved, in the upper the necrosis is confined to the alveolar process and palate.

Symptoms.—The approach of the disease is very insidious, the symptoms at first being mild and hardly noticeable. As the morbid process advances all the symptoms are manifested in a most marked and exaggerated manner. The pain is excruciating, the swelling is very great, not confining itself to the immediate seat of the disease, but involving the side of the face and head; the discharge is profuse and very offensive; numerous abscesses form and open externally, forming fistulæ through which the probe can be made to touch dead bone. The health of the patient rapidly gives way, owing to the quantity of fetid pus necessarily swallowed, and to inability to eat sufficiently. Death frequently supervenes from exhaustion.

A characteristic feature of phosphorus necrosis is the peculiar deposit of pumice-like bone upon the sequestrum.

Treatment.—Before detachment of the dead bone occurs, it is important to sustain the vital powers of the patient by the administration of tonics and stimulants. Locally the mouth should be kept as free as possible of the discharges by the frequent use of detergent and antiseptic washes. When the sequestrum is fully detached, it should be removed from within the mouth if possible, otherwise by external incision, especial care being taken to preserve the periosteum as far as may be possible.

Repair, after loss of the jaw from necrosis, differs in the two bones—in the upper no reproduction of bone takes place, and the gap is invariably left unfilled in adults; but in children, after necrosis following fevers, a hard fibrous tissue is formed which fills the gap, and may even serve as a support for artificial teeth.

In the lower jaw, especially in phosphorus necrosis, there is often the most abundant formation of new bone, which, however, is almost, if not entirely, absorbed afterward. In the case of Dr. J. R. Wood, mentioned above, there was entire reproduction of the inferior maxilla, as shown in the celebrated specimen preserved in the Bellevue Hospital Museum.

Tumors of the Lower Jaw, especially cysts, central myeloid sarcoma, and epithelioma, are more commonly observed than those of the upper. They frequently reach a vast size, very often entirely filling the mouth, pushing the cheek far beyond its natural dimensions, stretching the mouth, separating the jaws, and sometimes extending far down upon the neck, and even upon the chest.

Cysts of the Lower Jaw may be single or multiple. Single cysts are sometimes connected with the fangs of perfectly sound teeth, or may originate from diseased or misplaced teeth.

The first are usually small in size and are occasionally extracted with teeth, to which they may be attached by very slender pedicles. Single cysts of this mode of origin may, however, reach a large size and cause expansion of a limited portion of the body of the jaw.

Single cysts may develop in the cancellous structure of the bone, having an origin connected with the teeth in a manner which is not clearly understood. As the growth increases in size, the bone yields and expands, so that it presents the appearance of a solid tumor. As the walls of the jaw become thinner by absorption, pressure causes the bone to crackle like parchment.

In the more advanced stage of the disease the bone is entirely absorbed, and fluctuation can be readily detected. The fluid contents of these cysts are of a dark color, and rich in cholesterine.

Multilocular cysts occur frequently in the lower jaw. They originate either in the canaliculi of the bone or from cystic degeneration of solid tumors. They are composed of a number of cysts of varying size, with more or less solid matter interposed. They are of slow growth, and may exist for a long period without impairing the health of the patient. Heath mentions a case of multilocular cyst, the history of which extended over a period of thirty years. Multilocular cysts are capable of reaching immense volume. The tendency of multilocular cysts to become solid epitheliomatous tumors, as pointed out by Mr. Frederick Eve, should be borne in mind in the treatment of such growths.

Dentigerous cysts have been more fully described with diseases of the upper jaw. When growing in the lower jaw they form globular tumors, become very large if unmolested, and are very liable to be mistaken for solid tumors.

Treatment.—In the treatment of single cysts, evacuation of the contents with excision of a portion of the cyst wall usually effects a cure.

When multilocular, the cyst should be laid open by incision, its contents scraped or gouged out, and the cavity packed with carbolized tow or absorbent cotton, with the view of establishing granulation.

The well-known tendency of multilocular cysts to recurrence makes the advisability of excision of the portion of the jaw in which the growth is located worthy of consideration.

Dentigerous cysts should be evacuated, and the misplaced tooth found and removed.

Heath's case, in which the tooth was found embedded in the floor of the cyst some time after it had been opened, is unique.

Fibromata are growths of frequent occurrence in the lower jaw. They may be either of endosteal or periosteal origin.

The endosteal form of fibrous tumors, as suggested by Heath in his excellent monograph on "Injuries and Diseases of the Jaw," most probably has an origin in the deposit between the plates of the jaw of inflammatory products which have undergone organization.

The tumor, as it increases in size, leads to expansion and thinning of the two plates of the jaw—the external to a greater extent than the internal—and finally the bone undergoes absorption.

The periosteal fibroma grows most frequently at the junction of the gums with the teeth, and is only distinguished from fibrous epulis by its greater size.

Treatment.—If the disease is of long standing, the tumor very large, and the jaw more or less destroyed by the absorptive process, the growth should be removed with the segment of jaw that is involved. It may be possible to enucleate small tumors of this class. Advantage should always be taken of the fact that the external plate is principally involved to preserve the internal plate of bone, if practicable.

Enchondromata of the lower jaw are very rare. They occur chiefly in children, and are remarkable for their slow, painless growth. Enchondromata occasionally grow to immense size, not infrequently causing death by interference with the functions of respiration and deglutition. These growths nearly always contain more or less bony deposits, and sometimes they are almost entirely transformed into bone, generally cancellous in structure, when they are appropriately termed osteo-chondromata.

The accompanying woodcuts are from photographs of a patient from whom Professor W. T. Briggs, in 1878, removed the entire lower jaw for a tumor of this class. The patient was a boy twelve years of age, and the tumor had been growing for ten years. The enormous mass protruded from the mouth and extended as far down as the chest. The mouth was entirely filled by the tumor, so that deglutition was very difficult and articulation imperfect. The health of the patient was only slightly impaired.

The specimen measured six inches in diameter, and weighed eight pounds.

As may be observed from the cut of the macerated specimen, more than half of the jaw-bone had been absorbed. The second molar had been transported in the tumor half an inch above the alveolus.

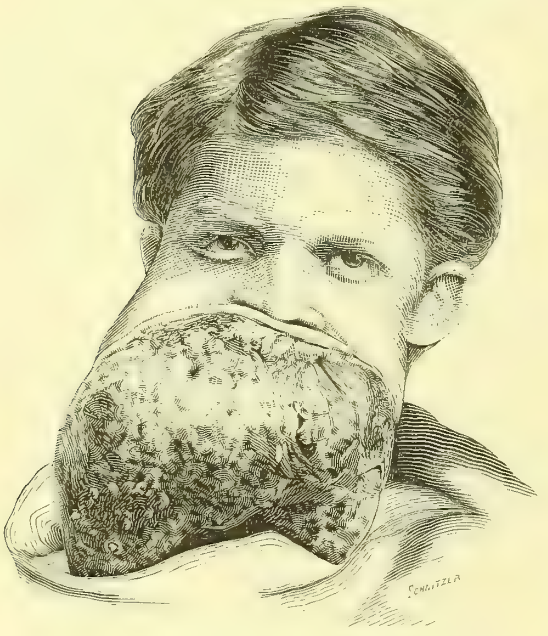

Fig. 1905.—Osteo-chondroma of the Lower Jaw. (From a photograph.)

The extraordinary size of the tumor may be estimated by the fact that the mouth had been so greatly distended that it was necessary, in the operation, to excise eleven inches of the patient's lip.

Osteomata of the Lower Jaw may be either cancellated or of the kind known as ivory exostosis.

The cancellated osteomata most likely originate from the conversion of enchondromata into spongy osseous structure.

Ivory exostoses are frequently found near the angle of the jaw. Such tumors seldom reach very great size. They are as hard and compact as ivory, of painless, slow growth, and irregularly nodulated. These tumors may be removed by chiselling or gouging them out from the surface from which they spring. The probability of recurrence is small.

Sarcomata.—The general appearance, symptoms, course, and treatment of this class of tumors are identical with those of similar affections of the upper jaw, given more fully in another part of this article. Sarcomata of the lower jaw are encountered more frequently and reach a larger size than those of the upper. Some of the largest tumors of the jaws have belonged to this type, among the largest recorded being one removed by Mr. Christopher Heath, which weighed six pounds four ounces.

The tendency to recurrence is one of the chief characteristics of sarcomata, and, therefore, in operations for their removal it should be the invariable rule to make sections through sound bone on each side of the growth.

Epitheliomata of the Lower Jaw occur most frequently in old age, though they may occasionally appear in early life. The principal features of epithelial growths are rapid destruction of bone, tendency to form fungating masses that protrude in the mouth, glandular involvement, etc. Epitheliomata are sometimes secondary to epithelial growths of the lower lip, the disease in such cases extending directly from the lip to the bone.

The nature, diagnosis, prognosis, and treatment of epitheliomata of the lower and upper jaw are the same, though the chances of non-recurrence after removal are greater in the former, owing to its more isolated position.

The rule in excising portions of the lower jaw should be to go as wide of the disease as possible.

Operations upon the Lower Jaw.—Before proceeding to the performance of any operation the true nature of the disease should, if possible, be first ascertained.

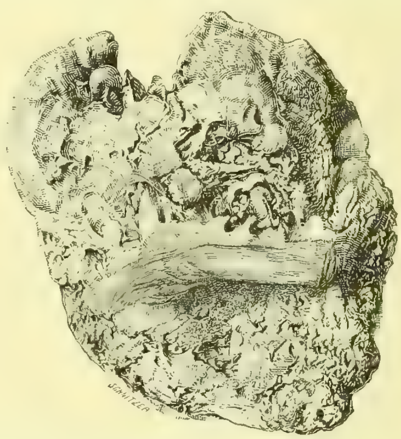

Fig. 1906.—Macerated Specimen of Osteo-chondroma Removed by Professor W. T. Briggs. (From a photograph.)

Rapid growth, infiltration of adjacent tissue, involvement of neighboring glands, the soft, pulpy consistence of the tumor, tendency to ulcerate, and impairment of the patient's health, should serve to distinguish malignant from innocent diseases.

It is important, also, to differentiate between the cystic and solid tumors, which may be readily done if the cyst is of large size and its bony walls have become so thinned by absorption as to yield the characteristic crackling upon pressure.

If doubt exists as to whether the growth is cystic or solid, an exploratory incision or puncture will usually clear up the diagnosis.

The special treatment appropriate to each variety of tumor of the lower jaw has already been given with the separate description of the various affections.

Excision of the Lower Jaw was first performed by Dr. W. H. Deadrick, of Tennessee, in 1810, although credit has usually been given to Dupuytren, whose case occurred in 1812. Dr. Deadrick's operation was undertaken for the removal of a large enchondroma, and was entirely successful.

When the tumor grows from the alveolus, and does not involve the entire thickness of the jaw, it is often possible to remove it from within the mouth with strong bone-forceps and gouge, without making a complete section of the bone.

If the tumor is large and occupies the body between the symphysis and angle, as is most frequently the case,

excision of a segment of the jaw between those two points is generally required. This operation has been performed from within the mouth, notably in two cases by Mr. Maunder, referred to by Heath, but the operation is a very difficult one, especially in cases in which the neoplasm has attained any volume. The greater ease and thoroughness with which the bone may be excised by the external operation more than counterbalances the advantages obtained by operating so as to avoid a scar.

The operation for removal of the jaw between the angle and the symphysis is performed as follows: The patient is thoroughly anæsthetized, his head raised somewhat, and an incision made directly down upon the bone from the symphysis to the angle beneath the lower border of the bone. If the tumor is so large as to require more room than is afforded by this incision, another incision may be made in the median line through the lip and joining the anterior extremity of the first. The facial artery and vein will be divided by the first incision at the point where they cross the border of the jaw, and should be ligated before proceeding further with the operation. The soft parts are now rapidly dissected from the bone, and the tumor thoroughly exposed to view. If the tumor is innocent, the surgeon should ascertain at this stage of the operation whether it can be removed without sacrificing the entire thickness of the jaw. If feasible, the growth should be enucleated or gouged out of its bed, and the lower border of the jaw left intact. If excision is determined upon, the internal surface of the bone should be cleared of its attachments with knife and elevator.

If the extent of the disease makes it necessary to divide the genio-hyoid and genio-hyo-glossus muscles, a stout ligature should be passed through the tongue, by means of which it may be drawn out and thus prevented from falling back into the pharynx and causing suffocation, as has happened in a number of cases.

A tooth on each side of the tumor having been extracted, a saw is now applied to the bone at the points at which the jaw is to be divided, and the bone partially severed at each point. The sections of the bone may now be completed with bone-forceps and the part removed. The fragment of jaw with morbid growth attached having been removed, all bleeding points should be ligated, the wound thoroughly irrigated with carbolized or iodinized water, and its surface dusted over with iodoform. The flaps of skin may now be brought in place and the wound closed with interrupted sutures of catgut or carbolized silk, and a drainage-tube inserted at the most dependent angle of the wound. A light compress of tow or cotton, placed over the wound and retained by a few turns of a bandage, will complete the dressing. The ligature through the tongue should be fastened to a part of the dressing or to the cheek with a piece of adhesive plaster, and not removed for several days, when the tongue shall have formed new adhesions. The patient must be fed for some days upon a liquid diet, which frequently has to be administered through a tube. The mouth should be carefully cleansed by the frequent use of an antiseptic wash.

The dental artery in the divided bone may give rise to troublesome hæmorrhage, to check which it may be necessary to apply the actual cautery, or to plug the dental canal with a piece of soft wood.

If the tumor encroaches upon the angle and ramus of the jaw, removal of half the jaw, with disarticulation, should be done; for even were the greater portion of the ramus sound, if it were left in place the powerful contraction of the temporal and external pterygoid muscles would tilt the fragment forward in such a position as to render it a constant source of irritation and discomfort.

For the removal of half the jaw an incision should be carried under the border of the bone to the angle, where it is joined by a vertical incision along the posterior border of the ramus to the level of the lobe of the ear. A third incision, from the inner extremity of the first incision vertically through the lip, may be required in cases of large tumors.

Occasionally the incisions cannot be made in conformity with any given rules, but must be adapted to suit the case, and in exceptionally large tumors it may be necessary to take away large segments of the skin.

The flap of skin should be dissected from the surface of the tumor, an incisor tooth extracted at the point at which the section of bone is to be made, and the jaw entirely divided with a small saw. Before proceeding further, the tongue should be secured in a looped ligature. The bone should now be seized with the lion-forceps and drawn forcibly outward, in order that the attachments to the buccal surface of the bone may be divided. Especial pains should be taken to keep the edge of the knife directed against the bone, in order to avoid wounding anteriorly the submaxillary gland and, nearer the articulation, the internal maxillary artery.

With the fragment still in the grasp of the forceps, it should be forcibly depressed so as to cause the coronoid process to start forward and thus permit of the division of the temporal muscle. The joint being exposed, the knife should be applied over it, by which the capsule is opened and the condyle released. In this step of the operation care should be taken not to twist the fragment

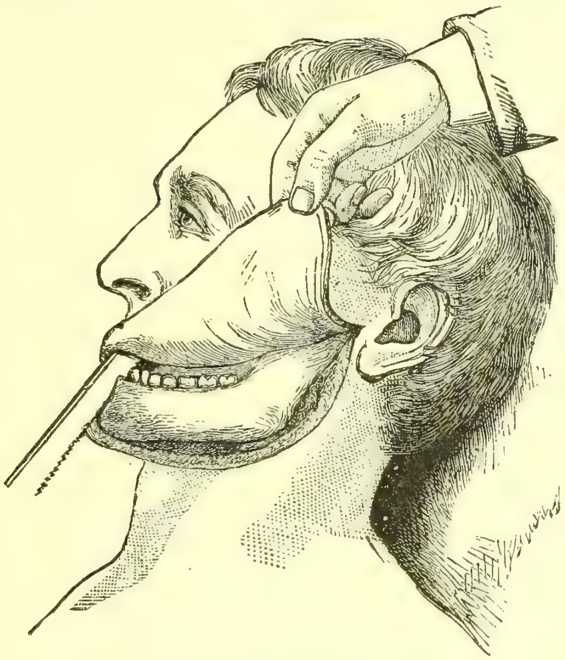

FIG. 1907.—Excision of Lower Jaw—Soft Parts Raised. (Erichsen.)

of jaw too far externally, as the internal maxillary artery may be thus pressed around to the front and wounded at the same time the capsule is opened. In very large tumors it is frequently impossible to reach the coronoid process. Under these circumstances the ramus should be divided as high up as possible, leaving the coronoid and condyloid processes to be dissected out after removal of the tumor. The few remaining attachments of the soft parts to the bone having been divided, the jaw is removed.

The close proximity of the internal maxillary artery to the neck of the condyle makes it very liable to be wounded, and it is therefore always necessary to observe the greatest caution in disengaging the condyloid process. When the artery is divided hæmorrhage is very profuse, necessitating the immediate application of a ligature, or if on account of the great depth of the artery this cannot be done, the temporo-maxillary artery should be ligated.

To prevent the remaining half of the lower jaw from falling inward, it has been proposed to fasten the teeth of the lower to those of the upper jaw by means of wire or metallic caps, but the measure has not been attended with much success.

The removal of the entire lower jaw, from one articulation to the other, for morbid growths is very seldom required on account of tumors, but in cases of phosphorus necrosis it was frequently performed. When excision of the entire bone is required on account of tumors, the incisions can be made to follow no special set of rules, but should be made to suit the requirements of the case. For example, in the removal of the large osteo-chondroma by Professor W. T. Briggs, mentioned above, one incision was carried from the commissure of the lips (as near as could be judged) to the articulation of the side from which the tumor had commenced, and a second incision was then commenced on the opposite side and carried through the lip vertically downward for several inches, and thence in a curvilinear direction under the tumor to the outer termination of the first incision, thus removing a large segment of skin and lip.

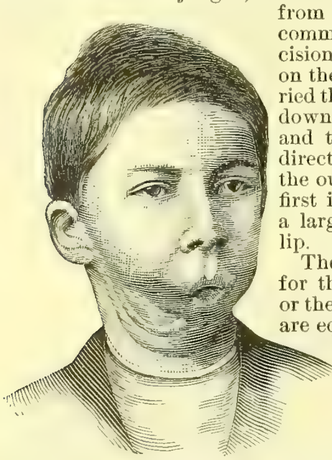
FIG. 1908.—Showing the Degree of Deformity left after the Removal of the Entire Lower Jaw. (From a photograph.)

The results of operations for the removal of portions or the whole of the lower jaw are equally as good as in excisions of the upper jaw. "Of 419 cases tabulated by Professor O. Weber, only 83, or twenty per cent., perished. Of these, 246 were excisions in continuity, with 46 deaths; 153 disarticulations of one-half the bone, of which 117 recovered, and 20 extirpations of the entire jaw, with only 1 death. Pyæmia, erysipelas, and exhaustion were the principal causes of death."[2]

Deformity after removal of portions of, or even the entire, jaw is remarkably slight (see Fig. 1908.) The gap left by the removal of the bone is filled with a thick, firm band of fibrous material, which takes the shape and general direction of the removed bone, and is in many cases sufficiently firm to support artificial teeth.

CLOSURE OF THE JAWS may exist in one of two forms, viz., temporary or spasmodic, and permanent or organic.

Spasmodic closure of the jaws is most frequently due to firm contraction of the masticatory muscles, especially the masseter and internal pterygoid, superinduced by prolonged irritation of branches of the third division of the fifth pair of nerves.

The most common cause of this condition is the difficulty that sometimes attends the eruption of the wisdom tooth, either from the fact of its being misplaced or because the space between the second molar tooth and the ramus of the jaw is insufficient. Among other causes of spasmodic closure may be mentioned alveolar abscess in the vicinity of the last two molars, suppurative tonsillitis, necrosis of the jaws, etc.

Treatment.—The treatment of this affection is obvious, viz., to remove the cause. When the condition arises from difficult eruption of the wisdom tooth, the patient should be thoroughly anæsthetized and the jaws forcibly separated by a screw-gag or lever, in order that access may be had to the seat of trouble. If the wisdom tooth is presenting normally, it may be sufficient to incise the gum freely or to extract it. Generally it is necessary to remove the second molar, in order that the wisdom tooth may have room to emerge. The cause of the irritation having been removed, the function of the jaw is in a short time completely restored.

PERMANENT OR ORGANIC CLOSURE OF THE JAWS is a far more serious affection than the spasmodic form, the management of which often taxes the patience and skill of the surgeon, as well as the endurance of the unfortunate sufferer, to the utmost. It may be conveniently divided into two classes, namely: those arising from diseases of the temporo-maxillary articulation, and those which have their origin in ulcerative action and cicatricial contraction in the perimaxillary soft tissues.

THE DISEASES OF THE TEMPORO-MAXILLARY ARTICULATION which, by causing fibrous or osseous ankylosis, lead to permanent closure of the jaws, are acute and chronic arthritis.

ACUTE ARTHRITIS may follow mechanical injury—for example, blows upon the side of the face, dislocations, or fractures into the joint—or it may supervene upon the exanthematous fevers in connection with diseases of the middle ear.

Symptoms.—The symptoms of acute arthritis of the temporo-maxillary articulation are pain, redness, heat, and swelling and stiffness of the jaw, sometimes amounting to entire closure of the jaws. If suppuration occurs, the pus may escape through the external auditory meatus or by means of an opening in the overlying skin.

Treatment.—The treatment of this condition should be rest to the joint by causing the patient to abstain from mastication, the application of leeches over the joint, hot fomentations, and evacuation of pus as soon as formed.

CHRONIC RHEUMATIC ARTHRITIS of the temporo-maxillary joint is essentially a disease of old age, fortunately, however, rarely met with. It may affect one or both sides, but is more frequently unilateral.

Symptoms.—The symptoms are gradual enlargement of the condyle, which may often be plainly felt beneath the zygoma, pain on opening the mouth, and a peculiar creaking in the joint on moving the jaw, plainly perceptible to the patient. The neighboring lymphatic glands are enlarged. The face is distorted, the chin being inclined to the sound side when the disease is unilateral, carried prominently forward when bilateral. The pathological changes are the same as those of chronic arthritis of any other joint—the articular cartilage undergoes disintegration and absorption, the glenoid cavity is enlarged, the interarticular cartilage disappears, the eminentia articularis is levelled down so as to permit of partial dislocation, and the neck and head of the jaw are thickened and enlarged. The muscles are in a state of tonic contraction in the effort to keep the inflamed joint-surfaces in contact, and, as a consequence, stiffness of the jaws is always present to a greater or less degree.

Treatment.—In the treatment of this disease little is to be hoped for from the action of medicines, though active counter-irritation over the joint and the exhibition of increasing doses of the iodide of potassium have been recommended.

In the "Transactions of the American Medical Association" of 1881, Dr. D. H. Goodwillie, of New York, describes an ingenious method of making extension in the treatment of this disease, which in his hands yielded the most encouraging results. The apparatus consists of an interdental splint which separates the posterior teeth while the anterior remain free, and which is made to act as a fulcrum when the chin is elevated by means of elastic straps attached to a skull-cap, thus serving at the same time to keep the joint-surfaces apart and to hold the jaws immovable.

ANKYLOSIS OF THE JAW, the result of arthritis, may be fibrous or osseous. No matter whether the disease is unilateral or bilateral, mastication is impossible.

The diagnosis between the fibrous and osseous varieties can only be ascertained when the patient is under the influence of an anæsthetic.

If fibrous, the jaws may be forcibly separated, and the adhesions broken up by means of a screw-gag made for the purpose, or of levers and a wedge introduced between the teeth to keep the jaws apart. The tendency of the parts to become fixed again renders the daily repetition of this process necessary for months, and even for years. Even with the most constant care on the part of the surgeon, and the fullest co-operation of the patient, the result is very seldom satisfactory, and at the present time is rarely resorted to, except as after-treatment to more radical operations.

Division of the fibrous bands by a tenotome passed

through the mouth into the articulation has been frequently done, with some showing of better results.

In both fibrous ankylosis, in which so little is to be hoped for from mechanical treatment, and in osseous ankylosis, or synostosis, the method which promises the best results is excision of the condyle with a portion of the neck of the jaw, and establishment of an artificial joint. Less radical measures, as Esmarch's operation, in which a wedge-shaped segment of the bone is removed, and that of Rizzoli, in which simple section of the bone is made—both with a view of establishing a false joint—are occasionally practised for the relief of ankylosis, but not with the same measure of success that follows excision of the joint.

Esmarch's and Rizzoli's operations are more applicable to the variety of closure of the jaw depending upon cicatricial formation in the buccal mucous membrane, and will be described later on.

The operation of excision of the joint is performed as follows: "An incision is begun at the lower margin of the zygoma, close in front of the temporal artery where it adjoins the ear, and carried forward along the zygoma one and a quarter inch, the tissues being divided, layer by layer, until the bone is reached. A second incision, involving only the skin, is then carried from the centre of the first directly downward for about an inch. The soft parts are carefully separated with elevator and knife from the margin of the zygoma and the outer surface of the joint, and drawn downward with a hook, thus preserving the parotid nerves and vessels from injury. The neck of the condyle is then freed by working around in front and behind with a small elevator, keeping close to the bone so as to avoid injury to the internal maxillary artery, and finally divided with a chisel. If there is bony union between the condyle and temporal bone, the chisel must be again used to separate them, its edge being kept directed somewhat downward so as not to break through into the cavity of the cranium." [3]

Permanent Closure of the Jaws may be due to cicatricial contraction following extensive ulceration and sloughing of the buccal mucous membrane.

This condition may be the result of cancrum oris, profuse ptyalism, or necrosis. In reference to closure of the jaws from the excessive employment of mercury, Gross says: "Such an occurrence used to be extremely frequent in our Southwestern States during the prevalence of the calomel practice, as it was termed, but is fortunately diminishing. Children of a delicate, strumous constitution, worn out by the conjoined influence of mercury and scarlatina, measles, or typhoid fever, are its most constant victims; but I have also seen many examples of it in adults or elderly subjects. In the worst cases there is always extensive perforation of the cheeks, permitting a constant escape of saliva and inducing the most extensive disfigurement." [4]

When the mucous membrane of the cheek, from one alveolus to the other, is involved, the cheek is bound so closely to the jaw that all movements of the jaw are rendered impossible, and often the space between the teeth and the cheek is so limited as scarcely to admit the passage of a probe.

Frequently the new tissue has bone developed in it, which occasionally is present in the shape of an osseous bridge extending from one jaw to the other, thus serving to bind the bones even more closely together.

The condition of the patient is pitiable in the extreme, as food can only be carried into the mouth in fluid form, or by being rubbed against the teeth.

Treatment.—Attempts at relief of this condition by division of the cicatricial tissue and forcible separation of the jaws have proved unsatisfactory, since as soon as healing had taken place contraction of the new cicatrices occurred.

Excision of the nodular tissue entirely, and transplantation of healthy mucous membrane, as proposed by Dieffenbach, or of healthy skin, as practised by Jaesche, is nearly always impracticable, on account of the difficulty of obtaining healthy mucous membrane or skin near enough to be utilized.

To separate the adhesions from the bone, and, in order to prevent readhesion, to adjust metal shields worn over the teeth to keep the surfaces apart, and at the same time to keep up forcible separation, is a method of treatment that is not only most trying to both surgeon and patient, but one that has never, even when fairly tried for a long time, given satisfaction.

Dieffenbach's operation of making an artificial joint behind the contraction, by simple section of the bone, has proved inefficient on account of the liability of the divided bones to reunite.

The operation proposed by Esmarch, of Kiel, in 1855, of establishing a false joint in front of the contraction, by excising a wedge-shaped piece of the bone, is the most rational treatment yet devised for closure of the jaws depending upon contraction of cicatricial tissue. Of course this operation is only applicable to cases in which the disease is limited to one side.

Esmarch's operation is superior to the method of Rizzoli, which consists in the establishment of a false joint in front of the contraction by simple division of the jaw, on account of the tendency of the divided bones to reunite.

Esmarch's operation is thus performed: "An incision is begun at the angle of the jaw and carried two inches along the lower border. A narrow strip of bone is then cleared on both sides up to the edge of the gum, a tooth drawn if necessary, the chain-saw passed around the bone through the incision, and the section made. The anterior fragment is then depressed and protruded through the wound, and a wedge-shaped piece, from one-third to one-half an inch in width at the widest part, cut off with cutting forceps." [5]

Dr. J. Ewing Mears, of Philadelphia, in vol. i. of the "Transactions of the American Surgical Association," reported a case in which he made a false joint for closure of the jaws from a gunshot wound by resection of a portion of the ramus of the jaw, together with the coronoid and condyloid processes, and obtained a good result.

In the discussion that followed Dr. Mears' paper, Professor W. T. Briggs reported a case of closure of the jaws from double synostosis resulting from arthritis, caused by a fall upon the chin, in which he removed the anterior portion of the body of the jaw. In this case the object of treatment was to obtain an avenue into the stomach, and excision of the jaw was the only method by which this object could be effected, inasmuch as the cause of the condition existed on both sides—the lower jaw was undeveloped, and occupied a position some distance behind the upper jaw; the lower teeth were buried in the mucous membrane of the palate, and the masticatory muscles had degenerated into fibrous tissue from long disuse.

In such extreme cases of closure of the jaw, excision of a portion of the bone is the only resort of the surgeon.

Charles S. Briggs.

[1] Hamilton: Fractures and Dislocations.
[2] Gross: System of Surgery, vol. ii., p. 415.
[3] Stimson's Manual of Op. Surgery, p. 190.
[4] System of Surgery, vol. ii., p. 405.
[5] Stimson's Manual of Op. Surgery, p. 191.

JEQUIRITY. *Abrus precatorius* Linn.; order *Leguminosæ.* This little vine, which has been long known in India and other tropical countries as Indian licorice, and whose seeds were frequently brought as curiosities and playthings to this country by sailors (often called "Black-eyed Susans," or some such fanciful name*), became suddenly famous a few years since in the treatment of refractory cases of granular conjunctivitis.

It is a woody, twining perennial, with mimosa-like, abruptly pinnate leaves, and axillary spikes of small, pretty, pink, papilionaceous flowers. Pods like pea-pods, about an inch long, each containing four or five ovoid seeds; these are beautifully polished, of a brilliant scarlet color, with a large, round, jet-black patch around the hilum: internal structure, odor, taste, and general composition the same as those of domestic peas and beans.

* "Prayer-beads," Bentley and Trimen.

This plant has a woody, yellowish root, used in the East as a poor substitute for Spanish liquorice. It is the seeds which have their recent employment in trachomatous conjunctivitits. They are not poisonous, and have even been used as food in Egypt. There is nothing peculiar in their composition to distinguish them from pulse in general, excepting that a decoction made from them and allowed to stand a day or two develops numerous microbes, and in this condition is capable of raising an intense acute inflammation of the conjunctiva, on the subsidence of which the chronic trouble will be found to have disappeared or abated. The process is one of severe substitutive inflammation, and not easily controlled when once called into activity; serious accidents and injury to the cornea and to vision have followed, but not often, and it is still considered a proper remedy for very troublesome cases, but is used but little compared to two years or so ago. This use of jequirity was introduced from Brazil, where it has been practised for many years.

The inflammation of jequirity follows its introduction in about fifteen or twenty hours, and lasts five or six days. Extreme swelling, closing of the lids, and profuse suppuration, are its symptoms.

Allied Plants.—Peas, Beans, Vetches, etc. See Senna.

Allied Drugs.—Chrysarobin is used upon similar therapeutic principles, in psoriasis and chronic eczema; but, of course, the bacterial element is not present.

W. P. Bolles.

JOHANNISBAD is a little village in Bohemia, near the Silesian border, picturesquely situated in a narrow valley about 1,900 feet above the level of the sea. It possesses a somewhat changeable mountain climate, and although the atmosphere is not so raw as in other less wooded regions, yet the average temperature is low, the summer corresponding in this respect very much to spring in our latitude. The air is balsamic, however, coming down the valley loaded with the odors of the pine woods. The spring rises from a bed of fine white gravel, and the water is clear and odorless, but has a faintly styptic taste. The temperature of the water is 86° F. The following is its composition. Each litre contains:

	Grammes.
Sodium bicarbonate	0.040
Calcium bicarbonate	0.071
Magnesium bicarbonate	0.055
Ferrous bicarbonate	0.006
Sodium chloride	0 004
Sodium sulphate	0.019
Potassium sulphate	0.001
Sodium phosphate	0.003
Silicic acid	0.020
Argillaceous earth, organic matter, etc.	0.007
Total solids	0.226

The gases are carbonic acid, oxygen, and nitrogen.

Johannisbad is classed among the indifferent thermal springs. Plunge-baths at the natural temperature, and also artificially heated baths are given. The waters exert a calming influence on the nervous system. The spa is frequented by invalids suffering from various neuroses, from sexual disorders, from rheumatism, from cutaneous affections, and from a tedious convalescence after debilitating diseases. It is sometimes also visited by patients who have just been through a somewhat active course of treatment at Carlsbad or elsewhere. *T. L. S.*

JOINTS, DISEASES OF. For the acute affections, see under the headings Osteitis and Synovitis; for the chronic, see under the heading Joints, Chronic Diseases of, in the Appendix.

JOINTS, INJURIES TO. A joint is defined to be "the place or part in which two things are joined or united;" in the human subject the term "articulation" is employed synonymously with it, especially if there be the least degree of movement existing between the bony surfaces which form a part of the joint. There are certain tissues that are common to all joints, such as the bones and the structures connecting them—among which latter, for the purposes of this article, will be considered those of a distinct ligamentous character. As joints ascend in the scale of perfection other tissues are added to their structure to meet the requirements incident to the increased freedom and symmetry of their motion. A fair example of this is shown by comparing the sacro-iliac articulation, a joint that is substantially fixed, with the hip- and shoulder-joints, that possess all varieties of motion. The introduction of additional tissues, to serve the purposes of increased motion, likewise exposes the joint to an increased danger of disease and injury by reason of their presence. While each of the individual tissues forming the structure of an articulation is liable to all varieties of injury and to its inflammatory sequels, yet, as a rule, ligamentous tissues are strained, cut, or ruptured; cartilaginous and bony tissues are bruised or broken, and the synovial membrane is bruised, punctured, cut, or torn. A respectful consideration must always be given to the vascular and nervous supply of a joint; and the common relations of the vessels and the nerves to its immediate structures are of inestimable importance in formulating the treatment, as well as in estimating the prognosis of a case. A joint may be sprained, dislocated, concussed, and wounded.

A sprain is a severe stretching or tearing of one or more ligaments of a joint, caused by violence that wrenches or twists its connecting structures. Although the connecting ligaments of a joint are usually the first of its structures to feel the effects of violence, and changes in them constitute the essential morbid characteristics of an ordinary sprain, yet not infrequently the contiguous tendons and muscles are torn; the synovial membrane bruised or ruptured; the articular cartilages, and even the bony prominences are detached; and the blood-vessels in and around the joint may be ruptured, causing the surrounding tissues or the joint cavity to be filled with blood. Nerves, too, are not infrequently bruised, the injury resulting in numbness and loss of power of the parts below the joint; and in obstinate neuralgias the ankle- and wrist-joints are sprained most frequently, and this is due, not only to the freedom of their movements, but chiefly to the relations which they hold to locomotion in one instance, and to self-defence and prehension in the other. The knee-joint is less frequently sprained than one would suppose from the knowledge of its relation to the weight of the body, and to the leverage of the extremities, to which function it forms a most important adjuvant. The orbicular joints are not frequently sprained, owing to their extreme range of motion, and also to the number and strength of the muscles that act upon them. The articulations of the foot, especially the medio-tarsal and calcaneo-astragaloid, and the metacarpo-phalangeal of the hand, are quite liable to suffer from strains caused by inequalities of the ground, and by accidents sustained in grasping. A practical classification of sprains into different forms is not feasible, although the term *sprain-fracture*, indicating that a small fragment of cartilage or bone is chipped off and remains attached to a ligament, is sometimes made use of to distinguish that form of injury from a simple sprain.

Symptoms.—The first symptoms are, an instantaneous and usually severe pain at the injured joint, attended by an impairment, if not a total loss, of motion. Nausea and vomiting, accompanied by a sense of faintness, may be present, even though the sprain be of a minor degree; the outlines of the joint become obliterated by the distention of the soft parts from inflammatory products and from extravasated blood. If the injury be severe, or the synovial membrane be lacerated, the cavity of the joint becomes likewise distended with similar products, that add their influence to efface the normal outlines of the joint. The pain and tenderness continue, and after a few days an indistinct sense of crepitation may be noticed on movement of the joint, caused by the deposit of plastic matter in the soft tissues about the articulation. A little later the surface discoloration peculiar to extravasated blood in the soft parts can be seen. Acute suppuration in or about a sprained joint is not to be apprehended, unless the physical state of the patient be greatly depreciated by the influences of pauperism or excesses. If the

sprain be slight, the pain and swelling soon subside and the functions of the joint are again restored. If the sprain be a severe one, and the bones, cartilages, or continuous joint-tissues be implicated, the inflammation and the suffering will be correspondingly increased, and the convalescence greatly retarded. It may require months and even years to restore complete usefulness to a sprained joint. A sprain is often more severe than either a fracture or a dislocation of the same joint. If the case have been neglected or improperly treated, and, too, even when every reasonable care has been employed, the joint may continue weak and uncomfortable for a long time, or the articular surfaces may become diseased, and the entire limb suffer from defective circulation and nutrition, together, possibly, with disordered sensations of a hyperæsthetic or neuralgic nature, which are modified by the various barometric changes.

Diagnosis.—Were it not for the occasional presence of the well-known complications of sprains, the diagnosis could be easily and quickly made. The frequency of sprains, and the familiarity of the laity with their local and general phenomena, usually render the diagnosis of the surgeon merely a confirmatory one. If a joint be much swollen from the effects of a sprain, a complicating fracture is difficult of detection, and if the fracture be an incomplete or impacted one, its presence may not be even suspected until the formation of bony callus. Usually, however, in spite of the swelling, the bony landmarks of a joint can be accurately defined, if but a little time and patience be employed. If the swelling have obscured them, firm and continuous pressure at their established situations by the thumb or the fingers of the surgeon will displace the fluids in the infiltrated tissues about the joint, and the determining of their situation and immobility becomes an easier matter. If the bony prominences of the injured joint correspond to those of its uninjured fellow in location and immobility, the presence of a fracture or of a dislocation need not be entertained. The bony prominences of injured joints located in the median line of the body can only be compared to the similar prominences of contiguous joints with which they are known to have an established relation; hence, it is important to recall the extent of their normal variations from each other before completing a diagnosis.

Complications.—Fractures, dislocations, concussions, and the contused and lacerated varieties of wounds may directly complicate sprains. The tendons and muscles contiguous to the joint may be torn or stretched, the synovial membrane lacerated, and the nerves and blood-vessels may be torn or bruised.

Treatment.—The following are the four leading indications to be met: (1) Secure complete rest to the injured joint; (2) subdue inflammation; (3) relieve pain; (4) restore the functions of the joint. The importance of rest, complete and absolute, cannot be overestimated. If the sprain be a severe one the patient should be put to bed, the joint elevated, and so placed that it will rest easily in a relaxed position. It may be necessary, for the better support and protection of the joint, that it be placed in a well-padded, open wire-gauze splint. If the sprain be slight the patient may be permitted to sit with the limb elevated and resting on a pillow or other similar support. There is not the least danger, in this stage of a sprain, of too much rest; the danger lies rather in permitting too early and too free motion; in allowing the patient, who insists that "it amounts to nothing," to overcome the better judgment of the surgeon, who should insist that he be quiet. Slight and unheeded sprains are more frequently followed by structural diseases of joints than are those sprains that are severe, but well treated. Many conflicting rules have been given to meet the second indication—the subduing or limiting of the inflammatory processes. All measures that judiciously lessen the arterial supply to the injured part can be used to meet the second indication. Elevation of the limb, as before mentioned, combined with the gentle, yet firm, pressure of cotton batting confined in place by flannel bandages, is an important measure preparatory to the transfer of a patient to his home or to a hospital, where other means of treatment can be adopted. The constant and judicious application of cold by means of irrigation, compresses, ice-bags, pig's bladder, etc., has its earnest advocates, and, no doubt, has a markedly depressing influence on the circulation of the injured joint. There are patients, however, to whom the use of cold causes much discomfort, and to these persons warm fomentations afford the greatest satisfaction. The degree of cold can be regulated by the interposition of lint, cotton-batting, flannel, etc., and also by elevating the temperature of the media by which it is conveyed. Medicated solutions, either hot or cold, can be used. A solution of the acetate of lead and opium, applied by means of superimposed layers of flannel saturated with it, or of chloride of ammonium and opium; thin bags of steeped hops and other domestic herbs, all afford much comfort and medicinal relief. The immersion of a limb for a considerable time in warm vapor, or in a hot water medicated bath, the temperature of the latter being gradually raised, by the frequent addition of warmer water, is an admirable measure, especially when the more distal joints of the extremities are injured. This measure not only soothes and relaxes, but derives the blood from the inner structures of the limb in a marked degree. Leeches can be applied when the pain is acute and the swelling unusually severe. The constitutional means of subduing the inflammation consist in the careful use of cathartics, sedatives, and anodynes, which should always be administered when the injury is severe. If the sprain be slight, tincture of arnica, camphor, or any of the recognized domestic remedies can be employed along with absolute rest. The application of a bandage, tightly applied, at the time of the accident, not infrequently relieves the pain of slight sprains almost instantaneously. It is important that the patient be relieved of all pain that may interfere with the necessary mental and physical rest. The local means already mentioned may be sufficient—if not, the internal use of anodynes, as codeia, morphia, or opium, will accomplish this purpose. The fourth indication—the restoration of the functions of the joint—is often difficult to accomplish. The pain, tenderness, swelling, and stiffness that so commonly follow a severe sprain, are the principal impediments to its free use. The first three can be abated in all stages of a sprain by gentle, methodical rubbing, once or twice daily, by the naked hand from above downward, followed by the uniform pressure of an elastic bandage. Dampened soft sponges, or dry cotton-batting, when bound firmly around a joint, are admirable means of relieving pain, and of promoting absorption at a later date. Stimulating embrocations, applied at the time of rubbing, will not only facilitate the act, but also hasten a recovery by their special influence. Hot and cold douches, too, are of great use as an adjuvant to the means just mentioned. Blistering and the use of electricity often afford great relief. Passive motion, once or twice daily, is the most important agent to complete the recovery of the functions of a joint. It can be commenced as soon as the inflammation has abated, provided that the act be not followed by pain. If pain be caused by pressing together the joint surfaces, passive motion should be deferred. At first the part should be moved but slightly, and the effects upon the joint watched; if pain and tenderness follow, passive motion must be discontinued until these symptoms have disappeared. If the pain be slight and the tenderness trifling and transient, the range of motion can be increased gradually until it corresponds to that of the normal joint. When it is certain that no synovial inflammation exists, sufficient force should be employed to gradually overcome all adhesions and contractions of the ligamentous, muscular, and other tissues that modify the functions of the joint. The limb should be used on all seasonable occasions, in order that the vascular, nervous, and muscular influences that act on the joint may become properly stimulated. Finally, it not infrequently happens, despite all possible caution and efforts, that the joint remains weak and troublesome for a lifetime; or destructive joint changes develop that cause great pain and suffering, and the patients are only relieved by excision or amputation.

Sequels.—Obstinate neuralgic pains of a joint or of

the parts about it, of a paroxysmal or of a continuous character, usually exaggerated by barometric changes, not infrequently follow a sprain. When other methods fail to give relief, it is advisable to cut the trunks of the nerve-filaments that supply the painful point. A joint may be more or less stiffened for an indefinite time, and it is, in rare instances, at intervals of weeks or months, subject to paroxysmal attacks of active or subacute inflammation ; a condition that has given birth to the misnomer "irritable joint." Counter-irritation and immobility are commonly sufficient to effect a speedy cure. Chronic synovitis and chronic osteitis, although they are not common sequels, yet, in those patients who possess the so-called scrofulous diathesis, the liability to their occurrence should be kept in view.

Concussion of a joint is caused by great violence acting directly or indirectly on the articular surfaces of that structure, as falling from a great height and striking on the feet may concuss one or more joints of the lower extremities, and even of the vertebral column itself. A strong blow with the fist may inflict a like damage on one or more joints of the upper extremity. The joints of the fingers suffer from this variety of injury, caused by striking the keys of a piano ; and every barefooted schoolboy has suffered not a little from concussion of the joints of the great toes. In some instances no appreciable changes of the joint-structures follow the receipt of the violence, the force having been dispersed, no doubt, by reason of the peculiar anatomical arrangement of the bony structure of the joint. In other instances the articular cartilage is bruised, or cracked, and may be chipped off ; the bony prominences about the joint may be separated ; the ligaments, too, are sometimes ruptured, and the synovial membrane lacerated or bruised. If the vertebral column have received the violence, spinal and cerebral concussion may be associated with it, and if a fatal issue does not take place at once the concussion is often followed by serious consequences. If a joint be concussed by direct violence, the injury done is limited to the joint itself. Since this variety of injury seems to be more nearly allied to a contused wound of a joint than to any other special form of injury, it will, therefore, be considered under that title. A concussed joint may speedily recover its integrity, or inflammatory processes may quickly supervene, causing infiltration and softening of its ligamentous tissues, and disintegration and ulcerative absorption of the articular cartilage. If the patient have a scrofulous, gouty, or rheumatic diathesis, chronic inflammatory changes may take place in the bones and cartilages of the joint.

Treatment.—The joint must be immovably confined by an appropriate splint, and the inflammatory processes combated and pain allayed by the various methods of treatment employed for sprains.

Wounds of Joints.—These wounds may be classified in the same way as those of the soft parts of the human body, *i.e.*, (1) incised ; (2) contused ; (3) lacerated ; (4) punctured, and (5) gunshot. The nature and degree of the violence causing the wound of a joint are the all-important influences that determine its character.

1. Incised Wounds of Joints.—Incised wounds are the simplest of the series of wounds of joints, and are caused by the entrance into the joint-cavity of a cutting instrument. The character of this wound is influenced by the condition of the cutting edge, by the cleanliness of the implement, and also by the size of the incision.

Symptoms.—The local indications are those of an open wound, from which blood and, usually, synovial fluid escape. If the cut be small the escape of synovia is proportionally limited in amount and in the freedom of its discharge. The synovial fluid is viscid and transparent normally, and may be mistaken for a similar fluid that escapes from a punctured bursa near the joint ; but, inasmuch as many of these bursæ do communicate directly with the main synovial cavity of the joint, the importance of its presence from this source should not be underestimated. If a small antiseptic probe be gently introduced in the course of the wound, it will not be difficult to determine the relation of the injury to the cavity of the joint. Somewhat later the symptoms of acute synovitis will probably occur, attended by constitutional manifestations, especially if the joint be a large one.

Treatment.—It should be the invariable rule of a surgeon to treat all open wounds of joints that involve their cavities with the strictest antiseptic precautions. If the opening be a small one, and the continuous flow of synovia or blood warrant the belief that the septic influences have not as yet gained admission to the joint, the external surface should be thoroughly washed in a strong antiseptic solution and the opening be closed by catgut sutures carried down to the synovial membrane. If at a later period the constitutional and local symptoms warrant the supposition that suppurative processes have invaded the joint-cavity, the opening must be enlarged and the cavity treated as if it had been freely exposed at the onset. If the wound be one that communicates freely with the cavity of the joint, leaving little or no doubt of the previous admission of external septic influences, the entire cavity of the joint must be washed out with an antiseptic solution, thoroughly drained, and the external opening closed by a superficial and deep row of catgut sutures ; the deeper row closes the opening in the synovial membrane, and the superficial one unites the remainder of the tissues. If, in spite of all precautions, the joint-cavity suppurates extensively, it should then be laid open freely, carefully drained, and washed with an antiseptic solution as often as is necessary to keep it in a cleanly condition, and under these circumstances it is always to be dressed antiseptically. If it be thought desirable to use cold to combat the inflammatory processes in a joint resulting from a penetrating wound, it can be readily accomplished by first enveloping the injured joint in a number of thicknesses of cloth saturated with a strong antiseptic solution, which solution is to be continuously applied by irrigation, its temperature being lowered by the means of ice ; or antiseptic ice-bags can be applied directly to the saturated envelopes of the joint, the moisture of which is maintained by irrigation with the antiseptic fluid at a low temperature.

Drainage of Special Joints.—The importance of proper drainage of all suppurating cavities, especially of a joint-cavity, demands that an independent consideration be given to such joints as are drained with difficulty on account of their anatomical peculiarities. To this class belong the knee, wrist, shoulder, hip, and the tarsal and carpal articulations. The proper drainage of a joint-cavity, like other cavities, is based on the simple fact that the drainage-aperture must be at the most dependent part of a cavity, and, also, that all of the pockets of the cavity be thoroughly drained. At the time when the drainage-openings are being made, the limb should be placed in the position it will take during treatment, in order to arrange their location and direction in accordance with the force of gravity. The knee-joint has not only extensive, but devious, outlines, which are greatly modified by the position of the leg. If the leg be extended and the muscles of the thigh be relaxed, all portions of the joint-cavity are then quite freely communicable with each other, a fact that is well illustrated pathologically by the floating patella and bulging pouches, so diagnostic of over-distention of its synovial cavity. As soon, however, as flexion of the leg is begun, the patella is brought in contact with the articular surface of the femur, and the greater the degree of flexion the firmer will be the apposition of their articular surfaces ; so that, when the limb is flexed at a right angle the joint-cavity will be practically, although not completely, divided into two cavities, one behind and below the patella and the other above it. With the limb in this position it is not possible to thoroughly wash out either cavity by the way of the other. When the limb is extended the upper synovial prolongation of the joint extends often four or five inches above the patella, beneath the tendon of the quadriceps extensor, and connects with the main joint-cavity by a free opening, which at times is much constricted. As the leg is flexed this pouch is continuously drawn down, until, with the limb fully flexed, it is located at the upper limit of the articular cartilage at the lower end of the femur ; therefore, when

this pouch is to be opened at its uppermost limit the leg must be fully extended. At the posterior aspect of the joint-cavity each condyle of the femur rests in a cup-shaped depression of the ligamentous tissues, and each one should be drained independently. The synovial membrane also surrounds the upper end of the tibia and the lower portions of the outer surfaces of the condyles of the femur, and in the recesses thus formed, unless unusual care be taken, inflammatory products may collect and decompose. In order to prepare for the thorough washing-out and draining of the knee-joint, the leg must be fully extended, and through an incision made at one side of the patella the index-finger of the operator should be introduced into the joint-cavity, and pushed upward beneath the patella into the mouth of the submuscular prolongation of the synovial membrane, the neck of which is stretched or divided if it be too narrow to admit the ready entrance of the finger, which is then carried beneath the vasti muscles to the uppermost limits of the sac ; and at these points the drainage-tubes are carried through to the antero-lateral surfaces of the thigh. The cavity above the patella should be additionally drained by tubes passed into it at either side of the tendon of the quadriceps extensor, close to the upper end of the patella. The remaining part of the cavity is drained through its anterior and posterior portions. The anterior openings are made beneath the ligamentum patellæ, at the apex of that bone. The posterior drainage-tubes are passed between the hamstring tendons and the bones in front, into the posterior condyloid pockets before mentioned. Each of the tubes should extend into the joint only a sufficient distance to permit the ready escape of all fluids ; in no instance should they pass through a joint from side to side. Through these openings the joint can be thoroughly washed out and well drained. The tubes are permitted to remain until all inflammatory symptoms have subsided. Those at the posterior condyloid depression and in the submuscular pouch are the last to be removed. The wrist, the carpal, and tarsal articulations are compound in their structure, since they possess more than one independent synovial membrane. Each of these joints is opened, as a rule, on the dorsal surface, and great care must be taken not to extend the operation into a synovial cavity not involved in the disease.

The phalangeal joints should be drained on their dorsal surfaces, on account of the presence of the flexor tendons and their sheaths. The shoulder-joint is best drained in front, while the hip-joint can be drained either behind or in front of the great trochanter.

Prognosis.—The prognosis for life, in all cases of penetrating wounds of joints followed by suppurative inflammation, is good, if the drainage and attention be thoroughly antiseptic, and the patient be not old or in feeble health. The larger the joint involved, the greater the danger to life. Pyæmia, septicæmia, and extravasation, from prolonged suppuration and suffering, are the common causes of death, although erysipelas and tetanus not infrequently occur. The precautions that tend to save the life also favor the recovery of the limb. The almost inevitable sequel of a continuous suppurative process in a joint is partial or complete ankylosis.

2. Contused Wounds of Joints.—These wounds are caused by direct violence alone ; they may be slight in degree, involving only the soft parts at the point of injury, or they may be extensive, accompanied even by fracture or complete crushing and disorganization of the bony structures of the joint. In the former instance a blow or a kick is a quite sufficient cause ; in the latter, the limb must be caught between two strongly opposing forces, as between the buffers of cars, or the like. Between the extremes just given any degree of contusion may occur. In some instances, when the local effects of the violence have not been great, the joint is said to have been "concussed." I can see no necessity, however, for this independent distinction, since the difference in the effects of the violence and in the indications for treatment do not warrant this discrimination.

Symptoms.—The symptoms will depend largely on the degree of the injury. The local symptoms are pain, tenderness, and swelling, to be found principally at the seat of the violence. The functions of the joint will be impaired in direct proportion to the degree of the violence. The first aim of the surgeon should be to ascertain if a fracture have occurred ; if so, the contusion becomes a secondary matter, and the limb is relegated to the treatment of fractures implicating joints.

Treatment.—The treatment of all uncomplicated contusions of joints is practically similar to that for sprains.

3. Lacerated Wounds of Joints.—In lacerated wounds of joints the soft tissues, and even the ligaments, are torn. This variety of injury is commonly associated with severe contusions, and also with compound dislocations and compound fractures of a joint. The violence of machinery, falls from high elevations, and from rapidly moving vehicles, are among the common exciting causes of these wounds. The knee, elbow, ankle, and metacarpo-phalangeal articulation of the thumb are, owing to their greater exposure to passing violence, as well as to their superficial situations, the joints most subject to this variety of injury.

Symptoms.—The nature of the wound and a knowledge of the degree of violence causing it are suggestive of the gravity of the symptoms. The patient suffers from shock due to the general effect of the violence causing the wound, as well as from the wound itself. Locally, the gaping, irregularly bordered opening from which blood and synovial fluid may be slowly oozing, and through which the smooth articular surface of the joint may be seen or felt, makes the diagnosis of a joint implication positive. The wound may be so small as to be readily closed by a blood-clot, or by the overlapping of the tissues. There is slight hæmorrhage, unless a main vessel be torn. The synovial fluid may flow almost imperceptibly through even a quite large wound ; it may be clear, or mixed with fluid or clotted blood.

Treatment.—Administer stimulants if the patient be suffering from shock. The local treatment is by far the most important. If a dislocation be present, reduce it at once ; if the bones be fractured, place them in position, and wash out the joint-cavity and all of the interstices of the wound with an antiseptic solution ; secure all bleeding points and wrap the wound and the limb contiguous to it in several thicknesses of antiseptic gauze or cloths saturated in a strong disinfectant solution, until the constitutional state of the patient will warrant a further procedure. As soon as reaction is thoroughly established, administer an anæsthetic and remove the temporary dressings under strict antiseptic precautions ; wash out the joint-cavity as before, removing all blood-clots and foreign bodies from it and from the surrounding tissues. The edges of the wound are then carefully trimmed to remove the torn, devitalized tissue at its borders, thereby converting it into an incised wound ; all bleeding is stopped, and the joint is drained by the means of small rubber or decalcified bone drainage-tubes, or horse-hair carried into, but not through, the joint-cavity, at its most dependent points. The opening in the soft parts is then closed by a continuous suture of catgut, the wound dressed antiseptically, and the limb immovably confined. The dressing of the wound thereafter will be governed by the recognized principles of antiseptic surgery. If the wound of the soft parts be small, and a doubt exists as to its communicating with the joint-cavity, the joint should be given the benefit of the doubt, and all interference with the opening by probing, etc., must be carefully done under an antiseptic douche. In this instance, too, the wound must be dressed antiseptically, and the limb immovably confined while awaiting the development of the true nature of the case. If the joint-cavity be opened sufficiently to admit of the escape of synovia, the opening should be enlarged under antiseptic precautions, and be treated with the same vigor and by the same means that were employed in the instance of a free communication with the joint. After the wounds of the soft parts are healed the functions of the joint are to be restored by means of the recognized agencies for this purpose. Erysipelas, pyæmia, septicæmia, and also tetanus, may complicate all forms of wounds of joints, although

much less danger of their occurrence is to be apprehended since the almost universal use of antiseptics. Ankylosis, more or less complete, and even necrosis, are sequels to be anticipated.

4. Punctured Wounds of Joints. — Punctured wounds of joints are less dangerous than the lacerated variety. The well-recognized agents that cause punctured wounds elsewhere about the body may likewise enter a joint-cavity. The severity of a punctured wound will depend on the size and the condition of the agent causing it, and also on the force expended. A small polished agent, that only enters the joint, need not be followed by any unfavorable symptoms. But if an agent be blunt and rusty, or be contaminated by septic matter, or be propelled with much force, sufficient to injure the internal structures, a prognosis of immediate recovery should not be entertained.

Symptoms.—The symptoms will be modified by the severity of the wound. If synovial fluid does not escape from the external opening the implication of the joint-cavity will be somewhat problematical, unless the vulnerating agent presents strong evidence to the contrary. If, after a day or so, acute synovitis supervenes, attended by the pain, heat, and joint disfigurement characteristic of it, little doubt can then exist that the joint was involved in the original injury. These symptoms, under proper treatment, may subside in a few days, or they may increase in intensity and become associated with a high constitutional fever; the site of the wound becomes red, swollen, and even fluctuating, indicating the existence of pus around, and probably within, the joint. On movement of the articulation the pain will be intense, and, if the knee be the joint in question, the patient will be apprehensive of the slightest movement of the bed. If the needle of an aspirator—or, better, of a hypodermic syringe—be now introduced into the joint-cavity, more or less pus may be found mixed with the synovial fluid. At this time, too, suppuration at the entrance of the wound is often seen, and, if the wounding agent have been a large one, oozing of purulent synovia may be present. The agent causing the wound should always be sought for as soon as possible after the receipt of the injury, not only for the purpose of ascertaining its previous physical peculiarities, but also to ascertain if it have been broken off, and if a portion of it may not have been left in the cavity of the joint.

Treatment.—The patient must be kept in bed, irrespective of the trivial appearance of the wound. The joint is made immovable, and one or two thicknesses of cloth saturated with a strong antiseptic solution should be wound around the joint to prevent external infection at the seat of the injury, and ice-bags placed around the whole. All pain is to be relieved by anodynes. If the joint becomes distended with a questionable fluid, and the symptoms point to a possible suppuration in its cavity, it should be aspirated. At first some pus-corpuscles may be found in the fluid of the joint, even though the suppurative action has not become established. If after two or three aspirations the symptoms increase in intensity, and the pus appears in the fluid in greater amount, a free incision must be made into the joint-cavity, its interior must then be thoroughly washed out with antiseptic fluid, drainage introduced at its most dependent portions, and the joint dressed antiseptically and immovably confined. If it be thought that a foreign body be in the joint-cavity, it must be sought after through a free incision in the joint, as soon as active symptoms, attended by pus formation in the joint, present themselves. The complications and sequels of punctured wounds are substantially similar to those of lacerated wounds.

5. Gunshot Wounds of Joints.—Gunshot wounds partake of the peculiarities of the lacerated and contused varieties, which peculiarities are often combined with more or less extensive compound comminution of the bony structures of a joint. When a rifle-ball of the regulation size passes through a joint, the bony, cartilaginous, and ligamentous structures are more or less disorganized, and even the contiguous vessels and nerves may be seriously injured or destroyed. If the missile be a spent one, or have been propelled by an inadequate force, it may lodge in the joint-cavity, or become more or less completely imbedded in the articular extremity of one of the bones of the joint; and, too, a ball may pass close to, or may open, either aspect of the capsule of the joint (peri-articular wound), causing a lacerated wound of it without any injury to the bony structures whatever; or it may pass through the joint, grooving either aspect of the bones or of the articular cartilage.

Symptoms.—Shock is usually present, and will demand special treatment in many instances. Locally, the openings caused by the ball, with their well-recognized differential characteristics, from which blood and synovia may slowly ooze, mark the picture. Crepitus and the presence of bony fragments may often be detected by manipulation. The different courses that balls may take, and the various effects that they may produce, are numberless; yet, for practical purposes, the wound may be supposed to present either of the following seven conditions: (1) The ball may have passed through the cavity of the joint without injury to its bony or cartilaginous structures. (2) It may have entered the joint and remained loose in its cavity. (3) It may have entered the joint-cavity and have become imbedded more or less completely in the head of a bone. (4) It may have passed through, or have remained in, the joint, after having fractured the bone. (5) It may have passed through the bone without fracturing it. (6) It may have caused a more or less extensive comminution of the bone structure. (7) It may have destroyed the vascular or nervous supply to the limb below the point of injury.

Treatment.—If severe shock exist, general stimulation must be employed. If a great loss of blood have occurred, it may be thought wise to transfuse, or to inject a saline solution into the circulation of the patient, in addition to the other recognized measures. The local treatment is conservative and operative, and every measure connected with it must be employed only with the most rigid antiseptic precautions. If the ball "have passed through the cavity," etc., as in the first of the seven conditions, the fact can be determined quite easily by exploring the course of the wound with a probe. The treatment thereafter is similar to that for lacerated wounds of joints.

The second condition of the seven above given is often difficult to ascertain, and must be strongly inferred rather than proven, by the comparative tardiness and mildness of the symptoms following the injury; by the inability to detect an injury of the bone with the probe, and by the sensation as of a foreign body within the joint, which may be elicited upon movement of the articulation. The location of the ball may be determined by means of the porcelain-pointed probe; if this cannot be done, the wound should be enlarged sufficiently to admit the little or index-finger of the surgeon, by means of which, aided by a change in the position of the joint, the ball may be located and the extent of the injury to the joint structures be likewise determined. The ball and other foreign bodies should then be removed, the joint washed out with an antiseptic solution, and treated in other respects as a lacerated wound of a joint.

The third of the seven conditions can be ascertained only by a direct examination by the porcelain-pointed probe or by the finger. When detected, if the ball be movable it should be taken away; if it be immovable and so imbedded in the bone as to interfere with the movements of the joint, it should be removed at once. The after-treatment should be similar to that of lacerated wounds.

If the ball have passed through the joint and fractured the bone, as in the fourth condition, the fact can be determined by the presence of crepitus added to the common signs of joint penetration. The treatment is similar to that for a lacerated wound of a joint complicated with a fracture extending into it, *i.e.*, a compound fracture of a joint. If the ball have not passed out, its location must be carefully sought for by examining the course of the wound with a porcelain probe. If the ball be found and be loose, it should be removed at once; if it be firmly

fixed, it should be permitted to remain, and the wound be treated as if the ball had passed out.

The fifth condition is of rare occurrence. Its existence is recognized by the aid of a probe, and by the absence of crepitus and of a false point of motion. All bony fragments should be removed from the track of the wound, which is then treated like a lacerated wound of a joint.

The sixth condition is the common one, especially in adult bones. The general appearance of the wounded joint, together with abundant crepitus and freedom of movement in all directions, will establish the nature of the injury; but if a finger be passed along the track of the wound a more definite knowledge of its extent will be gained. Large and small fragments will be felt, together with an abundance of bony detritus and disorganized cartilaginous tissue. When the constitutional condition of the patient will permit of it, a free exploratory incision should be made into the joint-cavity, so that the surgeon may choose between amputation or excision of the joint and the more conservative course of removing all of the fragments and trusting to nature to provide a satisfactory limb.

If the arterial and nervous supply to a limb be destroyed, it should be amputated; but it should not be amputated if the vascular supply be sufficient to prevent its death, and the nervous supply be ample to provide for one or more of the important functions of the extremity. If a ball or fragment of bone be permitted to remain in the joint-cavity, and its presence be followed by unfavorable joint-symptoms, steps should be taken to remove it at once, before the resulting inflammatory action shall have destroyed the joint.

The foregoing propositions of treatment are general ones, and any deviation in the nature of the injury, or in the course of the symptoms, may call for a new, and even a radical, change in the treatment.

Complications.—Pyæmia and septicæmia are the most common and fatal complications of wounds of joints, and they are especially prominent in connection with shot injuries of joints. The more extensive the injury done the bony tissue, especially the cancellous variety, the greater will be the danger from blood-poisoning. A shot wound of a joint, however trivial it may appear, is never without danger to the patient. Erysipelas and hæmorrhage too often occur, but they are not of such significance as the former complications. Good drainage of the wound and a thorough attention to the antiseptic method of treatment will reduce the occurrence of septic diseases to a minimum. The rates of mortality connected with the various wounds of joints, and with the operations for their relief, would no doubt have been greatly lessened by a close attention to the principles of the antiseptic mode of treatment.

Sequels.—Ankylosis, caries, and necrosis are the common sequels of shot wounds of joints.

WOUNDS OF SPECIAL JOINTS.—*Hip-joint.*—The periarticular and gunshot varieties only will be considered in connection with this joint. During the late war 49 periarticular wounds were inflicted on this joint, 35 of which were supposed to have involved the joint-capsule; of the 35, 21 recovered and 14 were followed by secondary traumatic coxitis, of which 7 died. From both Union and Confederate sources there are reported 386 cases of fracture of the hip-joint from gunshot violence; of these, 304 were treated conservatively and 55 recovered; in 55 the joint was excised, and but 2 recovered; in 27 cases amputation at the hip was done, and but 2 recovered. Primary excisions of this joint were followed by the greatest death-rate, 97 per cent.; intermediary by 91 per cent., and secondary by 73 per cent. Primary amputations at the hip were followed by a mortality of 88 per cent.; intermediary, 100 per cent.; secondary, 78 per cent. In reamputations about one-third perished. The comparisons of results, as to periods of time, between excision and amputation are based on an equal number of cases of each (66). It is not possible to determine which is the best method of treatment from the results of the civil war, with its septic associations. I believe, however, in civil practice, where all antiseptic precautions can be commanded, that the wound should be explored, all pieces of bone and foreign bodies removed, the wound-cavity thoroughly drained, and the antiseptic method strictly enforced. At a later date excision or amputation can be done when expedient.

Knee-joint.—During the late war 12 punctured wounds of the knee-joint were inflicted by bayonets, knives, etc., of which the entire number terminated in recovery. During the same period 39 incised wounds of the same joint were received, 33 of which were treated without operative interference, with 4 deaths, and 6 were followed by amputation at the thigh, 5 of which died. Contused wounds of the knee-joint from balls, shell, etc., are reported in 43 instances, of which 33 were treated without operative interference, with a death-rate of 33.3 per cent., while the remaining 10 were followed by amputation. Shot fractures of this joint occurred in 3,355 cases; of these about one-fourth were treated conservatively, with a mortality of about sixty-one per cent. Primary excision gave a death-rate of about eighty-six per cent.; intermediary excision, 92 per cent.; secondary excision, 43 per cent. Amputation at the knee-joint was done 189 times, of which 108 were primary, with a death-rate of 53.2 per cent.; 51 intermediary, with a death-rate of 68 per cent.; while 26 secondary operations gave a mortality-rate of 53.8 per cent. Four of the number are not classified. If the bone structures be comminuted, a free incision should be made into the joint-cavity, the entire damage fully exposed to view, and the fragments of bone and foreign bodies removed. If, then, the firm extremities of the bones can be placed in contact with each other sufficiently to warrant the expectation of a useful joint after recovery, the method of conservation can be carried out under strict antiseptic principles. If, however, the extremities of the bones be irregular and jagged, and the periosteum at the seat of their injury be destroyed, excision should be done as soon as the patient's condition will admit of it. The question of amputation should not be entertained, unless the bones or the vessels and nerves be so much destroyed as to make recovery with a useful limb a matter of great doubt. If the knee-joint be filled with blood as the result of a contusion, it should be withdrawn at once by aspiration, to avoid the delay incident to its absorption, and also the subsequent obstruction to motion caused by the presence of the coagulated fibrin in the joint-cavity.

Ankle-joint.—When a ball traverses the ankle-joint, it commonly reduces it to a mass of osseo-cartilaginous fragments. During the late war this joint was contused 11 times, 7 of which were treated without operative interference and 4 by amputation. It suffered 1,711 times from gunshot fractures, of which 518 were treated by expectant measures, resulting in a death-rate of 19.5 per cent. Excision was done in 33 instances, with a mortality of 29 per cent. Primary excision was done 11 times, with 2 deaths; intermediary, 8 times, with 3 deaths; secondary, 9 times, with 4 deaths. The joint was disarticulated 161 times, in 159 of which the death-rate was 25 per cent.; 103 primary amputations gave a death-rate of 22.7 per cent.; 39 intermediary, 35.9 per cent.; 13 secondary, 77 per cent. The mortality from Pirogoff's method was 28.5 per cent.; from Syme's, 25.6 per cent. The vessels and nerves are very liable to be destroyed in gunshot wounds of this joint, which makes the demand for a primary amputation urgent. If they be intact, and the bones of the leg be not split high up, remove the fragments, trim off the sharp bony points, and endeavor to preserve the joint without further loss of tissue; failing in this, a secondary excision is to be done, or possibly an amputation.

Shoulder-joint.—The periarticular wounds of this joint were 72 in number, of which 6 proved fatal; 36 were discharged for disability caused by false ankylosis principally, and 30 were returned to regular or modified duty. Of 505 gunshot fractures of the shoulder-joint treated by conservation, 247 were discharged for disability, 119 were returned to duty, and 139 died. Some portion of the articular surface of the joint was excised in 885 cases. The primary operations gave a death-rate of 30 per cent.; the intermediary, 46 per cent.; the secondary, nearly 30 per cent.; 8,562 amputations were done at the shoulder-joint

for gunshot fractures; of these, 24.1 per cent. perished from primary, 45.8 per cent. from intermediary, and 28.7 per cent. from secondary amputation. The general plan of treatment for gunshot fractures of this joint can be readily outlined by consulting the plans recommended for the several degrees of injury of joints that have been previously considered in this article. Special attention should be paid to securing proper drainage. Absolute rest and a restricted diet should be enforced in connection with the expectant method of treatment. The axillary pad of Stromeyer, or some contrivance that will fulfil the same indication, should be employed to support the arm.

Elbow-joint.—Punctured and incised wounds of this joint have occurred rarely, and but little of special interest is said of them. This joint was fractured 2,678 times from gunshot violence during the war, of which number 924 were treated throughout on the expectant plan, with a mortality-rate of but ten per cent. The percentage from amputation, twenty-four; from excision, twenty-three; the secondary excisions gave the most favorable results. When a ball traverses the elbow-joint, an almost complete disorganization of its structures is the result; the vessels and nerves, especially the ulnar nerve, are frequently injured or destroyed. During the treatment great care is to be taken that the recesses of the joint are well drained. If excision be done, the bony attachments of important muscles, as the coronoid and olecranon processes, and the tuberosity of the radius, must be preserved, if possible, else the functions of flexion and extension will be crippled or lost.

Wrist-joint.—Gunshot fractures of the wrist-joint are especially perplexing, since any obliquity in the course of the ball is liable to injure the articulations of the carpus as well. Fourteen hundred and seventy-six gunshot fractures of the wrist-joint occurred during the war, of which 716 were treated by conservation, with a death-rate of 7.6 per cent. Ninety-six excisions were followed by a death-rate of 15.6 per cent.; intermediary by 25 per cent., and the secondary by 12 per cent. Amputation at the wrist-joint was done in 68 instances, in 66 of which the death-rate was 10.6 per cent. Fifty-five were primary amputations, with a rate of mortality of 9.2 per cent.; 7 were intermediary, 1 of which died of tetanus; 5 were secondary, of which 1 died. The local treatment of gunshot fractures of the wrist-joint is plain and straightforward. Expose the seat of the injury and remove all bony fragments and foreign bodies, trim off the bony projections and the soft tissues that are superfluous or devitalized, establish perfect drainage, and treat with antiseptic precautions in all respects.

Vertebral Column.—Gunshot wounds of the vertebral column are treated on the general principles of similar injuries elsewhere. Remove all the foreign bodies and bony fragments possible through the tract of the wound, or through free incisions made for that purpose. The presence of the spinal canal and the vertebral foramina, with their important contents, must be kept in mind during the operative procedure; also the important vascular, nervous, and visceral relations of the vertebral column. Shot wounds of the vertebral column, when treated by expectancy, have had a death-rate of fifty-five and a half per cent.; by operative interference, ten per cent. less; still, the unknown relative severity of the two classes detracts from the importance of the difference of the results of treatment. *Joseph D. Bryant.*

JOINTS, MOVABLE BODIES IN. This title is expressive of conditions not thoroughly understood, and concerning the nature of which various and diverse opinions have been expressed. There is no doubt of the fact, however, that movable bodies are sometimes found in the joints of the human body, especially the knee-joint—bodies that possess more or less of the peculiar characteristics of hyaline and fibro-cartilage, but whose causation and origin are as yet more or less matters of speculation. The expression "movable cartilage" has been variously applied, according to the fancy or judgment of the surgeon. In the one instance it is expressive of a too freely movable semilunar cartilage, dependent on the elongation or rupture of the coronary ligaments that normally exert a strong influence in limiting its movements; in another instance it signifies the existence in the joint-cavities of movable fragments of cartilage, of a hyaline character, presumably separated from the articular cartilage by supposititious or actual violence. In fact, an internal derangement (Hey) of a joint, especially the knee-joint, attended by sudden symptoms of a character not unlike those that may occur with the known presence of an abnormally movable body or cartilage in a joint, has been thought, and perhaps justly, to depend on similar agents that fail to appear at a point where a superficial examination can confirm the suspicion of their existence. Many conditions that have been confounded with movable cartilages will be noted under the head of causation. These movable bodies vary in shape, size, number, color, structure, consistence, manner of formation, relations to intra-articular structures, etc. Their outline may be oval, with a biconcave, concavo-convex, or biconvex form; they may be globular or chestnut-shaped; conglobate or mulberry-formed; sometimes pisiform. The last two varieties are rare—the first of which is formed partly or entirely of osseous tissue; the last is commonly lipomatous. As a rule, their shape will be governed by the pressure to which they are subjected, during and after their development, by the structures of the joint in which they exist. They are of all sizes, from those scarcely appreciable to those of the dimensions of the patella or of a hen's egg. Their number is commonly in inverse ratio to their size. When of large size, but one or two usually exist, while, under certain circumstances, there may be fifty or more, especially in the knee-joint. Their color is commonly whitish, grayish, or of a pale straw-tint. Their structure will depend not a little on the age and source of the bodies. As a rule, the more recent their existence, the less firm will be their structure. They may be at first fibrous, later cartilaginous, and finally osseous. Those bodies that originate from other than cartilaginous and bony sources will undergo these various structural changes less rapidly and completely than if they arose from the latter. Their consistence keeps pace with their tissue changes, preserving the similar relation to these changes that characterizes other tissues of the human body while undergoing similar changes. The method of their formation is in many instances problematical, as will be seen further along in this article. Their relations to the intra-articular tissues are variable; they may remain unsuspected within the inaccessible recesses of a joint, or retreat quickly and easily into them when manipulated from without. Their undoubted presence in a joint may give rise to no symptoms; or their unconfirmed existence may torment the patient, and even render the limb unserviceable. Various joints are liable to their formation, especially the knee, elbow, wrist, and maxilla; the first named is, however, the most frequently affected, and here, too, they acquire the largest growth. The ball-and-socket joints suffer less frequently than those of a ginglymoid character, owing, no doubt, principally to the influence of their conformation, opposing the development of these bodies in the former instance, while facilitating their development in the latter.

Classification.—Movable bodies in joints, be they of cartilaginous parentage or otherwise, can be divided for practical purposes into two classes: (1) Those that are non-adherent or unattached to any restraining influence, consequently freely movable in all directions within the joint-cavity; (2) those that are attached by a longer or shorter connection to the cartilage or synovial membrane of the joint, whereby the extent of their movements is limited. To the first class belong the pieces of cartilage supposed to be broken from the articular extremities of the bones forming the joint; also such other bodies as may be formed from the synovial fringes, or whose development is associated in some problematical manner with other of the joint structures, from which they thereafter became detached. To the second class belong displaced semilunar cartilages; also all other attached movable bodies within joints. It is at once evident, with the

exception of the derangements of the semi-lunar cartilages in the second class, and the chipping off of the articular cartilage in the first class—conditions that are not interchangeable—that the freely movable bodies of the first class may be constantly increasing in number by rupture of the restraining influences of the attached bodies of the second class.

CAUSATION.—Adult males are afflicted most frequently, owing, no doubt, to the severer use of the joints, to the greater liability to traumatic influences, and to the adverse surroundings of more onerous occupations. They likewise develop in joints of those possessing rheumatic tendencies, especially of the chronic arthritic type. Traumatism, however, is the most common exciting cause, although it is not necessary that it shall be severe, since slight and almost forgotten violence has been quickly followed by tangible evidences of these bodies. In cases of this nature, however, it is but fair to presume that some morbid process has preceded the receipt of the violence, which process rendered a separation of the bodies easy on account of the structural changes attending it. The most prolific combination of causal influences is traumatism combined with rheumatic tendencies. The causative histological changes that underlie the development of these "movable bodies" have been much discussed since 1558, at which time they were first noticed in the knee-joint by Ambroise Paré. John Hunter referred their origin to the "living principle of the blood," a principle that, by vascularization and development, produced, according to circumstances, either membranous, cartilaginous, or bony growths at the seat of an extravasation of blood ; hence Hunter believed them to be due to an organization of a blood-clot effused into the joint. Andral at one time considered the possibility of their origin from chips of the normal cartilage, but dismissed the idea, for the reason that they were sometimes found in the cavities of serous as well as of synovial membranes. Laënnec and Béclard expressed the view that they were sometimes formed outside of a serous or synovial membrane, and that the membrane was pushed before them as they increased in size, until they became pedunculate and, finally, entirely separated from the surrounding joint-structures by the rupture of the slender band that connected them. These observers appreciated the fact, however, that this explanation failed to account for the occasional formation of bodies of a similar structure in the adipose tissue of the orbit, spermatic cord, and elsewhere. A belief in this method of formation is still extant. It is thought to depend on a hyperplasia of the tissue immediately beneath the basement-membrane of the synovial lining of a joint, or of fibrin located in this tissue, caused by the stimulus of a blow or some other form of injury. They are also thought to be developed outside the synovial membrane, where that structure is closely associated with the periosteum. In this instance osteophytic growths caused by violence, by deforming arthritis, or by both influences combined, are thought to press against the synovial membrane, causing it to project internally, and finally to lead to movable bodies in the joints by the mechanism just described. Rokitansky suggested that they might sometimes originate in the enlargement, transformation, and subsequent detachment of synovial villi. Rainey investigated the subject from this standpoint with much care and detail, and seemed to become convinced that the existence of movable bodies in joints depended almost, if not entirely, on this source of production. Klein, Velpeau, Virchow, Weichselbaum, and many others have cited instances to show conclusively that at least some movable bodies in joints may be of a cartilaginous structure, and have had their origin from the articular cartilage of the joint containing them. The great size of many of them, when compared with the presumptive size of the articular cartilage from which they are supposed to have originated, is thought to depend on the inherent vitality of the fragments and of the attached cartilage, which causes an increase in the size of the fragment, while it lessens the dimensions of the hiatus in the remaining cartilage. There can be no doubt of the fact, in my opinion, that movable cartilages, in the strict sense of the term, do exist in joints, and, moreover, that these cartilages originate from chips of the articular cartilage ; still it is manifestly unfair to suppose that a joint full of these movable bodies could have resulted only from the traumatic displacement of "chips" from the articular cartilage of the joint alone, although it can be conjectured that, under favorable conditions, detached cartilage-cells can maintain a separate existence, and finally become developed into the independent bodies in question.

SYMPTOMS.—The symptoms of movable bodies in joints will depend largely on their size, situation, and mobility. If of large size they cause but little pain, but when smaller and so constituted as to admit of their intrusion between the articular joint-surfaces, they occasion severe suffering, and not infrequently violent synovitis. A sense of pain or a queer feeling in a joint, the knee more especially, attracts the patient's attention, and causes him to examine it, when a lump of larger or smaller size may be found on a line of the articulation, which will elude his grasp, gliding from one superficial portion of the joint to another at a touch, or disappearing altogether into the joint-recesses. But little pain or tenderness attends these movements at first, and the functions of the joint are not interfered with, unless the body glides beneath a tendon or ligament that modifies the movements of the joint ; and even then the pain and loss of function are never of that acute character that attends the presence of the smaller bodies between the articular surfaces. If large substances slip around habitually, the joint will not only become painful and tender, but also enlarged from the increase in the secretions of the fretted synovial membrane, and from extra-articular deposits as well. It is seldom, indeed, that sufficient enlargement of the joint occurs to entirely obliterate the outlines or conceal the movements of the offending bodies. In the knee-joint they are found at the side of the patella, usually at the external border, also in front and behind the lateral ligaments. A movable body of large size may harbor itself in some joint-recess and remain there for an indefinite time without causing trouble, until finally it again migrates, and is then followed by its characteristic symptoms. If the affection progresses the tenderness and swelling of the joint increase, and it becomes weakened ; the continued irritation of the synovial membrane increases the amount of its secretion ; the ligaments may become relaxed, and the limb that was, at first, but temporarily incapacitated, then becomes permanently lame and often helpless.

The symptoms just enumerated are mild when compared with those commonly attending the intrusion of one of the smaller bodies between the articular surfaces of, for example, the knee-joint. The first sign of this occurrence is usually a sudden severe pain of an indescribable character, and the joint is fixed by the violent contraction of the muscles of the limb ; if the patient be moving he will stop instantly, seize the nearest object of support, or sit down. The pain is sometimes of a sickening character, causing the patient to vomit, and even to faint. The attack may occur either with flexion or with extension of the leg, and is much more severe when happening with extension, because the greater the degree of flexion, the greater the relaxation of the ligaments of the joint, and consequently the less the degree of pressure. In extension, however, exactly the reverse takes place, for the greater the degree of extension, the firmer are the articular surfaces opposed to each other ; and when the leg is completely and firmly extended, no separation of the articular surfaces can be made, by extension of a normal knee-joint, without rupturing or stretching its ligaments. Immediately after the attack there is a great dread of any movement of the joint, although one soon has the sense that flexion or extension will make it well again—a fact that not infrequently leads the patient, by a resolute effort, to make the attempt, painful though it be, and fortunately his fortitude is often repaid by a successful issue. In other cases the joint will remain fixed until, by rest or medication, the muscles are caused to relax. Attacks of the kind just described are usually followed by considerable pain, tenderness, and swelling of the joint, due to the synovitis caused by the violence. These attacks oc-

cur at irregular and uncertain intervals, sometimes at night, more often by day, and are always induced by a movement of the leg—whether it be a common or an unusual movement, the result may be the same. For these reasons the patient lives in the constant dread and uncertainty of succeeding attacks, and is therefore willing to submit to almost any remedial measures that offer a prospect of relief. Fortunately, however, every new or succeeding attack is not as severe as the one just depicted ; yet they are all painful, and their occurrence is to be dreaded not only for this reason, but also on account of the structural changes of the joint that follow their frequent repetition. The symptoms associated with deranged semi-lunar cartilages compare somewhat forcibly with those already mentioned ; in fact, the diagnosis between the two conditions will be impossible, unless, on the one hand, a physical examination or the history of the case reveals the existence of the movable bodies, while, on the other hand, their absence, along with repeated attacks with extension of the limb, will characterize the case as being one of simple derangement of the cartilages.

Diagnosis.—Movable bodies in joints are to be diagnosticated from only a few morbid conditions of these structures. The suddenness of the attack, the severity of the pain, and the ability of the surgeon or the patient to feel and to move the concretion, the ease with which the patient is able to relieve himself, the chronic course of the disease, without the history of an injury, and the frequent recurrence of the symptoms from trivial causes, point almost unerringly to the nature of the affection. These phenomena appear more or less constantly, with but little variation in their characteristics, in all joints afflicted by this disease. Hey's "internal derangement of the knee-joint ;" the existence of gouty concretions on the articular surfaces ; the catching of the flexor tendons of the leg on the bony prominences about the knee-joint ; and locking of the joint on account of direct violence received at the tender points of its anatomy, may each deceive the unwary surgeon. The nature of the derangement described by Hey, and attributed by him to "an unequal tension of the lateral or cross ligaments of the joint, or some slight derangement of the semi-lunar cartilages," is still an unsettled question. Mr. Knott believes it to be caused "by the combined twisting and lateral movement conveyed to the knee at a moment when the ligaments are as lax as possible, whereby the margin of the condyle is *jerked over* the edge of the internal semilunar fibro-cartilage." He cites from a personal experience based on repeated attacks in his own knee, and adds, "It has always been the result of *very slight*, and in every instance *indirect*, violence applied so as to produce a twist of the knee, either of the leg outward or femur inward," as from a light blow at the inner side of the great toe when the knee is slightly flexed. He describes the pain attending it as agonizing, located at the inner side of the joint, and accompanied by slight flexion and external rotation of the leg. Mr. Noble Smith, while he does not doubt the correctness of the mechanism of the abnormal condition in the knee-joint of Mr. Knott, does not consider it typical of Hey's internal derangement of the knee-joint. Mr. Knott believes that the variety of displacement from which he himself suffers is the only known form which can occur, from slight or indirect violence, in an otherwise normal knee-joint. A cursory examination, even, of the literature of this subject will convince one that displacement of the semi-lunar cartilages, especially of the inner one, is quite frequently the active element in a case of so-called internal derangement of the knee-joint ; and there can be no doubt of the fact that direct and circumscribed violence received at the margin of the tibia may destroy the coronary attachments of the semi-lunar cartilage. Mr. Annandale reports a case of a miner who, while working in a kneeling position, felt something give way in his right knee, which was followed by sharp pain. After a general treatment at home the patient was admitted to the hospital. "On admission the joint was slightly swollen, and there was a small amount of effusion into its cavity. The patient complained of acute pain on certain movements of the joint, which frequently became locked in a fixed position," and although a little manipulation unlocked the joint, the frequency of occurrence of this accident incapacitated the patient from labor. A careful examination revealed a marked hollow at the proper site of the internal semi-lunar cartilage. A subsequent incision at this point disclosed the fact that the cartilage had been torn from its fastenings in front and had receded into the joint-cavity. Dr. Reid, in 1835, reported a case in which the external semi-lunar cartilage had been detached at its outer margin, and the cartilage was lying between the spine of the tibia and the posterior crucial ligament. Gouty changes in joints, displacement and interruption of the action of their tendons, and joint-locking from direct violence, can be easily diagnosticated by the history, combined with a careful external examination of the joint. The differentiation of attached movable bodies that get between the joint-surfaces from semi-lunar displacement is not practicable, at least until repeated attacks have been observed ; and even then only a probable conclusion can be formed ; but inasmuch as the treatment of both conditions is somewhat similar, the prognosis is not materially modified.

Treatment.—Two methods of treatment are recognized, the palliative and the radical. The former consists in the enforcement of rest and caution in the movements of the limb, avoiding all such motions as may be followed by attacks, and especially guarding against extension of the limb or rotation when flexed. Stimulating liniments, counter-irritation, and friction may afford the patient satisfaction. The rubber bandage, or knee-cap, will give a sense of security, afford support to the joint, and limit its movements. The palliative treatment is to be recommended to such as experience only a moderate amount of trouble from the condition, and in whom the joint is not in danger of becoming permanently impaired. Old persons, and those of indolent habits or feeble health, need not be encouraged to submit to the radical treatment, unless the annoyance be so great as to lessen the hold on life. The radical treatment may be employed for the relief of the following conditions : (1) To remove troublesome concretions that can be seen or felt ; (2) to readjust a displaced semi-lunar cartilage and fix it in position ; (3) to expose the interior of a joint for the purpose of removing all concretions that cause great trouble, and which cannot be detected by external examination. Before operating it is essential that the following conditions shall exist, for the safety of the patient and also for the good repute of the surgeon : (1) The acute symptoms resulting from previous attacks shall have subsided ; (2) all palliative measures shall have failed and the patient shall have expressed a wish for the treatment after all its dangers have been explained ; (3) the opportunity and ability to employ a complete antiseptic method. Prior to operating on a joint for either of the three foregoing conditions, it is absolutely necessary that the surgeon be entirely familiar with the minutest details of the antiseptic method of treating wounds, for, on this factor alone, even more than on all the others combined, will depend the safety of the limb and the life of the patient, as well as the success of the operation. Concretions that can be seen or felt can be removed in the following manner : The concretion must be first "cornered," and held by the fingers of an assistant ; it is then fixed and held in position by a strong, sharp needle, which is passed through the super-imposed soft parts into its structure. The disengaged hand of the assistant should hold the needle, while the fingers of his other hand are retained in a position to steady the movable body and, if necessary, to prevent its escape. A free incision is then made by the operator through the soft parts, directly down on the long axis of the morbid body ; when the synovial membrane is reached all bleeding points must be closed by fine catgut ligatures ; the membrane is then incised, its lips separated, and the growth seized by a strong pair of mouse-tooth forceps, and extracted. Not infrequently the growth will escape through the opening in the synovial membrane as soon as it is made. If the concretion be attached by a pedicle, its connection should be severed as far inward as possible. If other concretions be present, they, too, should be re-

moved through the same opening, if it be possible to do so. The wound is then closed by two rows of sutures; the deep one, of fine catgut, unites the lips of the synovial membrane and the soft tissues immediately above it; the superficial row, which may be of coarser catgut, unites the remaining portion of the incision. A few strands of carbolized horse-hair can be passed between the two rows to drain the wound, which is then surrounded by antiseptic dressings, and the joint is immovably fixed by a plaster-of-Paris splint, or by any other agent that will meet that indication. The sensations of the patient must be carefully noted, and his temperature taken at least three times daily, until all danger of inflammation shall have passed. If additional concretions exist at another aspect of the joint, they should be permitted to remain until another time, since it is unwise to expose the patiént to the dangers of additional incisions into the joint-cavity. A displaced semi-lunar cartilage may be readjusted and fixed in position in the following manner: Place the limb at an angle of about forty-five degrees, then make an incision down to the synovial membrane, in the long axis of the depression corresponding to the normal situation of the displaced semi-lunar cartilage; check all hæmorrhage, and open into the synovial cavity as in the preceding instance; extend the leg somewhat, so as to push the cartilage forward, if possible; seize the cartilage with mouse-tooth forceps and attempt to draw it into its normal position; at the same time extend the leg to facilitate the attempt. When properly located it is sewed to the fascia and periosteum at the border of the tibia, by fine catgut sutures, and the wound is then closed as in the preceding operation. The limb is then placed as straight as possible without causing pain to the patient. The wound, the limb, and the patient are then treated in other respects as after the operation for the removal of floating concretions. The limb should be kept extended for at least five or six weeks, to permit the repair of the tissues that hold the semi-lunar cartilage in proper position. The exploration of the interior of a joint, especially of the knee-joint, may be deemed feasible, as one of the *derniers ressorts*, for the purpose of removing therefrom movable concretions, the effects of which may have reduced the patient to a state of despair. A stiff, painless joint is much more to be preferred than a flexible one every movement of which may inflict upon the patient indescribable pain. A joint of this character may be fixed by mechanical appliances, and by this means become a useful member. If this plan should fail, however, excision is the only measure remaining whereby the limb may be saved and the joint trouble eradicated at the same time, —except, perhaps, when it is amenable to treatment by arthrotomy. There can be no doubt of the fact, I think, that a simple exploration of the knee-joint, under thorough antiseptic precautions, and the removal therefrom of all offending concretions, is fraught with much less danger to the patient than is the operation of arthrotomy or excision. The immunity from danger almost invariably attending the opening of the knee-joint for the purpose of wiring a fractured patella, seems to me to emphasize the advisability of adopting a similar procedure before resorting to excision or amputation. It is no doubt true that the irritated and inflamed state of the joint-structures, caused by the harrowing they have received from the concretions, predisposes to attacks of severe inflammation. Yet, notwithstanding this tendency, I am of the opinion that an explorative operation, and the removal of these bodies when found, is a measure that may be commended in advance of arthrotomy, excision, or amputation. The incision for this purpose can be made at either side of the patella or through it—no special directions can be given for it; general principles, however, do teach the surgeon to so regulate all incisions into a joint as to best meet their purpose and at the same time to best preserve the functional integrity of important structures. After the completion of the operation the joint should be drained at its lowest point by means of rubber or decalcified-bone drainage-tubes introduced into, but not through, its cavity. The wounds of the soft parts are then closed by two rows of catgut sutures, as before described, and dressed antiseptically and the joint immovably fixed. The intra-articular lipomatous bodies can be best treated by the palliative means, which means may even be sufficient to effect a cure. These are, however, the only ones that can be removed by any other than the radical measure.

Prognosis.—The prognosis as regards life is always good in this disease, but it is uncertain as regards the use of the limb, depending largely on the frequency and severity of the attacks, as well as on the degree of the resulting synovitis. It can be safely said, however, that an instance of cure by the palliative methods is yet to be recorded, except, perhaps, when the disease was characterized by the presence of only lipomatous bodies. The death-rate following the removal of the concretions is, according to the figures of Dr. G. Gaujot, published in 1881, a little over five per cent., which is nearly three per cent. in excess of the results shown by Barwell in 1875; but inasmuch as it does not appear whether or not all of these cases were treated by rigid antisepsis, the results cannot be accepted as conclusive evidence of the issue of similar cases at the present day. So far as my own observation is concerned, I have yet to learn of an unfavorable termination to this operation when strict antiseptic precautions were observed. The prognosis as regards life or limb following the fixation of a displaced semi-lunar cartilage is difficult to estimate, since there is but one case reported, so far as I know, which was that of Mr. Annandale, in 1883. This patient made a complete recovery, from both the operation and from the semi-lunar displacement. I am not in the possession of any data upon which to base the prognosis of exploratory incision of the knee-joint for the purpose of removing troublesome concretions, but if the amount of damage necessary to accomplish this object be compared to that inflicted on the joint for other purposes, one can at least hope for a comparatively favorable prognosis.

Complications.—Synovitis of a greater or lesser grade of intensity is quite sure to follow each attack, and, also, the joint-structures often become much disorganized by the complicating inflammatory processes. Gout, and especially rheumatism, are important in the light of causal complications. The physical and moral conditions of the patient are depreciated, not only by indoor confinement, but also by the effect of the repeated and varied disappointments incident to the persistency of the disease. The sequelæ and complications are so closely interwoven that a practical discrimination between them is hardly essential for the purposes of treatment. *Joseph D. Bryant.*

JORDAN ALUM SPRINGS. *Location and Post-office,* Jordan Alum Springs, Bath County, Va.

Access.—By Chesapeake & Ohio Railway to Goshen; thence by stage to springs.

Analysis.—One pint contains:

	Alum Spring. (Wm. E. Aiken.)	Chalybeate Spring, 52.7° F. (T. W. Mallet.)
	Grains.	Grains.
Carbonate of magnesia	.....	0.092
Carbonate of iron	. ...	0.088
Carbonate of manganese	.....	0.005
Chloride of sodium	0.091	0.014
Sulphate of potassa	0.164	0.016
Sulphate of soda	0.022	0.017
Sulphate of magnesia	0.647	.....
Sulphate of alumina	3.172	.....
Sulphate of iron	2.317	.....
Sulphate of lime	0.555	0.464
Phosphate of iron	0.031	. ..
Phosphate of lime (tribasic)	.....	0.002
Iodide of sodium	0.088	.....
Silicate of soda	0.314	.....
Crenate of iron	0.085	.....
Crenate of ammonia	0.066	.....
Alumina	.....	0.007
Silica	.....	0.090
Sulphuric acid (free)	2.955	....
Organic matter	0.073	0.011
Total	10.580	0.806
Gases.	Cubic inches.	
Carbonic acid	0.77	0.70
Oxygen	....	0.20
Nitrogen	....	1.07

THERAPEUTIC PROPERTIES.—This is an excellent alum water, beneficial as a mild astringent and tonic. Catarrhal diseases are cured or relieved by it, and the form of the iron (carbonate) in the chalybeate spring is a very useful adjunct.

These springs are situated in the Mill Mountains of Western Virginia, a range about thirty miles east of and parallel to the Alleghanies. The scenery round about is beautiful, which, with the efficacy of the water, renders this a very attractive resort. *Geo. B. Fowler.*

JORDAN SPRINGS. *Location and Post-office*, Stephenson's Depôt, Frederick County, Va.

ACCESS.—By Baltimore & Ohio Railroad (Harper's Ferry & Valley Branch from Harper's Ferry) to Stephenson's; thence by stage to springs.

ANALYSIS (T. Antisell).—One pint contains:

	Grains.
Carbonate of potassa	1.213
Carbonate of magnesia	0.360
Carbonate of iron	trace
Carbonate of manganese	0.002
Chloride of sodium	0.095
Sulphate of potassa	0.262
Sulphate of lime	0.641
Alumina	0.001
Silicic acid	0.032
Total	2.606
Gas.	Cub. in.
Sulphuretted hydrogen	0.25

THERAPEUTIC PROPERTIES.—These are very mild sulphur waters.

The springs are situated in the famed Shenandoah Valley, about five miles from Winchester. The hotel and springs are beautifully located in a grove on the banks of a stream. *G. B. F.*

JUJUBE (Codex Med.). The fruit of *Ziziphus vulgaris* Lamk.; Order, *Rhamnaceæ*, a Syrian shrub, cultivated in Southern Europe. It consists of oval drupes as large as nutmegs, with a yellowish, sweet, acidulous, or astringent pulp, which acquires a slightly vinous odor upon drying, and has a pointed, one-seeded stone. They are edible, slightly nutritious, and demulcent, but have no important medicinal properties. The so-called jujube paste seldom contains any product of the jujube itself.

ALLIED PLANTS.—Several other species of *Ziziphus* furnish similarly inferior, but edible fruits. The order contains a number of very good cathartic plants, and some which yield coloring-agents of value. (See BUCKTHORN.)

ALLIED DRUGS.—Black Currants, Elderberries, and Mulberries, and other mawkish fruits, may be taken for comparison. *W. P. Bolles.*

JULIUSHALL. This is a small place in Brunswick, near Harzburg, lying at an elevation of nearly 1,000 feet above the sea. The air is invigorating, and laden with the balsamic odors of the Oberharz. There are several saline springs, the composition of two of which is as follows: In every thousand parts are contained of

	Juliusbrunnen.	New Soolbrunnen.
Sodium chloride	61.10	66.55
Potassium chloride	....	0.40
Magnesium chloride	0.61	0.90
Magnesium sulphate	0.59	1.10
Calcium sulphate	1.93	0.84
Potassium sulphate	0.95	....
Organic matters	0.02	0.01
Total solid constituents	65.20	69.80

The waters are diluted and used for bathing, and are also taken internally mixed with whey or selters. To the water used in bathing is often added a decoction of pine-needles. *T. L. S.*

JUNGBRUNNEN is a small spa lying in a pretty valley in Würtemberg, a short distance from Rottweil, at an altitude of some 2,000 feet above the sea. There is a weak earthy mineral spring in the place, the water of which, mixed with the saline waters of Wilhelmshall at Rottenmünster, is used for bathing purposes. Much use is also made of whey in the treatment of patients visiting the spa. *T. L. S.*

JUNIPER (*Juniperus*, U. S. Ph.; *Fructus Juniperi*, Ph. G.; *Genièvre*, Codex Med.).

The common European juniper, *Juniperus communis* Linn.; Order, *Coniferæ* is of variable stature, sometimes attaining the dimensions of a small tree; more often it is a short, broad, pyramidal shrub, with spreading branches; sometimes it consists only of a large flat rosette, with its prostrate or slightly ascending branches lying on and rooting in the ground; by this habit, as well as by its slender, spreading, awl-shaped leaves in whorls of three, and by its larger and more juicy berries, it is easily distinguishable from the common juniper of this country (*J. virginiana* Linn.).

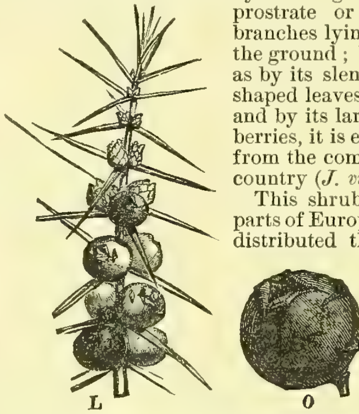

FIG. 1909.—I, Juniper Branch, with Fruit attached. (Baillon.) O, Juniper fruit, separate. (Baillon.)

This shrub grows in nearly all parts of Europe, and is also widely distributed through Central and Northern Asia, as well as in the United States (either native or naturalized). The (false) "berries" are in reality short fleshy cones, whose three upper scales have become soft and juicy, and coalesced over the three stony carpels: the rudiments of their scale-tips may be seen near the top of the fruit. The lower scales are small, dry, and appressed to the axis or peduncle. The berries shrivel a good deal in drying, and are described in the Pharmacopœia as follows:

"Nearly globular, about one-third of an inch (8 millimetres) in diameter, dark purplish, with a bluish-gray bloom, a three-rayed furrow at the apex, internally pulpy, greenish-brown, containing three ovate, somewhat triangular, bony seeds, with several large oil-glands on the surface; odor aromatic; taste sweet, terebinthinate, bitterish, and slightly acid."

COMPOSITION.—The most important substance is the *essential oil*, of which they contain from one-half to one and a half per cent. This is a clear, colorless or yellow, pleasant-smelling, turpentine-like liquid, capable of being separated into a lighter and heavier portion. Upon standing it oxydizes and separates a stearoptene. Juniper berries contain also six or eight per cent. of *wax*, twenty or more of *grape sugar*, six or eight of *mucilaginous* substances, a little *malate of lime*, and a considerable quantity of a yellow powder resembling chrysophanic acid, called *Juniperin*. The medicinal value is principally in the oil.

ACTION AND USE.—Juniper berries and oil have the properties of the terebinthinate substances in general. In small doses aromatic, stimulant to the stomach and intestines, hæmostatic; in large ones capable of producing gastritis, nephritis, strangury, etc., as well as nervous disturbances. A violet-like odor in the urine, and a copaiba-like erythema, are occasionally observed after its administration. Juniper berries are, or ought to be, used in making the *liqueur* called gin, which is alcohol distilled off from them and containing their oil. They are not much given by themselves in this country, but might be used as a stimulating diuretic; an infusion or the oil being used.

ADMINISTRATION.—From four to eight grammes (4 to 8 Gm. = gr. lx. ad cxx.) may be given at a dose. An infusion of the bruised berries extracts much of the oil, the sugar, etc., and is an acceptable form. The oil (*Oleum Juniperi*, U. S. Ph.) may also be given, but is

much adulterated with harsher oils from the tops and leaves, and even with oil of turpentine. Dose, five or ten drops. There is also a simple spirit of juniper (*Spiritus Juniperi*, U. S. Ph., three per cent. in alcohol), not much used; and a compound spirit (*Spiritus Juniperi Compositus*, U. S. Ph.), or artificial gin, offered as a more reliable aromatic than that liquor. Its composition is as follows: Oil of juniper, 10 parts by weight; oil of caraway, 1 part by weight; oil of fennel, 1 part by weight; alcohol, 3,000 parts by weight; water, 1,988 parts by weight. Dose, ten or fifteen cubic centimetres.

ALLIED PLANTS.—Several other junipers are used in medicine. *J. Oxycedrus* Linn. is the principal source of oil of cade, a tar distilled *per descensum* from its wood; other junipers probably contribute a share. *J. virginiana* Linn. was formerly officinal, its fragrant tops, like those of the European *J. sabina* Linn. (*Sabina*, U. S. Ph.), being used. Its oil, the *Oil of Red Cedar*, is an article of commerce, but not employed in medicine; properties similar to those of the other oils of this order. "Cedar apples" are galls growing on this tree; they have been used as anthelmintics; its heart-wood, reddish-pink and very fragrant and hard, is used to line fur-chests and closets. Several of the cedar oils have been used for producing criminal abortion, sometimes effecting it, occasionally killing also the mother. *Callitris quadrivalvis* (*Thuja*) Vent., in a nearly related genus, yields the resin sandarac. *Thuja occidentalis* Linn., arborvitæ, several cypresses, and other plants in the same group, supply oils of similar character. For the rest of the order see TURPENTINE.

ALLIED DRUGS.—See also TURPENTINE.

W. P. Bolles.

KAINZENBAD. A watering-place in Bavaria, pleasantly situated at an elevation of over 2,000 feet above the sea. There are five medicinal springs, the most important of which are the Kainzenquelle and the Gutiquelle. The waters contain about one part per thousand of solid constituents, chiefly bicarbonates of sodium, calcium, magnesium, and iron. The Gutiquelle contains also some sulphates and sulphuretted hydrogen. Baths of mineral water, to which sometimes a decoction of pine-needles is added, and mud-baths are employed. Kainzenbad is frequented by convalescents from acute diseases and by others suffering from debility, and the waters are also used in the treatment of anæmia, scrofula, catarrhal laryngitis, bronchitis, and female disorders. The air is fresh and invigorating, and adds greatly to the value of the place for the class of invalids who seek relief there.

T. L. S.

KAIRINE. The name *kairine* is in present use to designate, generically, certain artificially prepared derivates of chinoline, where either a *methyl* or an *ethyl* substitution has been effected in the chinoline molecule. Of the two kairines, the *methylated*, although the one first made and experimented with, has now been superseded by the *ethylated* example, for the double reason that the latter is both easier and cheaper to make, while, at the same time, it is better as a medicine. The ethylated compound, *kairine E.*, as it has been technically called, is what is now commonly dispensed under the simple name *kairine*. The kairine in medicinal use appears as a whitish crystalline powder, without smell, but of a bitter and pungent taste, of slight aromatic quality. It is fairly soluble in cold water, freely in hot, moderately only in alcohol and in glycerin, and but sparingly in ether.

Physiologically, the essential action of kairine is that of a powerful but evanescent antipyretic. Experiments upon animals show reduction of body temperature, along with slowing of rate of pulse and respiration, and, where the drug has been given by hypodermatic injection, anæsthesia and paralysis in the limb receiving the injection. Elimination is by the kidneys, and the urine presents a dark-green color, observable, it may be, within half an hour after administration of the drug. Toxic effects have followed when the dosage has risen to between one and two grains per pound weight of the animal. In the human subject, kairine produces certain and speedy lowering of fever temperatures, with less proportionate derangement than the cinchona alkaloids in the way of roaring in the ears, headache, giddiness, and gastric distress. The action is, however, apt to be attended by profuse sweating during the fall of the temperature, and a decided chill when the after-rise begins. Overdosage has produced profound reduction of temperature, with a condition of general collapse, but, so far as the writer knows, no case of death from direct kairine poisoning has yet been reported.

Therapeutically, kairine has been used solely as an antipyretic in febrile diseases, for which purpose it commends itself for its certainty and speed of action, but makes itself obnoxious by reason of the sweating, secondary chill, and considerable depression that may accompany its medicinal action. A dose of 1 Gm. (fifteen grains) of kairine begins to affect a febrile temperature in about an hour, effects its maximum influence within another hour, holds its effect for yet one hour more, and then rapidly fails in potency, so that when a fourth hour has passed since the time of taking of the medicine the temperature has commonly reattained its original elevation. By continuous medication, however, a practically continuous depression can be maintained. In ordinary cases, four successive hourly doses of 0.50 Gm. each (about eight grains) will bring down the temperature to 101° F., at which point it may be held by succeeding doses of half the previous dimensions. Where necessary, however, kairine has been given hourly in gramme doses (fifteen grains) for four successive hours. Kairine may be administered in capsule, pill, aromatized solution, or elixir. (See, also, remarks on kairine in the article on Antipyretics.)

Edward Curtis.

KAMALA (U. S. Ph.; Br. Ph.; Ph. G.). An orange-colored powder, consisting of resin-containing glands and stellate hairs rubbed from the fruit of *Mallotus philippinensis* Müller (*Croton philippinensis* Lam.); Order, *Euphorbiaceæ*, a small Asiatic tree. The fruit is a small tricoccous capsule, covered with a dense, crimson, velvety surface, consisting of the above-mentioned glands and hairs. Kamala is collected by gathering the fruits and shaking or rubbing them about in baskets, and sifting out the dust-like glands.

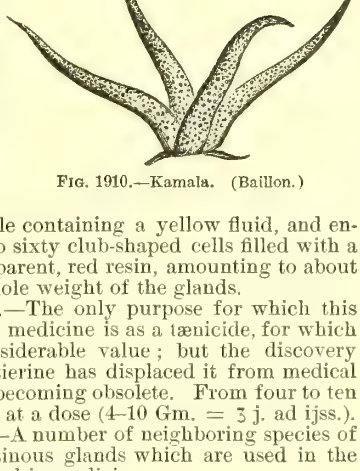

FIG. 1910.—Kamala. (Baillon.)

It has long been used in India, both as a dye and medicine, but its employment as a cure for tapeworm appears to date only from the middle of the present century.

The glands consist of an external capsule containing a yellow fluid, and enclosing from forty to sixty club-shaped cells filled with a homogeneous, transparent, red resin, amounting to about four-fifths of the whole weight of the glands.

ACTION AND USE.—The only purpose for which this drug is employed in medicine is as a tænicide, for which purpose it has considerable value; but the discovery of koosso and pelletierine has displaced it from medical favor, and it is now becoming obsolete. From four to ten grams may be given at a dose (4–10 Gm. = ʒ j. ad ijss.).

ALLIED PLANTS.—A number of neighboring species of *Mallotus* produce resinous glands which are used in the arts and recommended in medicine.

ALLIED DRUGS.—See KOOSSO.

W. P. Bolles.

KARINTHIAQUELLE is the name of a spring in Austria, the water of which is exported and employed to some extent in the treatment of catarrhal troubles of the stomach, air-passages, and bladder. The water is highly charged with carbonic-acid gas, and contains 30.6 Gm. of sodium bicarbonate, 13.2 of sodium chloride, and 7.2 of sodium sulphate in each litre. *T. L. S.*

KELOID (Greek, κηλη, a tumor, or χηλη, a crab's claw, and ειδος, resemblance). Synonyms: Kelis; Chelis; Cheloid; Fr., *Kéloïde;* Ger., *Knollenkrebs.* Keloid is characterized by the development upon and in the skin of one or more flat or rounded, smooth and firm tumors of varied and irregular size and shape, usually presenting claw-like prolongations, and bearing much resemblance to the cicatrix of a burn. The color is generally of a violaceous red, but may be nearly or quite that of the surrounding skin, and the elevation above the level of the skin may vary from a trifle to a quarter of an inch, rarely more. When pinched up, the tumor is found to be dense and hard. There are generally the subjective symptoms of pricking or tingling and pain, sometimes itching; these may be so slight as hardly to call attention to the tumor, or they may be troublesome. Keloid may appear upon any portion of the body, but is most common on the chest and neck; it occasionally follows a preceding cutaneous lesion, as a burn, syphilitic ulceration, sycosis, etc.

Diagnosis.—This is seldom difficult; no other lesion presents a similar appearance; it is distinguished from ordinary scars by its tendency to spread slowly, and by the pricking pains, etc.

Etiology.—Alibert associated this lesion with cancerous affections, but it has no relation or tendency to cancer. Nothing is known in regard to its etiology; it is more than probable that the older division into true or spontaneous and false or cicatricial keloid, where the former appears to be idiopathic and the latter to develop from preceding irritation or disease, has little or no foundation. The disease is probably always the result of local irritation. It appears to be somewhat more common in males than females, and is far more frequent in colored than in white persons. It is a comparatively rare affection.

Pathology.—Keloid belongs to the class of benign new-formations, and consists in a dense mass of fibrous tissue, involving the entire corium; the hair-follicles and sebaceous glands are absent, and the epidermis atrophied.

Treatment.—Unfortunately but little can be done in most cases of keloid; removal by surgical operation or caustic is very commonly followed by a return of the disease, even in a greater degree. Some success has been reported from the continual application, as far as possible, of the compound iodine ointment; also from repeated and multiple incisions, with the subsequent application of strong acetic acid. Collodion, freely painted on, and lead-plaster are also recommended. Personally, I am not sure that I have ever known of any remedies being of benefit.

Prognosis.—Keloid is generally of slow development, and may last a lifetime without giving rise to serious inconvenience. Occasionally it develops rapidly, and may prove troublesome by its size or the number of its tumors, or the pricking pain or itching attending them. Sometimes the tumors disappear spontaneously, and often they attain a certain size and then cease to develop; more commonly, however, they slowly progress, possibly with occasional and temporary arrest of development.

L. Duncan Bulkley.

KERATOSIS PILARIS, known also under the names lichen pilaris and pityriasis pilaris, may be defined as an hypertrophic affection characterized by the formation of pin-head-sized, conical epidermic elevations seated about the apertures of the hair-follicles.

The lesions are usually confined to the extensor surfaces of the thighs and arms, especially the former; they may occur, however, upon other parts. They appear as pin-head-sized, whitish or grayish elevations, consisting of accumulations of epithelial and sebaceous matter about the apertures of the hair-follicles. Each elevation is pierced by a hair, or the hair may be twisted and imprisoned within the epithelial mass; or it may be broken off just at the point of emergence at the apex of the papule, in which event it may be seen as a dark central speck. The skin is usually dry, rough, and harsh, and in marked cases, to the hand passing over it, feels not unlike a nutmeg-grater. The disease varies in its development, in most cases being so slight a disorder as to escape attention. In its milder form it is not uncommon. It is, as a rule, free from itching. It is seen in those who are unaccustomed to frequent bathing, and is most usually met with in cold weather. It occurs at any age, but is most common during early adult life. Its course is chronic.

It is to be distinguished from goose-flesh (cutis anserina), the miliary papular syphiloderm in its desquamating stage, and lichen scrofulosus—diseases to which it bears slight resemblance. In goose-flesh the elevations are evanescent and of an entirely different character; the papules of the syphiloderm are of a reddish color, tend to group, are more solid and deeply seated, and less scaly; in lichen scrofulosus the papules are larger, incline to occur in groups, and appear usually upon the abdomen. The disease yields readily to treatment. Frequent warm baths, with the use of simple or green soap (sapo viridis), will usually be found curative. Alkaline baths are also useful. In obstinate cases the ordinary emollient ointments, glycerine, etc., may be advised in conjunction with the baths. *Henry W. Stelwagon.*

KERÖ is a small place in the Siebenbürgen, Hungary, in which are several cold saline-sulphur springs. The waters contain a large proportion of sodium sulphate and sodium chloride. Fair accommodations are provided for visitors, and there is a bath-house in the place for the use of the guests. *T. L. S.*

KEY WEST. [For a detailed explanation of the accompanying chart, and for directions as to the best method of using it, see Climate.]

The city of Key West, Fla., lying upon a coral island bearing the same name and distant about sixty miles southwest of Cape Sable, is the southernmost town of the United States. Key West Island is seven miles long, from one to two miles broad, and its surface is elevated but eleven feet above sea-level. There are no springs on the island; consequently the water-supply is derived entirely from rain-water and from distillation. Precise information respecting the merits of Key West as a health-resort the present writer cannot give; the writer of the article describing the island and town which is published in the "Encyclopædia Britannica" alludes to the climate as healthy, and states that it "attracts an annually increasing number of invalids from the north." According to this writer, the city of Key West "covers nearly one-half of Key West Island. It has broad streets, arranged on the rectangular plan; and the houses, almost all wooden, are picturesquely surrounded by tropical shrubs and plants." The United States Census Report for 1880 puts the population of Key West City at 9,890.

Lying, as it does, not more than fifty miles north of the Tropic of Cancer, and surrounded upon all sides by the warm waters of the Gulf of Mexico, the climate of Key West is essentially tropical, and is typically insular. A study of the accompanying chart will clearly demonstrate these facts. The reader's attention is particularly called to columns L, M, N, and O of the chart, the data in which show distinctly the existence at Key West of the regular tropical "dry" and "rainy seasons," and serve, at the same time, to demonstrate the fallacy of the belief, commonly held by dwellers in northern countries, that a tropical "rainy season" is a season of almost perpetual cloudiness and rainfall.

Climate of Key West, Fla.—Latitude 24° 34′, *Longitude* 81° 49′.—*Period of Observations, November* 1, 1870, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 6 *feet.*

	A			AA	B		C	D	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature.
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January....	67.8	73.6	69.5	70.3	71.9	66.0	75.4	66.5	90.0	79.0	67.5	48.0	25	28
February...	69.4	75.5	70.7	71.8	75.0	67.7	77.1	68.2	87.0	80.0	65.0	55.0	23	24
March......	71.2	77.4	72.2	73.6	76.6	70.6	78.9	69.5	89.0	83.0	68.0	53.0	22	26
April.......	75.1	80.7	75.1	76.9	79.2	74.4	82.7	72.3	91.0	85.0	74.0	61.0	22	27
May........	78.6	83.4	77.8	79.9	82.4	78.3	85.6	75.1	93.2	86.0	74.0	63.0	19	18
June........	82.1	86.7	81.2	83.3	84.7	81.0	89.4	78.4	95.5	88.0	77.0	71.2	21	26
July........	82.8	87.3	82.0	84.0	86.0	82.3	91.3	79.8	97.0	88.0	77.0	72.7	21	24
August.....	82.7	87.7	82.4	84.2	85.6	82.7	90.5	79.5	95.4	90.0	79.0	72.0	18	24
September..	81.3	86.0	81.3	82.8	84.5	81.6	88.4	78.5	95.0	90.0	76.0	71.5	20	24
October.....	77.3	81.8	77.9	79.0	80.3	76.2	84.2	76.0	92.0	84.5	75.0	65.0	27	18
November..	73.1	77.5	73.7	74.7	78.5	72.4	79.3	71.7	91.0	83.0	67.5	52.0	20	28
December..	68.3	73.6	69.6	70.1	74.4	66.1	75.3	67.2	88.0	79.0	68.0	44.0	26	30
Spring......	......	......	......	76.8	78.7	74.9	......	......	......	......	......	......	......	......
Summer....	......	......	......	83.8	85.1	82.6	......	......	......	......	......	......	......	......
Autumn....	......	......	......	78.8	80.3	77.0	......	......	......	......	......	......	......	......
Winter......	......	......	......	70.7	73.8	68.0	......	......	......	......	......	......	......	......
Year........	......	......	......	77.5	78.7	77.0	......	......	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind in miles, per hour.
						Inches.	From	Miles.
January...	42.0	79.7	14.7	11.3	26.0	2.32	NE.	10.8
February..	32.0	76.6	12.6	11.7	24.3	1.84	E.	10.4
March.....	36.0	70.5	12.5	15.8	28.3	0.66	E.	11.2
April......	30.0	69.3	13.3	13.9	27.2	1.42	E.	10.5
May.......	30.2	70.6	16.9	9.3	26.2	4.37	E.	9.5
June......	24.3	70.8	18.6	6.2	24.8	4.06	E.	7.6
July.......	24.3	70.3	19.8	5.7	25.5	4.27	E.	7.5
August....	23.4	71.5	20.1	5.1	25.2	5.41	E.	7.3
September.	23.5	74.9	19.3	4.2	23.5	6.56	E.	8.1
October ...	27.0	76.4	15.8	8.0	23.8	5.87	NE.	11.6
November.	39.0	77.5	13.4	11.2	24.6	2.26	NE.	11.2
December.	44.0	78.7	15.5	11.0	26.5	1.84	NE.	11.2
Spring	40.2	70.1	42.7	39.0	81.7	6.45	E.	10.4
Summer...	25.8	70.9	58.5	17.0	75.5	13.74	E.	7.5
Autumn...	43.0	76.3	48.5	23.4	71.9	14.69	NE.	10.3
Winter	46.0	78.3	42.8	34.0	76.8	6.00	NE.	10.8
Year.......	53.0	73.9	192.5	113.4	305.9	40.88	E.	9.7

Other data of the Key West climate, and further remarks upon that climate, will be found in the article entitled Florida. *Huntington Richards.*

KIDNEY, ANATOMY OF. The kidneys are usually two in number. Sometimes one is absent. More frequently the two are joined, forming the well-known "horse-shoe kidney." In rare instances one or more supernumerary glands exist.

The kidneys lie imbedded in a mass of loose connective tissue and fat (the fat-capsule) behind the peritoneum, in the hollows upon either side of the vertebral column, opposite the bodies of the last dorsal and three upper lumbar vertebræ. The right lies lower than the left. They are usually fixed in their position by the fat-capsule, the peritoneum, and vessels, but occasionally one or both are quite mobile, sometimes even having a mesentery. The upper part of the kidneys lies upon the diaphragm, the lower upon the aponeurosis of the transversalis muscle. In shape the adult kidney resembles a bean. On its inner convex border is a deep depression, the hilum, at which point the vessels and nerves enter and leave the gland and the expanded upper end of the ureter is attached. The upper border is convex and thick, and in contact with the suprarenal capsule; the inferior is sharper and thinner than the upper. The outer border is also convex, but flatter than the others. The anterior surface is rounded, and covered by the fat-capsule; the posterior is flatter, and lies in contact with the diaphragm and aponeurosis of the transversalis, as has been mentioned. In view of the frequency with which operations are now undertaken upon the kidney, the relations of the glands become of great importance. As has been said, they lie usually entirely behind the peritoneum, and rarely possess any mesentery. Hence they may be incised or removed through a lumbar incision, in many instances without opening the serous cavity. The transversalis aponeurosis separates the posterior surface from the quadratus lumborum and psoas magnus muscles. The upper extremity of the right kidney lies in relation to the upper border of the eleventh rib. The right lobe of the liver lies in front of the upper part of the anterior surface and upper border. Below this the kidney is in relation, anteriorly, with the duodenum and ascending colon. The left kidney is in contact with the lower border of the eleventh rib and portions of the stomach, spleen, pancreas, and descending colon. Both have coils of the small intestine in front of them. The inferior extremities reach nearly, if not quite, as low as the crest of the ilium. The left kidney is usually longer and thinner, and somewhat heavier than the right. The average measurements of the glands in the human male are about 3¾ to 4¼ inches in length, 2 inches in breadth, and 1 inch in thickness. Their average weight, together, is about 9 to 12 ounces, the left being a little the heavier. In the female they are smaller and lighter. The proportion of their weight to that of the whole body, in the adult, is from $\frac{1}{250}$ to $\frac{1}{240}$; in the new-born child it is somewhat more.

During life it is impossible to feel the normal kidney through the abdominal walls, unless the latter be much relaxed and the subject thin. It is also difficult or impossible to estimate the size of the glands by percussion over the lumbar region, because of the thickness of the lumbar muscles.

The kidneys derive their blood from the renal arteries, two short, thick trunks given off from the abdominal aorta below the origin of the superior mesenteric. Frequent cases occur of abnormalities in these vessels (see Arteries, Anomalies of). The veins empty into the inferior cava. The left renal vein crosses in front of the aorta, receiving usually the left spermatic, suprarenal, and phrenic veins. The right generally receives blood

only from the kidney and suprarenal capsule. The vein, at the hilum, lies in front of the artery, the ureter behind and below it.

A plexus of nerves, derived from the sympathetic and cerebro-spinal systems, enters the kidney with the vessels. These form a plexus around the vascular trunks.

The lymphatics are derived partly from vessels which enter at the hilum, partly from some which are distributed upon the capsule from neighboring plexuses.

Besides that received from the renal arteries, a little blood enters the kidneys from small anastomoses with the lumbar and phrenic arteries, through which it is possible to partly inject them.

The surface of the kidneys is brownish red in color. A dense membrane, the capsule, closely invests the whole gland. Beneath this membrane may be seen numerous stellate venous plexuses, the venæ stellatæ, or "stars of Verheyen." The capsule in normal kidneys strips off readily, leaving a surface beneath, which, at first glance, looks smooth, but which close inspection shows to be covered with very small shallow dimples. The capsule consists of numerous layers of white fibrous tissue, which may be readily torn off, one from the other ; and beneath these a layer of non-striated muscle-cells. The connective-tissue layer, at the hilum, becomes continuous with that of the ureter. The muscular layer, having been re-enforced by fibres derived from the ureter, is distributed over the surface of the papillæ, around the orifices of the tubes. The latter fibres no doubt serve to protect the secreting structures from injurious urinary pressure by closing the tubes, while the fibres beneath the capsule give the gland some contractility as a whole. Lymph-spaces may be demonstrated in the capsule.

If the kidney be laid open by a vertical incision carried from its outer to its inner border, the secreting structure of the gland, and also the attachment of the ureter, is brought into view. The latter forms a funnel-shaped pouch, the pelvis, into which enter a number of short, thick tubes, the infundibula and calyces.

The kidney-tissue proper is made of two parts, the medulla and cortex. The medullary portion forms, in the section we have made, a number of fan-shaped bodies, with their apices projecting like a teat into the calyces, their bases toward the surface of the kidney. From the bases a number of diverging lines, medullary rays, or pyramids of Ferrein, may be seen radiating toward the surface. The fan-shaped bodies are called the medullary cones, or pyramids of Malpighi. The pyramids are made up of alternating lighter and darker lines, due to alternating tubes and blood-vessels.

Toward the papillary end they are lighter in color than near the cortex. Between the medullary rays are lighter pyramidal cortical portions, with their apices toward the medulla, called the cortical pyramids. The cortex also dips down between the medullary pyramids in the adult human kidney. At the base of the pyramids may be seen sections of fair-sized blood-vessels.

The cortex is grayer than the medulla, and is very slightly granular in appearance. It dips down between the medullary rays and cones, as has been said, and it also forms a thin layer between the apices of the rays and the capsule. In the part of it which lies between the medullary rays and pyramids may be seen numerous small red dots, the Malpighian bodies. These are wanting in the thin layer beneath the capsule.

The uriniferous tubules commence in a small dilatation containing a vascular tuft, and called the Malpighian body. The tube leaves this dilatation by a narrow opening, the neck, and then dilates and pursues a tortuous course for some distance, forming the proximal convoluted tube. It then narrows and descends, at first in a spiral but soon in a straighter course, forming the descending or narrow limb of Henle's loop. This descends in the medulla for a considerable distance. The tube now makes an abrupt bend upon itself, the loop of Henle, and ascends, still in the medulla, having widened somewhat either just before or just after forming the loop. It is now called the ascending or wide limb of Henle's loop. The tube then leaves the medulla, and, widening still more, becomes tortuous, forming the distal convoluted or intercalated tube. The latter lies in the cortex among the proximal convoluted tubes. After turning a number of times the tube finally empties into a collecting-tube, usually by a narrow neck. The latter, lying in a medullary ray, descends straight toward the papilla, receiving other collecting-tubes and increasing in size as it goes, and finally emptying by a small opening in the latter into one of the calyces. There is no anastomosis between uriniferous tubules in any part of their course from the Malpighian body to their entrance into the collecting-tubes. One collecting-tube probably receives the contents of several of the tubes of Henle, and also joins dichotomously with other collecting-tubes.

It will be seen that the cortex is made up of the Malpighian bodies, the convoluted tubes ; the medullary pyramids, and rays, of the looped tubes of Henle and the collecting-tubes.

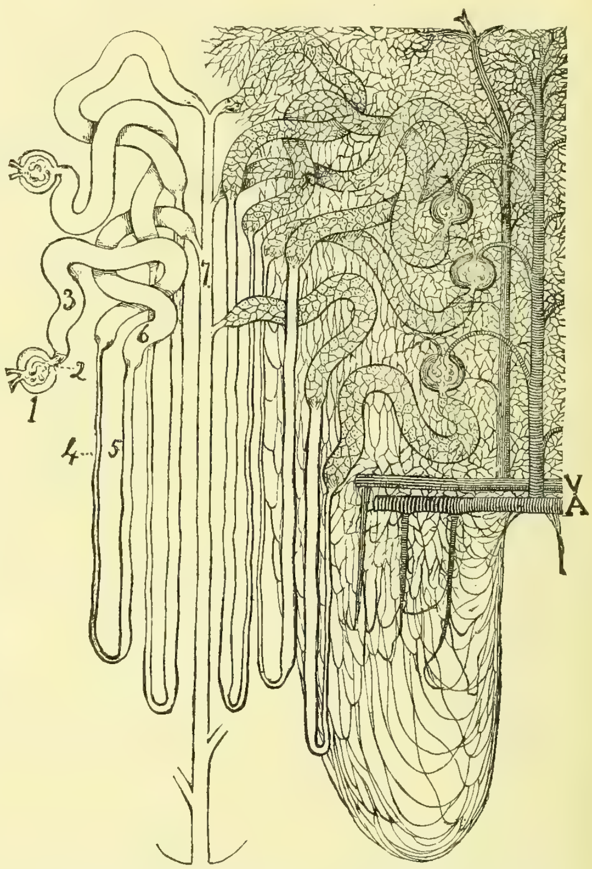

FIG. 1911.—Diagram of the Renal Tubes and Circulation. 1, Malpighian body ; 2, neck ; 3, first convoluted tube ; 4, descending limb of Henle's loop ; 5, ascending limb ; 6, second convoluted tube ; 7, collecting tube ; *A*, artery ; *V*, vein. An interlobular artery is shown ascending and giving off branches to the tufts ; the straight arteries descend ; the interlobular vein is shown commencing as a stellate plexus on the surface.

The epithelium of the tubes differs in different parts of their course. The Malpighian body, the dilated extremity of the tube, consists of a capsule, the capsule of Bowman, containing a tuft of capillaries. The capsule is lined with flat, nucleated cells, on a delicate, homogeneous basement membrane. This layer of cells, with its membrane, is reflected over the surface of the tuft in the manner shown in Fig. 1912.

The epithelium of the distal and proximal convoluted tubes may be described as a continuous layer of protoplasm with large nuclei. Individual cells are hard to demonstrate, though clefts descend here and there almost

to the basement substance. The epithelium occupies a large part of the diameter of the tube. This epithelium has been described as columnar cells, and as cells having numerous variously shaped processes which might be said to mortise the individual cells together. It nevertheless looks like an almost continuous layer in the adult human kidney. In fresh sections the protoplasm of the cell-bodies is extremely granular, so that the nuclei are concealed. In well-hardened sections, with a high power, it presents a striated appearance, as if containing bundles of very thin rods. Hence it is called "rod epithelium" (Heidenhain).

It is said that these rods may be partly isolated by tearing the cells. Late researches make it probable that this rod-like appearance is due to the peculiar arrangement of

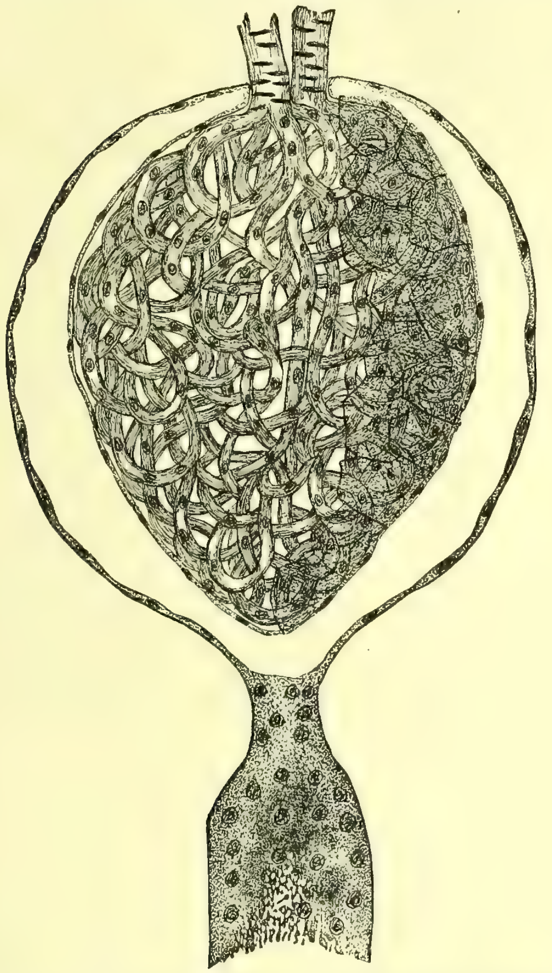

FIG. 1912.—Diagram of a Malpighian Body, showing the Afferent and Efferent Vessels above, with the Tuft. The reflection of the cells of Bowman's capsule over the vessels is shown on the left; on the right, the cells are shown in the flat; the neck and part of a convoluted tube are shown below. The space between the tuft and the capsule is drawn wider than normal.

the intracellular net-work, which may be demonstrated in these as in other cells. In the descending limb of Henle's loop the epithelium is flat, with projecting nuclei. In the ascending limb it is thicker and of cuboidal type. In the collecting-tubes, cylindrical cells, with clear bodies and distinct nuclei, are seen.

The epithelium of the tubes lies on an almost structureless basement membrane, in which scattered nuclei are here and there demonstrable. Occasionally, in nitrate-of-silver specimens, there are traces of irregular cell-outlines, like those demonstrable between the endothelial cells of blood-vessels and lymphatics (Ludwig). H. B. Millard states that in diseased kidneys the endothelial cells in this membrane become quite visible. His description, however, leaves one in doubt as to whether the appearance which he describes is really due to endothelial growth or not.

The blood-supply of the kidney is complicated. After entering at the hilum the renal artery breaks up into numerous branches, and at the bases of the medullary pyramids forms a number of incomplete arches. From these arches short trunks descend toward the papillæ and, dividing, form a capillary net-work, with wide meshes, about the straight tubes. The descending trunks are called the arteriæ rectæ. From the capillaries the blood

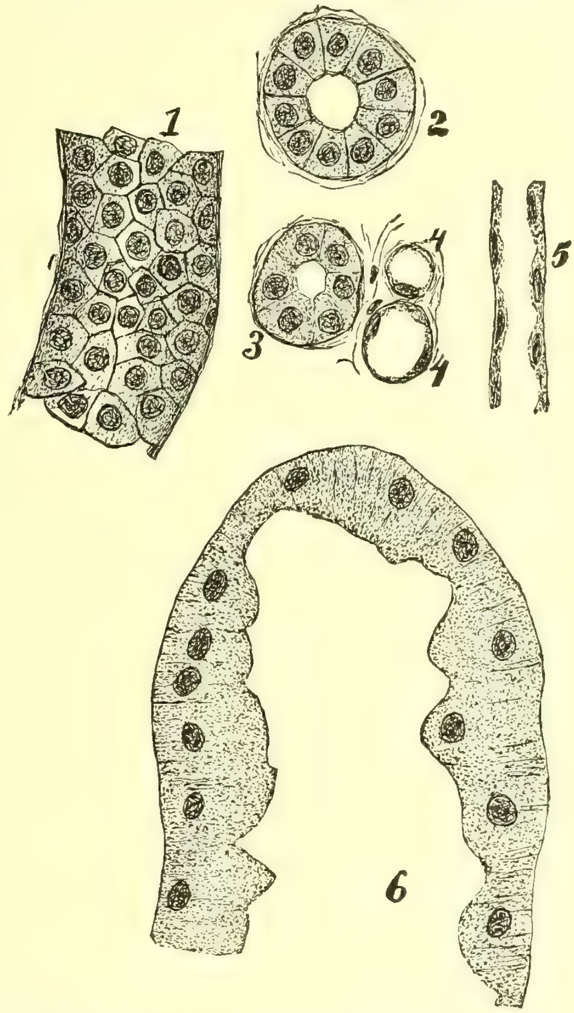

FIG. 1913.—Epithelium of Kidney. 1, Collecting-tube viewed in longitudinal outline; 2, transverse section of collecting-tube; 3, ascending limb of Henle's loop; 4, descending or narrow limb of Henle's loop; 5, longitudinal section of descending limb; 6, convoluted tube. (The drawings, with the exception of No. 5, were all made from specimens in the author's collection.)

is received into short, straight veins, which empty into larger veins running, like the arteries, near the base of the pyramids. Unlike the arteries, these veins form complete arches. From the upper side of the arterial arch vessels enter the cortex between the medullary rays and pursue a nearly straight course toward the surface of the kidney. These vessels are called interlobular arteries—a rather unfortunate name, since the kidneys can hardly be said to have any lobules. It is customary, however, to speak of the portion of the gland which lies around a medullary ray, and between it and these arteries, as a lobule. The interlobular arteries give off lateral branches, each of which enters a Malpighian body, usu-

ally nearly opposite the neck of the capsule. Here this branch, called the afferent vessel, breaks up into a tuft of capillaries, the glomerulus, or glomerular tuft. The latter often shows more or less division into two or more lobes. This tuft is covered by a layer of flat cells continuous with those lining Bowman's capsule. The glomerular capillaries unite to form a single trunk, the efferent vessel, which usually leaves the Malpighian body near the point of entrance of the afferent vessel. The efferent vessel at once breaks up into another capillary net-work, which is distributed around the neighboring convoluted tubes, and the vessels of which finally unite to empty into the interlobular veins which accompany the arteries. The glomeruli are connected with the interlobular arteries like currants on a stem. Besides branches to the glomeruli, some branches are given off from the artery which form capillaries around the tubes, especially near the surface of the kidney.

The veins of the cortex begin in the star-shaped plexuses beneath the capsule, and, receiving other branches, descend and empty into the venous arches before mentioned. These, uniting, form the renal vein.

The capsule receives some blood from branches of the lumbar and phrenic arteries, and the capillaries of these anastomose with those of the renal artery. (See, also, the next article, on Kidney, Circulation of.)

Lymphatics may be demonstrated in the capsule and between the tubules.

The distribution of the nerves in the kidney is not quite satisfactorily demonstrated. Nerves enter with the vessels, and form net-works around them and around the tubes. Holbrook (as quoted by Millard) states that he has demonstrated fibres entering the glomerulus with the vessels and forming a delicate net-work over the capillaries. The same observer also thinks that he has traced fibres through the basement membrane of the tubes and into the intercellular substance.

The kidney contains but little connective tissue between the tubes. Some may be demonstrated here and there. The capsule seems to be the main support of the gland. *J. West Roosevelt.*

KIDNEY, CIRCULATION OF. I. PHYSIOLOGICAL.—As a comprehension of the arrangement of the blood-vessels of the kidney is absolutely necessary in order to understand the renal circulation, we give here a short account of it. The circulatory apparatus consists essentially of three divisions: 1, the capillaries; 2, (*a*) the direct arterial supply to the capillaries, (*b*) the mediate supply to the same by way of the Malpighian tufts; 3, the veins (see Fig. 1914).

1. *The capillaries* are found in all parts of the organ, their arrangement varying, however, with their location. About the tubuli contorti in the cortex they form a close net-work of polygonal meshes, while about the straight tubes of the pyramids and of the septa that separate them (columnæ Bertini) the meshes are extended in the direction of the length of the tubes.

2. The renal artery, which is singularly large, when the size of the organ is considered, divides at the hilum into four or five branches. These enter the substance of the kidney between the papillæ, and when at the bases of the pyramids—at the junction of cortex and medulla—give off branches which form incomplete arches (*arcus arteriosi*, *A*, Fig. 1914), whose concavities are directed inward. These arches, in turn, give off two sets of branches. One set, the *interlobular arteries*, *b*, run toward the cortex, passing between the rows of Malpighian bodies, and giving off lateral twigs which form their *afferent vessels* (*a*, *a*). Another set passes toward the hilum, forming the *arteriæ rectæ veræ* (*r′*), which break up into a long-meshed capillary network as they run toward the papillæ.

The *afferent vessel*, on entering Bowman's capsule, divides into a number of looped branches, which form a vascular tuft, or *glomerulus*. These loops do not again subdivide, but reunite to form an *efferent vessel*, which is somewhat smaller than the afferent one. The vasa efferentia belonging to those capsules which lie nearest the bases of the pyramids penetrate the latter under the name of *arteriæ rectæ spuriæ*, *r*, and break up into bundles of capillaries running between the straight uriniferous tubules. They finally unite with the capillaries formed by the arteriæ rectæ veræ.

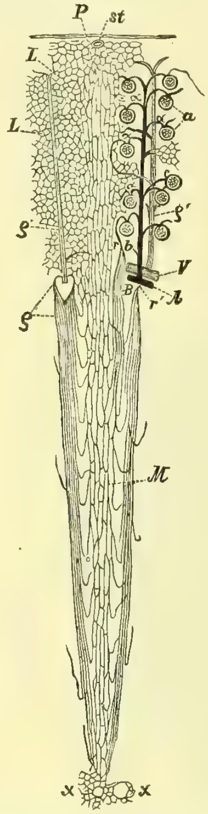

FIG. 1914.—Diagram of the Blood-vessels of the Kidney. (From Ludwig, "Hermann's Handbuch der Physiologie.") *A*, *arcus arteriosus*, giving off the *arteria interlobularis*, *b*, from which numerous twigs supply the glomeruli, *a*, *a*, with *vasa afferentia*, *a*, *a*. The *vasa efferentia* break up into a fine polygonal network, *L*, about the convoluted tubules, and called the *labyrinth.* In the pyramids of Ferrein this net-work becomes more elongated, *P*. From some of the lower glomeruli the *vasa efferentia* pass down into the pyramids, forming the *arteriæ rectæ spuriæ*, *r*. *r′*, one of the *arteriæ rectæ veræ*, springing directly from the *arcus arteriosus*, and, like the former, breaking up, in the pyramids, into elongated meshes, *M*; *V*, *arcus venosus*, receiving the *vena inter-lobularis*, *ρ′*, which, by means of the *venæ rectæ*, *ρ*, collects the blood from the arteriæ rectæ; *χ*, *χ*, fine venous plexus about the mouths of the excretory tubules at the apices of the pyramids; *st*, vena stellata.

The efferent vessels from the capsules lying near the cortex break up, almost immediately after their exit, into a fine plexus surrounding the convoluted tubules, and which communicates both with the capillary plexuses formed by the true and false arteriæ rectæ, and with that formed in the renal capsule by branches of the lumbar arteries.

Besides the main arterial supply through the renal artery, the lumbar arteries give off branches which enter the kidney by way of its capsule, anastomosing there with the capillaries of the cortex. These lumbar branches, though usually individually quite small, are often present in considerable numbers; and it is possible to inject a large part of the kidney through them alone by injecting the aorta after tying the renal arteries, as shown by Ludwig.

Ludwig has furthermore demonstrated that the interlobular arteries penetrate to the surface and resolve themselves there into a fine plexus, which communicates both with the capillary network of the capsule from the lumbar arteries, and with that of the cortex from the plexus about the convoluted tubules. Thus it will be seen that the blood-supply from the renal arteries is quite intimately and freely connected with that coming through the lumbar branches.

3. *The veins* follow in all essential particulars the same course as the arteries. The venous radicles of the medulla form a plexus about the mouths of the uriniferous tubules at the papillæ, and from there gradually collect to form *venæ rectæ*, which empty in the *arcus venosi*. In the cortex the veins unite to form star-shaped arrangements (stellulæ Verheynii), which are the beginnings of the *venæ interlobulares*, running parallel to the arteriæ interlobulares to join, in their turn, the arcus venosi.

From this short survey of the anatomical arrangement of the blood-vessels the physiologically important fact becomes evident that the amount of blood in the Malpighian bodies will vary according as the *direct* arterial supply to the capillary plexus of the tubuli contorti is increased or diminished. If these direct arterial channels are dilated, more blood flows through them and less through the glomeruli, and *vice versa*. The *arteriæ rectæ veræ* (*r′*) in the pyramids will be the ones chiefly concerned in this regulatory function, for by their contraction they will force more blood toward the cortex, and consequently into the glomeruli, and less into the pyra-

mids, while by dilating they will, on the contrary, cause a determination of blood toward the medullary portions of the organ, and away from the cortex.

Ludwig has shown that the arrangement of the vessels in the glomerulus is such that the loops formed by the afferent artery occupy the periphery of the tuft, while those which eventually unite to form the efferent vessel occupy a central position. In consequence, when the pressure in the afferent vessels is increased, they distend the capsule, affording thereby a freer passage for the blood into the efferent channels. When, however, there is a rise of pressure coming from the direction of the vasa efferentia, they, by their distention, force the efferent loops against the sides of the capsule, thus closing them. This anatomical arrangement of the vessels explains why it is so easy to completely inject a kidney from the artery, while injection through a vein rarely extends beyond the Malpighian bodies; also, why, in cases of cardiac insufficiency, with venous congestion, the kidneys become so intensely congested as to assume an almost stony hardness; for the venous reflux is dammed back at the glomeruli, and prevented from getting into the arteries, while, at the same time, the arterial pressure is maintained sufficiently to fill all the arterial channels. Blood is thus, as it were, forced into the organ from opposite directions, the current being thereby rendered extremely slow. It is no wonder, therefore, that the secretion of urine is scanty, or often, indeed, entirely suppressed.

The Normal Circulation.—The renal artery, as has been pointed out, is very large in proportion to the organ which it supplies. Nevertheless it has been found that in dogs its lumen may be compressed to half a millimetre without causing any notable decrease in the amount of blood issuing from the vein, showing that the volume of blood in the organ is due not alone to the capacity of the renal artery, but as well to the height of the aortic pressure, and to the resistances offered to the current both in the organ itself and beyond it. For in addition to the peculiar arrangement of the loops of the glomerulus it must be remembered that its vas efferens is smaller than its vas afferens, and that the latter breaks up into a very close capillary plexus almost immediately on leaving Bowman's capsule; also, that this plexus, by the resistance which it interposes, diminishes the rapidity of the blood-current, and at the same time increases the intra-glomerular pressure. The blood in this plexus also will be under comparatively low pressure, because, in the first place, it has lost a great part of its momentum in overcoming the resistance presented by the glomeruli, and secondly, because the venous system beyond offers no marked resistance to its outflow.

The plexus of the medullary portion affords more resistance to the blood than does that of the cortex, for in it the capillary meshes are narrow and long, and are arranged in bundles alternating with groups of uriniferous tubules. By this arrangement in alternate bundles the capillaries and uriniferous tubules exert a reciprocal pressure, each conditioning the circulation in the other, as will be shown later.

Changes in the current of blood flowing to the kidney, or away from it, will have the following effects on the various divisions of the capillary system of the organ:

A rise of the general arterial pressure causes an increase of pressure, as well as an increase in the rapidity of the current, within the glomeruli, provided that no compensatory contraction of the vessels more immediately supplying the glomeruli occurs. This increased pressure will be the greater, the greater is the resistance offered by those arterial paths by which the blood reaches the capillary system directly, *i.e.*, without the intervention of the glomeruli. In the capillary plexus of the convoluted tubules the increase of pressure will be less than in the glomeruli, for although the force with which the blood reaches each is the same, yet in the former it soon becomes dissipated by being broken up and distributed over the large area of numerous channels.

A rise in the venous pressure, affects primarily the capillary plexus of the convoluted tubules. The glomeruli will be but little influenced comparatively, for as they present considerable resistance, by reason of their internal arrangement, to the blood-current, the backward pressure will find an easier channel by way of those vessels which communicate directly with the larger arterial trunks; and, furthermore, the rise of pressure in the plexus of the convoluted tubules, by dilating its capillaries, causes an enlargement of the channel through which the blood has to flow, in this way still further relieving any tendency to congestion occurring within the glomeruli. Nevertheless, in spite of all, some degree of increased pressure, accompanied by a slowing of the blood-current, must, in all cases of venous congestion, occur within the glomeruli.

Venous congestion may, by dilating the venous capillaries of the pyramids—which, as we have seen, are arranged in bundles alternating with bundles of uriniferous tubules—exert such an amount of compression upon the latter as to even close them entirely (and it may be interesting to note also, on the other hand, that by increasing the pressure in the uriniferous tubules the venous current may be considerably slowed).

Secretion of Urine.—For a knowledge of these highly interesting details of the circulatory mechanism we are chiefly indebted to Ludwig and his pupils. The renal circulation is so intimately bound up with the secretion of the urine, that we think it not out of place to consider the latter in this connection.

At present two views, for the elaborate discussion of which the reader is referred to the larger works on physiology, are prevalent: the older one of Ludwig, and the more recent one of Heidenhain.

Ludwig's theory is, stated briefly, as follows: The rapidity of the secretion of the watery elements of the urine is in direct proportion to the amount of blood-pressure in the glomeruli; in other words, the process is a merely mechanical one. The amount secreted depends, furthermore, on the difference of pressure between the inside and the outside of the glomerulus. Thus, if the pressure in the uriniferous tubules be increased, even though the arterial pressure in the glomeruli remain the same, less urine will be secreted. The urine after leaving the capsules becomes more concentrated by a reabsorption of part of its water, in its passage through the tubules, especially the convoluted ones.

In Heidenhain's theory, on the other hand, it is contended that the amount of secretion depends not so much upon the pressure as upon the rapidity of the blood-current within the glomeruli, and it is referred not to simple mechanical filtration, but to a special selective action of the epithelium covering the vessels of the glomeruli. It holds, furthermore—and this fact Heidenhain proved experimentally—that the epithelium of the convoluted tubules and of the ascending portion of Henle's loop tubes exerts a direct and positive action in the elimination of certain of the solid elements of the urine, gathering them from the lymph surrounding these tubules, and mingling them with the watery elements already secreted by the Malpighian bodies, which mixture then forms the finished urine.

Bowman, as early as 1842, advanced the same views. He based his opinions wholly on what he conceived ought to be the case from the anatomical structure of the kidney, and not on any experimental researches, showing thus a remarkable physiological insight.

Though many of the experiments deemed conclusive by Heidenhain have been disputed by other observers, still it must be allowed that his theory explains many points which are not satisfactorily accounted for by the simple mechanical filtration hypothesis. While competent physiologists are still disputing, it seems needless to remark that we must content ourselves in simply pointing out the prevalent views, leaving time to decide between them. To the practitioner, however, this difference is not of such great importance, for in the majority of cases increased blood-pressure within the glomeruli and increased rapidity of the current go hand in hand.

Innervation of the Kidney.—The splanchnic nerve is the chief source of innervation for the renal vessels, as it is of the other abdominal organs; but besides this, nu-

merous branches of the sympathetic run in the sheaths of the great vessels and along the ureters, and enter at the hilum. These nerves are frequently so delicate and transparent, as my own experience has shown me, that they escape detection. Hence it is that in some cases erroneous conclusions have been formed regarding the rôle which the nerves play in the kidney, for the experimenter has considered all the nerves to have been severed, whereas, in reality, many have remained intact. Section of the splanchnic is followed by a diminution in the secretion of urine, not because, as has been held by some, it is a secreto-motor nerve which section would paralyze, but because the paralysis of the abdominal vessels which follows this section causes such a lowering of the general arterial pressure that the kidney, although its vessels are dilated to their fullest extent, receives, in common with the other abdominal organs, less blood than before. If, instead of cutting the main trunk of the splanchnic, the nerves entering upon the renal vessels and ureter be carefully divided, it will then be found that the vessels of the kidney follow exactly the variations in the general arterial pressure; that when the blood-pressure rises the vessels expand and more urine is secreted; and contrariwise, when the general arterial pressure falls, the renal vessels contract through their own elasticity, less blood flows through the organ, and less urine is secreted. This experiment the writer has too frequently performed to doubt the interpretation of its results.

The nerve-centre for the kidney, if such a thing really exist, would seem, from the experiments of Claude Bernard, to lie in the floor of the fourth ventricle, in front of the origin of the vagus, for this observer found that punctures in this region produced polyuria, either with or without sugar, according to a slight difference in the locality of the puncture. Eckhard, on the other hand, was not able to confirm Bernard's observations regarding the appearance of polyuria, either with or without sugar. He found, however, that stimulation of the vermis of the cerebellum gave rise, in rabbits, to a polyuria with mellituria if the hepatic nerves were intact, and to a simple hydruria if these were severed. Too much weight must not be given to these results. Certain it is, however, that diabetes insipidus is frequently associated with localized disease of the medulla, with cerebral concussion, and with other cerebral diseases. Our knowledge of the nervous supply of the kidney is, on the whole, still incomplete and fragmentary, and much yet remains for explanation in this field.

Albuminuria.—The weight of evidence of most observers tends to prove that albuminuria occurs whenever in the kidney the rapidity of the blood-current falls below that which is necessary for the nourishment and life of the epithelium covering the glomeruli. Whenever this state occurs, whenever these epithelia receive less oxygen and less of the other elements necessary for the maintenance of their physiological integrity than they require, they then become permeable to the albumin of the serum of the blood, which, filtering through them, becomes mixed with the watery and saline elements that form the urine.

Under certain circumstances, not yet fully determined, albumin may be found in small quantities in the urine of, to all appearance, healthy persons, as has been reported by Leube, Frerichs, Senator, Munn, Moxon, Marcacci, and others. In these individuals the albumin is not always present, and when present is in such small quantities as to require very delicate tests for its detection.

It has been repeatedly affirmed by different observers that albuminuria may be produced by cutting the nerves that supply the kidney. More accurately conducted experiments have shown, however, that when this operation is carefully done, and without injuring the vessels, no albuminuria results. The epithelial cells of the kidney, those of the glomeruli as well as those of the tubules, are extremely sensitive, and a compression of the renal artery but for a few minutes leads to serious disturbances. Thus, Overbeck found that closing the renal artery for a minute and a half caused a suppression of urine in the corresponding kidney, lasting in some cases as long as three-quarters of an hour, and that the urine first secreted was highly albuminous, the amount of albumin decreasing as the flow of urine became more free.

II. Pathological.—Having thus considered the normal circulation of the kidney, we will now turn to the consideration of some of the changes which may take place in the circulation under pathological conditions: First, of those which occur within physiological limits, and which do not affect the structure of the organ; and secondly, of those determined by structural changes either in the kidney itself or in organs standing in close relationship to it, and of those determined by fever.

For the first category we have all those circulatory changes which partake of the nature of reflex phenomena. For instance, prolonged exposure of the skin to cold, by contracting the cutaneous capillaries, drives the blood from the periphery to the interior, and consequently more blood will be forced through the kidneys and other internal organs, whose capillaries then dilate to compensate for the contraction of the cutaneous vessels. This explains the increased flow of urine which always occurs after prolonged chilling of the surface, though part of this increase is due also to the diminution in perspiration. If muscular inactivity go hand in hand with this coldness of the skin, the increase in the amount of urine secreted is still more marked, for, as during repose the muscles are in a state of anæmia, still more blood will be forced into the internal organs. We have a most striking example of this in the chills of intermittent fever, where, after the chill, a large quantity of pale urine is voided. In this case the chill seems strong enough to overcome that anæmic state which we shall show further on to be the condition of the kidney during fever.

Cohnheim and Roy have observed—and the author has had the opportunity of confirming these observations—that electric or other stimuli applied to the peripheral nerves through the medium of the skin, or to an exposed nerve directly, cause an immediate and often very great contraction of the vessels of the kidney, as shown by the marked diminution in the size of the organ itself. Asphyxia produces the same results, and in both sets of cases, hand in hand with the renal contraction, there is a corresponding rise in the general arterial pressure. The essentially reflex nature of these phenomena is confirmed by observing that when all the nerves entering the kidney are carefully cut (and this, as we before called attention to, is not always easy), stimulation of a sensory nerve is not followed by a contraction. On the contrary, the size of the organ follows now the general arterial blood-pressure, being enlarged when that rises, and becoming smaller when it falls.

Various chemicals and drugs have been found to affect the renal circulation in various ways when introduced into the general circulation. Thus, the injection into a vein of as small a quantity as one or two cubic centimetres of water causes at first a contraction of the kidney, which in different experiments varies in duration from a couple of seconds to two or three minutes, followed by a secondary expansion, which lasts much longer than the contraction. The injection of one-half per cent. salt solution causes a primary expansion, which may last some time, according to the quantity injected and the state of the individual. Urea, on the other hand, causes, like water, a primary contraction, followed by a secondary expansion. "Digitalis causes also a primary contraction, differing, however, from urea in the fact that this contraction is of longer duration, but resembling it in so far that it is followed by a secondary expansion. A certain number of other diuretics resemble water, urea, and digitalis, in causing a primary contraction with diminution or arrest of secretion, followed by expansion and increased secretion. Other diuretics, again, such as nitrate of soda, acetate of potash, resemble salt solution in causing a primary expansion of renal vessels. All the diuretics mentioned, when they are given in not too large a dose, cause a very considerable change in the volume of the kidney without causing any change in the blood-pressure. The secretion of urine increases or diminishes,

cæteris paribus, with the degree of expansion of the renal vessels" (Roy).

In certain spasmodic diseases, such as epilepsy, strychnia-poisoning, hysteria, lead colic, and eclampsia, where during the attacks there is generally a partial suppression of urine followed by a more copious secretion after the attacks have passed off, and often—at least in epilepsy, strychnia-poisoning, lead colic, and eclampsia—by a transient albuminuria, we may assume with Cohnheim, that these effects are due to a primary spasm of the small arteries of the kidneys, succeeded by a secondary dilatation. Not as if this tetanic condition affected the vessels of the kidney alone; on the contrary, the visible pallor of the skin during the prodromal stage of an epileptic attack (and Echeverria claims to have observed anæmia of the fundus oculi during this stage), and the continued paleness of the skin during an attack of lead colic, would seem to point to the fact that this arterial spasm may affect the vascular system in many organs. When the spasms of lead colic and eclampsia pass off, and after patients have recovered from epileptic or hysterical seizures, the spasmodic contractures are followed by a period of general relaxation, and as the heart's action remains practically unaffected, the result must be to force a greater quantity of blood in a given unit of time through the dilated vessels than before, and thus give rise to an increased amount of secretion from the kidneys.

The transient albuminuria following the attacks of lead colic, strychnia-poisoning, epilepsy, and those cases of eclampsia in which no lesions of the kidney are found post mortem, Cohnheim thinks are fully explained by the tetanic contraction of the smaller vessels of the kidney being of such a degree as to cause an anæmia in the organ sufficient to at least temporarily disturb the functions of the epithelium of the glomeruli, and make them permeable to the serum albumin.

Whether the polyuria of diabetes insipidus, where abnormally large quantities of a sugarless urine of low specific gravity are passed daily sometimes for many years, without either the general health of the patient or the integrity of the kidneys becoming affected—whether these symptoms are to be explained by a local active renal hyperæmia, the result of some lesion or disturbance of the innervation of the kidney, may yet be regarded as a very open question. Cohnheim offers the above explanation of these cases, at the same time, however, calling attention to its purely hypothetical nature.

We now pass to those cases of disturbed renal circulation caused either directly by pathological changes in the kidney itself, or secondarily by changes in other organs, and of these the heart and lungs are the most important.

Causes and Effects of Increased Arterial Pressure.—In cirrhosis of the kidney, where, by the obliteration of a number of glomeruli, a serious obstacle to the intrarenal circulation is presented, a compensatory hypertrophy of the left ventricle is invariably caused, and, in consequence, an elevation of the general arterial pressure results. As a consequence of this the blood is forced through the remaining glomeruli with more than normal rapidity, and also at a higher pressure, and, in spite of a considerable destruction of secreting surface, more urine is secreted than normal. This urine is of low specific gravity, containing but a small percentage of solid matter, though the total quantity of urea and of other salts excreted daily may not be below the normal.

It is only when the cirrhotic processes have become too extensive to be compensated for by the cardiac hypertrophy that we observe a lessening in the amount of urine—a lessening which may, in some cases, amount shortly before death to a virtual suppression.

The albuminuria of cirrhotic kidney is, during the greater length of the disease, usually of a very slight grade. It is only toward the end that it becomes marked. This is explained by the extreme chronicity of the disease, comparatively few of the glomeruli being involved at any one time. The obliteration of a glomerulus is preceded by a stage in which, by the gradual thickening of the walls of the vascular tuft, an anæmia is produced sufficient to destroy that function of the epithelial covering which, as we have seen, is the retention of the albumin of the blood. Thus but little albumin finds its way into the urine at any one time. Then, too, the grade of albuminuria often appears much slighter than it really is, from the amount of albumin being diluted by a large quantity of urine.

The large amounts of albumin which usually make their appearance toward the end of the disease are dependent on other causes besides those dwelling within the kidney itself, and they will be considered under another heading.

Any obstruction in the circulation giving rise to an hypertrophied left ventricle, and thus to an increased arterial pressure, be it from what cause it may, by increasing the pressure and the rapidity of the blood in the kidneys, will cause an increased secretion of urine. Of these obstructions we may instance valvular lesions, pulmonary induration, atheromatous disease of the arteries, and hepatic cirrhosis. There are others, but we do not think it necessary to go into an explanation of each one, since all cause an increased secretion of urine by increasing the rapidity of the renal circulation, provided there does not arise some other compensatory disturbance of the circulation, which has the effect of lowering the blood pressure, and which, as a matter of fact, always occurs sooner or later.

Causes and Effects of Diminished Arterial Pressure.—We have seen that physiological experiments on animals have shown that diminishing the pressure, and hence the rapidity of the blood in the glomeruli, causes a diminution of the quantity of urine secreted, and that if the amount of blood withheld from the kidneys be large enough to cause a marked anæmia, albuminuria results. Pathological changes perform the same experiment on the human body, and with the same clear and unmistakable results.

Any inflammation of the kidney, by causing a local interference of the circulation when the inflammation is circumscribed, or a general derangement of the circulation in the organ when the inflammatory process is diffuse, causes a diminution in the amount of urine secreted, and also albuminuria.

As in every inflammation, so in that of the kidney, there is a dilatation of the capillaries and a slowing of the current in the affected area followed by a transudation of a highly albuminous lymph filled with white blood-corpuscles. These factors combined cause ischæmia of the affected area sufficient to produce a degeneration of the epithelium of the glomeruli and of the tubules as well. In consequence we have, if the inflammation is acute and somewhat widespread, a diminution in the amount of urine, accompanied by albuminuria and the appearance of desquamated epithelium, epithelial and bloody casts, and all the products of inflammation in the urine. The more chronic and circumscribed the inflammation is, the less has the urine these appearances. Indeed, in many chronic cases where the vessels themselves soon become involved (as in chronic diffuse nephritis), causing an obstruction to the blood-current, compensatory cardiac hypertrophy sets in, and we have all the phenomena discussed in the previous paragraph.

In no instance are the effects of a localized disturbance of the renal circulation more sharply marked than in *renal embolism*. We do not refer so much to the septic emboli, for they, from their nature, cause an ever widening area of inflammation and destruction, but to the effects produced by an aseptic embolus acting simply as a mechanical plug to some small vessel. In such a case the urine, which has before been perfectly normal, suddenly becomes filled with epithelial casts, white and red blood-globules, and a considerable amount of albumin. In uncomplicated cases there will not necessarily be any diminution in the amount of urine voided, for the sound kidney acts compensatorily. All the abnormities of the urine just cited are caused by the embolus cutting off the arterial supply to a smaller or larger area of kidney tissue. The part involved undergoes necrosis—the coagulation necrosis of Weigert—and is absorbed, and nothing remains later to mark the place but a mass of shrunken

white cicatricial tissue. The urine, after keeping these appearances for a varying period, which will depend on the amount of kidney-tissue involved, gradually becomes normal again.

In patients suffering from valvular or pulmonary lesions, whose obstructions to the circulation the compensatory cardiac hypertrophy is unable to overcome, we notice that, without exception, the amount of urine secreted daily is far less than the normal. It is also dark-colored, and of high specific gravity, for, in accordance with Ludwig's experimental observations, the elimination of the solid constituents does not decrease proportionately with the diminution of the watery elements; thus the amount of urea eliminated daily may even exceed five per cent. of the whole quantity of urine passed, whereas normally it is about half that amount. When by means of suitable medication the heart's action is made stronger, and the arterial pressure and the rapidity of the current are thus increased, we note at once marked changes in the urine. From being scanty, dark-colored, and of high specific gravity, it becomes abundant, and normal in color and density. No laboratory experiment could be more conclusive.

Section of, or pressure on, the spinal cord, if occurring high enough to cause marked lowering of the general arterial pressure, is invariably accompanied by such a lessening in the amount of urine secreted as, in many cases, to amount to suppression; and this is not due to interference with any secreto-motor nerves, but simply to the great slowing which the renal circulation undergoes in common with all that part of the circulation whose vessels are innervated by the portion of the cord lying below the lesion.

Of the effects of a local diminished arterial pressure (in epilepsy, lead-colic, etc.) we have already spoken.

Causes and Effects of Increased Venous Pressure.—Pure and uncomplicated cases of diminished arterial pressure alone, such as we instanced in the previous paragraph, are of rather rare occurrence and of short duration; for, as the arterial pressure becomes diminished, another factor, namely, increased venous pressure, steps in, causing changes in the circulation which have to be allowed for when considering the whole. Venous congestion, which is the result of insufficiently compensated cardiac or pulmonary lesions, nowhere makes itself more evident than in the kidneys. The blood-current through the glomeruli becomes slowed—firstly, because the arterial pressure is low, and secondly, because the venous congestion is pressing the blood back upon them. As a result we have diminished secretion of urine accompanied by albuminuria. The appearance of albumin and of red blood-corpuscles in the urine of these cases is pathognomonic of venous congestion, for, as Ludwig has shown, neither albuminuria nor hæmaturia occurs when the glomeruli are subjected to a diminution of the arterial pressure alone. The experiments of Robinson and of Weissgerber and Perls, of causing a venous congestion by partly closing the renal vein, have shown that there is an immediate and marked lessening of the amount of urine secreted, and that the urine contains albumin, red blood-corpuscles, and some hyaline casts. According to this it would seem that the urine of cardiac disease owes its main characteristics to the venous congestion, and not to the diminished arterial pressure. The albuminuria is easily explained, for, as we have seen elsewhere, this condition obtains whenever the epithelium of the glomeruli is insufficiently nourished with arterial blood, as is here the case, and the grade of albuminuria will be inversely proportional to the amount of arterial blood which passes through the glomeruli in a given unit of time.

In all venous congestions there is an extravasation of the serous elements of the blood and a diapedesis of red, together with a few white, blood-globules into the perivascular lymph-canals. This serous fluid, however, contains but a small amount of albumin—much less than is contained in the blood itself.

Senator found, after closing the renal vein entirely for a period of about ten minutes, and then removing the kidney at once from the animal, and coagulating its contents by dropping the organ into boiling water, that coagulated albumin and red blood-corpuscles were to be found in a number of the straight tubules, while Bowman's capsules were entirely free of these elements. If the closure of the vein lasted longer, however, albumin and red blood-corpuscles were to be found in the capsules as well.

From this experiment the presence of red blood-corpuscles in the urine is readily accounted for.

Effects of Increased Pressure in the Urinary Passages.—M. Hermann, a pupil of Ludwig, has shown that if the pressure in the uriniferous tubules be increased by anything interfering with the free exit of the urine, a decrease in the amount secreted in a given unit of time occurs, and at the same time there is an even more marked decrease in the elimination of the solid constituents, and especially of urea. As the pressure increases, secretion becomes less and less active, till a point is arrived at where it is entirely suppressed. In the dogs used for this experiment it was found that when this point was reached the intratubular pressure amounted to only about one-half of the general arterial pressure. Upon then removing the obstruction to the exit of urine a large quantity of clear urine of low specific gravity was secreted. Ludwig saw in this a confirmation of his theory that secretion depended on the difference in pressure existing between the blood within the glomeruli and the urine without. But according to this, secretion should take place as long as any difference whatever existed between the two; and furthermore, no account was taken of the resorption of the water secreted, though, according to Ludwig, this plays an important part, even in the normal condition of things. For if the mercury of a manometer attached to the ureter be observed to rise gradually and then stop, it is not necessarily a sign that secretion has ceased at this point, but perhaps only that resorption has then become equal to secretion. That resorption does actually take place is abundantly proved, as Cohnheim points out, by the œdema not only of the kidney itself, but also of the loose surrounding tissue, and by the visible fulness of the larger lymph-vessels at the hilum. Though there is considerable obstruction to the venous outflow, still this œdema cannot be considered as due to that, for it is always observed that the kidney is pale and anæmic, and not in a state of venous engorgement. We have seen that the capillaries and uriniferous tubules are arranged in alternate bundles, so that the distention of one set of vessels causes compression of the other. It is not hard to conceive, therefore, that when the uriniferous tubules are widely distended, by damming up their contents, they should exert such a pressure upon the blood-vessels as to materially interfere with their circulation, and that the blood, consequently, flows less quickly through the organ, and that hence, also, according with the views of Heidenhain, diminished secretion results. The secretion of a large amount of clear fluid, after an obstruction which has persisted for some time is suddenly removed, may be explained by the fact that when an obstruction to the circulation anywhere in the body is suddenly removed, the vessels of the part undergo a dilatation which may last some time. So in the kidneys this secondary dilatation allows the blood to flow with increased rapidity, and we have increased secretion in consequence.

The changes which occur vary considerably, according as the obstruction is sudden and complete or gradual and partial. In the first case, after the exit of the urine has been stopped, we have seen that the urine is gradually secreted in smaller and smaller amounts, and that the kidney is rendered anæmic by the pressure of the uriniferous tubules, and also œdematous from the urine being reabsorbed by the lymphatics. The calyces, pelvis, and that part of the ureter lying above the obstruction—for we will assume that the impediment lies in the ureter—will be tensely distended, giving rise to the condition known as hydronephrosis. In a short time, however, this overfilling causes the parts to stretch, relieving thereby the pressure within the kidney somewhat, and the blood then circulating again more freely, secretion is renewed, which again results in overfilling and dilatation. The continued

anæmia, however, quickly begins to tell upon the nutrition of the organ, and soon secretion ceases entirely, as is shown by the formerly œdematous condition being replaced by one in which the kidney is much drier even than normal. Atrophy then sets in. This is shown in the beginning by a flattening of the pyramids, and later by a thinning of the whole substance of the organ, which finally may become so thin as to form an elevation but a few millimetres in thickness on the inner wall of the sac. In these cases the hydronephrotic sac does not become very large, for the reason that the atrophy begins too soon to allow enough urine to be secreted for the formation of a large sac.

In cases where the obstruction is gradual and partial, or where the hindrance is of an intermittent nature, the state of affairs is somewhat different from the above. The circulation in these cases, as the pressure is not so overwhelming, gradually adapts itself to the surrounding circumstances, and the organ still keeps on secreting, causing, by the gradual pressure exerted on all portions of the urinary tract lying above the obstruction, a slow but ever-growing distention. In this way enormous tumors may be formed, sometimes filling up the greater part of the abdominal cavity.

The Renal Circulation during Fever.—It has always been the opinion that during fever the kidney is in a state of congestion, but the writer, in a series of experiments made in conjunction with Professor Cohnheim, has shown that this view is erroneous. On the contrary, the kidney, at least in acute fever, is in a state of extreme anæmia, being small, pale, shrunken, and bloodless. Although the arterial pressure may increase, as it does, as a rule, in the beginning of a fever, the renal vessels begin to contract as soon as the temperature of the body rises, and they remain thus contracted, even after the blood-pressure falls, from a general relaxation of the system, owing to the temperature having reached lethal limits. This extreme renal anæmia (its degree depends on the degree of pyrexia) accounts for the scanty, dark-colored urine of high specific gravity voided by feverish patients, and also for the albuminuria which so frequently occurs shortly after the onset of the fever, the continued anæmia being quite sufficient to cause such a degree of malnutrition of the glomerular epithelium as to render it permeable to albumin. In the experiments made the observations extended over fevers of five to eight hours' duration, but the temperature of the dogs used was very high, amounting to 39° C. (102.2° F.), 42° C. (107.6° F.), and even 44° C. (111.2° F.), and above. In these cases it was observed, without a single exception, that the kidney grew progressively smaller from a contraction of its vessels. Experiments made to determine whether this was due to a peripheral or central nervous cause pointed very strongly to the latter. How the renal circulation is affected in fevers of long duration we cannot say with any degree of positiveness, as there are no experimental data to go by. It is not improbable, however, that when the general relaxation of all the tissues, which occurs in long-continued fever, sets in, the renal vessels dilate; but owing to the slowness of circulation through them from the diminished arterial pressure, and from the malnutrition of the sensitive epithelial cells, the scanty urine and albuminuria still persist. The reader must bear in mind that the study of the renal circulation, as has been made possible to us by Roy's oncometer, is still in its very beginning, and that we may expect the most valuable contributions to physiology and pathology from further observations made with this instrument.

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KIDNEY, DIFFUSE AFFECTIONS OF. The term "diffuse" designates lesions of the kidney in which tissue-elements of the same histological and functional value are similarly affected throughout both kidneys, although not always in the same intensity.

In 1827 Richard Bright [1] first pointed out distinctly the connection between certain cases of dropsy and morbid changes in the kidneys, both structural and functional. The study of the diffuse inflammations of the kidney dates from these investigations of Bright, and the name "Bright's disease" has been ever since that time applied to diffuse affections of the kidney, accompanied during life by excretion of albumen and by dropsy. It was soon discovered, however, that the cases so described differed among themselves in very essential respects; and while it is impossible to trace in every case the relation between the multiform histological changes in the morbid kidney and the course of the malady, both anatomical and clinical necessity have led to classifications which, in the main, recognize a few well-marked types of disease, differing in their causes, nature, and clinical course.

The generic name, Bright's Diseases (Stewart), is made to cover the following distinct clinical groups: 1. Acute nephritis—involving chiefly the secreting apparatus (glomeruli and tubes), and usually accompanied by fever; the urine is diminished in quantity, of high specific gravity, containing much albumen, casts of the uriniferous tubes, leucocytes, and often blood; dropsy is a common event, and many cases lead to uræmic convulsions. 2. Chronic parenchymatous nephritis—affects primarily the epithelium of the glomeruli and tubes, only secondarily the interstitial tissue, and runs its course without fever; the urine is scanty, highly albuminous, and contains casts in great number; dropsy, often of high degree, is common, uræmia rare. 3. Contracted kidney—depends on new-formation and cirrhotic contraction of interstitial tissue, and runs an insidious course without fever; the urine is abundant, of low specific gravity, and contains little albumen and few casts; commonly associated with arterial lesions in the kidney and in other organs, and with hypertrophy of the heart; dropsy is rare, uræmia constant. 4. Amyloid disease of the kidney, in company with amyloid degeneration in other organs—affects mainly the walls of the small arteries; the urine is abundant, albuminous, of low specific gravity; dropsy is frequent, uræmia exceptional. Many modern authors exclude the amyloid kidney from the category of Bright's diseases.

Besides these forms, the kidney suffers diffuse lesions arising primarily from disturbance of the circulation, viz., 5, active, and 6, passive, hyperæmia, the latter ending in cyanotic induration of the gland; 7, the renal affection of cholera; and 8, the renal affection of pregnancy.

To these clinical groups correspond more or less accurately the more conspicuous types of anatomical lesions: the mottled and hæmorrhagic kidney of acute nephritis; the "large white" kidney or the "contracting white" kidney of chronic nephritis; the "small, red, granular" kidney of genuine arterio-sclerotic atrophy; the "cyanotic," indurated kidney of passive congestion, etc., with numerous intermediate and mixed forms.

The infinitely varied macroscopic appearances of the morbid kidney are due to a limited number of histological alterations, varying chiefly in degree and in modes of combination. In all cases that may be considered of inflammatory origin, acute or chronic, analogous changes take place in the Malpighian bodies (vascular loops of the glomeruli, glomerular and capsular epithelium), in the tubular epithelium, and in the blood-vessels (hyperæmia, anæmia, endarteritis, arterio-sclerosis), and interstitial infiltration occurs, resulting in new-formation of cicatricial tissue and, eventually, in cirrhotic contraction. These lesions combine to produce great diversity in the post-mortem appearances, and the often confusing groups of

symptoms during life. Thus, enlargements of the kidney may depend on hyperæmia, on swelling and proliferation of epithelium, on interstitial white-cell infiltration. The large white, yellow, or mottled kidney owes its size and paleness to the swelling and fatty degeneration of the epithelium; the size of the waxy kidney is due to the deposition of amyloid material, its paleness to anæmia. Contraction of the kidney results from obsolescence of glomeruli, atrophy, or desquamation of the tubular epithelium and collapse of the tubes, and the consequent shrinking of new-formed tissue in the interstices.

The cardinal symptoms of functional disturbance may similarly be referred to the kind and degree of the histological changes. The albuminuria of nephritic patients depends mainly on lesions of the glomeruli, especially in the walls of their capillaries, and runs, as a rule, parallel in degree with the intensity of the lesions.[2] Scantiness or suppression of urine depends on the obstruction or obliteration of glomerular capillaries; on clogging of the uriniferous tubes with swollen epithelium and exudation of cast material; on general or local anæmia and low blood-pressure. *Vice versa,* the high blood-pressure in true cirrhosis of the kidney may account, in part, for the increased flow of urine. The latter must, in part, be owing to increased permeability of the diseased blood-vessels; perhaps, also, to disease of the pyramids interfering with their normal function of reabsorbing water from the dilute urine secreted by the glomeruli.[3] Retention of urinary constituents, leading to uræmia, is the result of lesions of the secreting apparatus, especially the epithelium of the glomeruli and tubes.

ACUTE PARENCHYMATOUS NEPHRITIS.—Those authors who look upon all diffuse inflammatory affections of the kidney as successive stages of the same disease, designate this as the first stage of Bright's disease—chronic parenchymatous nephritis representing the second, contracted kidney the third, stage. A large number of synonyms, resulting from the dominant pathological (anatomical rather than clinical) views, have been applied to it: acute Bright's disease, albuminous (Rayer), catarrhal and croupous (Virchow), desquamative (Johnson), hæmorrhagic (Traube), epithelial (Lancereaux), tubal (Dickinson), nephritis.

Ordinarily the kidney is enlarged, especially in the cortical substance, the capsule smooth and tense, varying in color from the bloody red (hæmorrhagic) or mottled kidney to a pale buff, according to the predominance of capillary hæmorrhages on the one hand, or anæmia, swelling of the epithelium, and interstitial infiltration on the other. The renal epithelium is the chief seat of the tissue changes. In probably the majority of cases, the histological lesions begin in the Malpighian bodies, with morbid alterations of the loops of the glomeruli which render their walls abnormally pervious to albumen and blood-corpuscles, and at the same time obstruct their calibre, accounting for the early and intense albuminuria and hæmaturia, as well as for the anæmia of the renal parenchyma, and the scanty secretion of urine. Swelling, proliferation, and detachment of the glomerular and tubal epithelium, and more or less interstitial infiltration, are the immediate consequences. In some forms of nephritis (after scarlet fever and measles) the glomeruli are the chief, even the only, seat of the lesions —the glomerulo-nephritis of Klebs; in other (particularly toxic) forms the glomeruli are almost untouched; in the great majority, the tubes and glomeruli are equally affected.[2] (For details of the morbid anatomy of this, as well as other renal diseases, consult article Kidney, Morbid Anatomy of.)

Etiology.—Acute parenchymatous nephritis may occur at any age, but it is rare after forty. Children are most liable to it, because the most prolific causes of the disease attack children oftener than adults.*

Cold is an important, though not very frequent, cause of acute nephritis, especially in the form of sudden changes of temperature, or wetting and chilling of the heated body. Extensive burns, and some other general affections of the integument, may likewise cause acute Bright's disease. The connection between these causes and the disease is not traced, the theory of checked perspiration and retained excrementitious material being unsatisfactory and not proved.

All other cases may be explained by the direct specific action of noxious substances upon the tissue-elements of the kidney. Various poisons, among them a number of remedial drugs, are potent causes of acute inflammation in the kidney. Chief among them is cantharides; other irritant diuretics, as turpentine, copaiva, cubebs, squills, act similarly. Moreover, all drugs capable of producing hæmoglobinuria, *e.g.*, potassium chlorate, petroleum, pyrogallic acid, chrysarobin, carbolic acid, and for the same reason the bile acids (in icterus), may cause nephritis. Since it has been observed that periodical hæmoglobinuria is caused by the action of cold, it seems possible that a similar condition may be the connecting link between the cold and the nephritis.

By far the greatest number of cases of acute Bright's disease occur as sequels to acute infectious diseases, and among these scarlatina is pre-eminent. The frequency of nephritis varies greatly in different epidemics of scarlet fever, being rare in some, but attacking nearly half the patients in other epidemics, quite independently of the severity of the fever; not seldom the renal affection supervenes in the mildest cases, even in those *sine exanthemate.* Measles, small-pox, chicken-pox, and mumps, are more rarely followed by nephritis. Diphtheria is second only to scarlet fever as a cause of acute renal disease; the nephritis of diphtheria differs, however, from scarlatinal nephritis in that it occurs only in severe cases, and sets in during the acme of the diphtheritic process. Typhoid, typhus, and relapsing fever, cerebro-spinal meningitis, pneumonia, and erysipelas, are sometimes followed by acute nephritis. Malaria also is an undoubted cause of it;[4] and it has been observed as a sequel to acute articular rheumatism. Lastly, a number of inflammatory and septic processes—especially surgical fever, carbuncle, puerperal fever, and septic endocarditis—are occasional causes of nephritis.

Bacteria and micrococci have sometimes been found in large numbers in the urine, but they have not yet been shown to play the part of morbific agents, although this is probable in the cases following sepsis and erysipelas.

Finally, acute inflammation may supervene in the course of any of the chronic forms of Bright's disease.

Symptoms and Course.—The beginning of acute nephritis is sometimes sudden, more often gradual. When the case is severe from the first, its onset may be marked by a chill followed by decided fever; in milder and subacute cases there is no chill, and the temperature throughout is but slightly elevated. Fever, therefore, is not a prominent or constant symptom, and frequently belongs to the conditions underlying the nephritis rather than to the latter. Pain in the loins is an early but infrequent symptom, not often severe, and usually soon disappears. More constant, more valuable as a warning of acute renal trouble, is vomiting; it is often the first symptom, sometimes violent and uncontrollable, but does not persist long. In the absence of etiological indications, this group of symptoms is of small diagnostic value. More frequently the nature of the illness is first disclosed by the appearance of anasarca, or by scanty excretion of urine containing albumen, or even blood, and tube-casts. These are, indeed, the cardinal symptoms of acute nephritis: oliguria, albuminuria, and perhaps hæmaturia, casts, and dropsy. Neither of these symptoms alone suffices to establish the diagnosis, but commonly a sufficient number co-exist to leave no doubt, and the diagnosis of acute Bright's disease is seldom difficult.

The course of the disease varies widely in cases of different etiology. The variety most frequently met with is *scarlatinal nephritis,* which may serve as a type. The convalescence from scarlet fever is interrupted (in the second to sixth week, commonly about the end of the third) by renewed feeling of illness, the face becomes

* I have seen the disease in a woman fifty-four years of age. Hirschsprung reports four cases of non-scarlatinal acute nephritis in infants (Jahrbuch f. Kinderheilkunde, xix., p. 424).

pale and a little œdematous, a moderate fever sets in, often preceded by headache and vomiting; occasionally a dull pain in the back is complained of, and usually a desire to urinate frequently (*pollakiuria*, Dieulafoy). The urine is now scanty, turbid, often discolored by blood—pink, red, or smoky brown—contains a good deal of albumen, and deposits a sediment of red and white blood-corpuscles, epithelial cells, and casts. The œdema increases rapidly; finally dropsy of the serous cavities, especially ascites, supervenes. Oftentimes the onset is more violent, with chill, high fever, total suppression of urine for a time, or an intensely bloody urine; in other cases the disease begins insidiously, without fever, even without conspicuous changes in the urine. The dropsical symptoms may be the first to announce the kidney affection, and rapidly attain to a high degree; or they may be subordinate or absent altogether.

The changes of the urine are usually characteristic. The daily quantity is considerably diminished, owing to the early lesion of the capillaries of the glomeruli. In cases of sudden inception complete anuria may exist for a day or longer; such cases are often fatal.

The specific gravity is high, 1.025 to 1.030, or more; the reaction is always acid. During convalescence the amount of urine rises again, sometimes suddenly and beyond the normal, the specific gravity falls correspondingly to 1.010, or less, and then gradually sways back to normal figures. Albuminuria is a constant symptom; but in not a few cases it sets in late, so that it is not always available for an early diagnosis.[5] The amount of albumen is sometimes small; in the great majority of cases it is abundant from the first, exceeding one per cent. Besides albumen, globulin is often found, and Werner reports a case in which globulin was the only proteid body present.[6] When the urine is scanty, the brown or reddish sediment contains uric acid and urates. During the acme of the disease it contains numerous white and red corpuscles, the latter often making a very large deposit in the distinctly bloody urine, and almost always renal epithelium, either free or in casts, in a state of cloudy swelling or of granular degeneration. Invariably, tube-casts of many kinds are present, hyaline, epithelial, and dark granular, as well as mixed forms. In some cases they are mostly small casts crowded with leucocytes; these white-cell casts are regarded by Johnson as diagnostic of glomerulo-nephritis.[7] To these formed elements is added an abundant débris of blood-cells, casts, and epithelium. As convalescence progresses, the urine becomes clearer, the blood disappears, while casts and albumen continue to be present in diminishing amounts, often for months.

Dropsy is a very constant symptom; in a number of milder cases it is limited to a moderate œdema of the face and hands, rarely absent entirely. As a rule, there is general anasarca of the extremities, and, in severer cases, ascites, hydrothorax, and hydropericardium. The most dangerous events of this class are œdema of the glottis, œdema of the brain, and pulmonary œdema. It is generally characteristic of renal dropsy that it is independent of position, not invading first or exclusively dependent parts, and that it shifts place frequently; hence the dropsical symptoms vary much in the course of the disease as to degree and locality, and the amount of effusion by no means always corresponds to the intensity of the renal lesion. In favorable cases it diminishes in time, slowly, as a rule, but sometimes very rapidly, with consequent polyuria or copious watery stools.

The pulse is always hard, the tension in the aortic system being very high.[8] This is frequently an early symptom, and a very conspicuous one. It depends chiefly upon the sudden obstruction of renal capillaries, imperfect elimination of water, and retention of urea, etc.; but often precedes manifest disturbance of the renal functions. In consequence of the high arterial tension, dilatation of the left ventricle of the heart, usually compensated for by hypertrophy, occurs in many cases of scarlatinal nephritis.[9] This excentric hypertrophy develops with great rapidity—in from two to four days—and can often be demonstrated during life. Acute dilatation of the heart, when not compensated for by hypertrophy, may manifest itself in severe dyspnœa and other symptoms of weak heart, and is one of the serious dangers to life, sometimes causing sudden death.[10]

But the most insidious, and a very frequent and dangerous, complication is uræmia. Milder uræmic symptoms, such as sopor, violent headaches, jactitation, and dyspnœa, are occasionally met with early; acute uræmia in the form of eclamptic convulsions or coma, more rarely of tetanus or hemiplegia, may occur at any period. The advent of these symptoms is not dependent on the severity of the renal lesion, and I have observed uræmia even when the urine was still copious and but little albuminous, and free from blood and casts. The sudden amaurosis sometimes met with is probably a uræmic symptom.

Affections of the serous membranes (pleurisy, pericarditis, peritonitis, and inflammations of the joints), pneumonia, and bronchitis not rarely complicate the course of acute nephritis.

The *Duration* of scarlatinal nephritis is usually short. Fatal cases commonly terminate in a week or two; death rarely supervenes later than three months after the attack. Mild cases recover in a few weeks; and even severer cases which end favorably are not so protracted as those of nephritis in adults. Termination in chronic Bright's disease is very rare indeed. The most frequent causes of death are uræmia, respiratory lesions (pneumonia, pleurisy, hydrothorax), and failure of the heart.

From this typical course cases of other than scarlatinal origin deviate in important particulars. Those rare cases which occur in the course of malaria, are said to resemble the scarlatinal form very closely. Not so the *diphtheritic nephritis*, which differs essentially in that it sets in much earlier, during the acme of the diphtheritic process, and in the usual absence of blood from the urine. The latter is pale and of rather low specific gravity, but often contains much albumen, many hyaline and granular casts, and numerous free epithelial cells in a state of cloudy swelling, or, later, of fatty degeneration. Dropsy is rare, and cardiac hypertrophy is absent. The disease does not begin with a glomerular lesion.[11] Its course is more uniform, and often brief. Recovery is usually rapid and complete, but even a very protracted case may end favorably.

The nephritis of typhoid fever is complicated by catarrh of the urinary passages; that of relapsing fever is accompanied by abundant desquamation, and characteristic microbes have been found in the urine.

The nephritis induced by exposure to cold and moisture is characterized by a rapid onset, with severe chill and often high fever, pain in the loins, and the early advent of dropsy.

Among the toxic varieties, that induced by cantharides and similar irritant diuretics is complicated by cystitis, and is marked by severe pain in the loins, tenesmus of the bladder, large lumpy gelatinous coagula, and much blood in the urine.

Prognosis.—The prognosis of acute nephritis is always doubtful, and depends largely on the causes. It is decidedly more favorable than in any of the chronic forms. Of the varieties from different causes, scarlatinal nephritis is the most dangerous; diphtheritic nephritis, and the acute Bright's disease of adults from exposure to cold, offer better chances; malarial nephritis also tends to recovery. Termination in chronic nephritis is exceptional.

The danger of acute nephritis lies almost wholly in the retention of material which the normal kidney excretes (water and nitrogenous metabolites), resulting in dropsy and uræmia. The loss of albumen is a secondary danger.

In the individual case the ominous symptoms are: complete anuria, which, if it lasts for days, indicates a fatal issue; uræmia, which always makes the prognosis doubtful, although even severe cases recover; and a high degree of dropsy, especially hydro-thorax and hydro-pericardium, as well as pulmonary œdema. The quantity of blood in the urine is of no influence on the prognosis, but its continuance through many weeks is an unfavorable sign. Even in the absence of severer symptoms, death

may occur unexpectedly, *e.g.*, in scarlatinal nephritis, from failure of the dilated heart.

Treatment.—Prophylactic measures are confined to the avoidance of renal poisons, and care in the administration of irritant diuretics, as cantharides, both externally and internally. (In scarlet fever Spanish-fly blisters should not be used for any purpose.) The development of acute nephritis in the course of infectious diseases, can be neither foreseen nor prevented.

Frequently the disease is directed to a favorable issue by simple dietetic means. The value of a strict regimen and suitable diet, with rest in bed and uniform warmth, cannot be too much insisted upon. The patient should be warmly clothed in woollen, and remain in bed until the albuminuria has quite or nearly ceased. This measure appears absolutely necessary. Warm (not hot) baths are useful in the beginning. The diet, at this time, should consist chiefly of gruels, well-baked or toasted bread, milk, and perhaps stewed fruit, with abundant drinks of effervescent waters, lemonade, or weak tea. Meat and eggs should be given very sparingly during the first weeks. Later, an exclusive and systematic milk diet is of great benefit, if the digestive organs consent to it; the use of peptonized milk is advisable. Coffee is to be avoided. If, after some weeks, anæmia and debility set in, a more nutritious diet is allowable, with preponderance of milk, small quantities of mild alcoholics, and preparations of iron. The stronger wines and spirits are contra-indicated.

In cases of stormy onset, with pain and fever, dry cups to the loins and antipyretics, especially quinine; in moderate cases these are not needed, and blood-letting is never required by the nephritis itself. Diuretics and diaphoretics should not be employed early. Moderate oliguria is commonly overcome by abundant (preferably warm) drink.

On the other hand, the more urgent symptoms of suppression of urine, rapidly increasing dropsy, and uræmia, demand prompt and active interference. In case of complete anuria, hot baths (40° C. = 104° F.—for five minutes), followed by hot packs, or by hypodermatic injection of pilocarpin (0.005 to 0.02 Gm. = gr. $\frac{1}{12}$ to $\frac{1}{3}$, according to age), with lemonade and solution of acetate of sodium, have been successfully employed. Pilocarpin is contra-indicated in cases of weak heart, and of respiratory complications, and must be used with caution. The same measures are indicated when uræmia threatens, and may be reinforced by drastic cathartics, senna, colocynth, or gamboge. Uræmic convulsions, in patients of good strength and hard pulse, call for blood-letting—in adults venesection, in children a number of leeches proportioned to their years; it matters little where these are applied. Meanwhile, chloroform or ether will control the convulsions; chloral by enema, and potassium bromide, will tend to prevent their recurrence. In debilitated patients, with small pulse and feeble heart, stimulants, such as camphor, or hypodermatic injections of ether, are required. Chronic uræmia, when the pulse becomes frequent, small, and soft, demands measures to sustain the heart, especially digitalis (0.1 Gm.=gr. jss. for an adult every three hours, continued for several days). Benzoic acid (Frerichs) and other acids have not proved as valuable as was anticipated.

The dropsy is the object of energetic treatment only when it is general and increasing. The removal of water is best accomplished by active diaphoresis, aided, if need be, by hydragogue cathartics; diuretics are best avoided in acute inflammations of the kidney. (For treatment of dropsy, see section on chronic nephritis, below.)

During convalescence tonics and generous diet may be called for, and woollen clothing should continue to be worn for some time.

Chronic Parenchymatous Nephritis.—*Synonyms:* Chronic Bright's disease (or the second stage of Bright's disease of the unitarians); non-desquamative nephritis (Johnson); chronic tubal nephritis (Dickinson); chronic diffuse nephritis. A disease involving all the tissue-elements of the kidney and presenting, *post mortem*, histological evidence of all stages of lesions, from recent inflammation to atrophy and contraction, often in the same kidney. The changes are of a genuinely inflammatory character, ordinarily beginning with cloudy swelling, molecular and fatty degeneration of the epithelial cells (chiefly in the glomeruli and convoluted tubes), which gradually break down into a granular or fatty débris, and aid in forming the dark granular and oily casts. White and red corpuscles find their way into the tubes, and exudation of an albuminoid material fills the tubes with casts. Consequent upon the epithelial changes and collapse of the tubes, obsolescence of the glomeruli, interstitial white-cell infiltration, resulting here and there in cellular or fibrous hyperplasia and cicatricial contraction. Deposition of amyloid material in the walls of blood-vessels is not infrequent, and leads to mixed forms of disease. Endarteritis may be added to these changes and contribute to a modification of the clinical course, merging it in that of the genuine contracting kidney.

The macroscopic appearances after death are, therefore, of the most varied character, and often differ surprisingly from what the clinical symptoms led one to expect. They present transitions from the mottled or hæmorrhagic kidney to the large white kidney (which is the most typical anatomical expression of this disease), and from double the normal size to a small contracted kidney.

Etiology.—Most frequent in middle age, chronic nephritis is yet met with at all ages, and in both sexes. In a majority of cases its cause remains obscure, especially when its origin is insidious and the date of its commencement unknown.

Very rarely does it take its rise from an acute nephritis. Cold, in the shape of repeated chilling of the surface, of exposure to wet and cold combined (incident to some occupations), of the damp dwellings of the poor, is among the common causes. In many malarial districts chronic Bright's disease is of frequent occurrence, and observations are not wanting (Bartels, Kelsch and Kiener, Busey,[12] Atkinson[4]), which establish the connection of malaria with Bright's disease as a cause. Many chronic constitutional diseases are subject to complication with chronic nephritis, particularly protracted rheumatic affections, chronic skin diseases, prolonged suppuration, inveterate syphilis, phthisis, and gout. Whether alcohol and mercury are ever by themselves causes of this form of renal disease appears doubtful.

Symptoms and Course.—The cardinal symptoms of chronic parenchymatous nephritis are, adding general anæmia, the same as those of acute nephritis, their relative value being somewhat shifted. Dropsy here assumes the first rank, is an almost constant symptom, and usually the first that warns both patient and physician. Its access is gradual, but its course, though variable, is protracted, its locality frequently shifting, and not confined to dependent parts. In degree it varies from slight œdema of the face, hands, or feet, to general anasarca and dropsy of the serous cavities, with imminent danger to life. Cases are on record, however, in which dropsy was entirely absent, and the general course frequently interrupted by attacks of subacute inflammation with bloody urine, leading Wagner[13] to class them under the title of "chronic hæmorrhagic Bright's disease without œdema." The amount of dropsy present is often a fair measure of the rapidity of the morbid process; it is apt to lessen toward the termination of a very protracted case, when the kidneys become atrophic.

Anæmia is one of the early symptoms, and explains the great debility of the patient and the progressive emaciation, masked for a time by the anasarca. It accounts also for much of the dyspnœa, the disturbed digestion, the headaches, and neuralgias.

The diagnosis of a case presenting these symptoms can be made only through the examination of the urine, to which they invite. The urine has become scanty, though it is never suppressed; it is commonly high colored, and deposits a brownish, muddy, rarely a bloody, sediment. The specific gravity is not characteristic, varying in inverse ratio to the amount excreted; occasionally it attains to high figures (1.040), but ordinarily it is low, considering the small quantity. Albumen is present in large

quantity, usually exceeding one per cent., and sometimes reaching the enormous amount of five per cent. or more, when the urine solidifies on heating. The loss to the economy of albumen is thus very great; Bartels computed average daily losses, continuing through months, of from 10 to 17.26 Gm. Besides albumen, globulin is frequently found, and T. Hoffmann [14] attributes unfavorable significance to it, when abundant. Blood in quantity is usually absent. The sediment contains, however, some red blood-corpuscles, and invariably great numbers of white cells. Casts are always present, and usually numerous—casts of all kinds, small and large, hyaline, epithelial, dark granular, and the broad, strongly refracting, wax-like casts; casts with oil-globules, blood-globules, or fragments of epithelial cells. The latter also appear in the sediment more or less well preserved in form, in various stages of granular and fatty degeneration. In the beginning the casts are not numerous, and the majority are hyaline or pale granular; in time the dark granular, in company with large waxy casts, predominate.

When secondary atrophy and contraction set in, the urine begins to change; it grows more abundant, of lower specific gravity, less albuminous and clearer, so that it more and more nearly approaches in character the urine of contracted kidney, *q.v.* In very chronic cases, when atrophic processes go on almost parallel with the inflammatory changes, the behavior of the urine may be so little characteristic as to be of no value in the differential diagnosis.

Fever is always absent, except as a symptom of acute inflammatory complications, either in the kidneys themselves or in other organs.

Pain in the region of the kidneys is scarcely ever present. But certain forms of paræsthesia are frequent, and sometimes early manifestations of chronic nephritis, especially pruritus, numbness of the extremities, particularly of the fingers (*doigt mort*), and formication; [15] they are held to be valuable in establishing an early diagnosis, and are commonly interpreted as uræmic.

Uræmia is, however, rare in this form of nephritis, and seldom fatal; it is more often chronic than acute, manifesting itself in dyspeptic symptoms, vomiting, dyspnœa, and headache that is sometimes violent and most obstinate. The dyspnœa—aside from that which is due to organic lesions of the respiratory organs—is frequently a prominent symptom of chronic Bright's disease, and may be continuous or paroxysmal. Uræmic convulsions have been observed as a result of the rapid absorption of dropsical effusions (Bartels).

The heart is less frequently affected in this disease than in either acute nephritis or contracted kidney; hypertrophy or dilatation, in a degree demonstrable during life, is a rare occurrence; only in cases where much contraction has taken place hypertrophy of the left ventricle is the rule. The pulse, also, is hard and full only in cases of rather rapid development in robust subjects, and then only in the beginning; when anæmia and emaciation have once been established it is small and rather soft.

Complications with inflammation of the lungs or serous membranes, with erysipelas, or with dysenteric affections, are common and sometimes the causes of death; cerebral hæmorrhages, on the other hand, are comparatively rare. Albuminuric retinitis occurs, but not very frequently, and, as a rule, only in later periods.

The course of chronic parenchymatous nephritis is seldom uniform, tending steadily toward the fatal end. Oftener decided remissions, with great diminution of albumen and casts, disappearance of the dropsy, and abatement of the general symptoms, raise vain hopes of recovery. Periods of more acute inflammation may also alter the complexion of the symptoms. The duration is accordingly variable. Some subacute cases, as well as those which are superadded to phthisis or other chronic disease, terminate in a few months. Frequently the date of beginning cannot be determined at all; such cases are most apt to be of long duration, extending over one or even many years, unless cut short by intercurrent inflammatory diseases of other organs. These protracted cases disclose, *post mortem*, contracted kidneys.

Diagnosis.—When the above symptoms are present in marked degree, the diagnosis is very easy; it is based upon the general dropsy with localizations characteristic of its renal origin, the high degree of albuminuria, the abundance of casts of many kinds, especially the dark granular and oily casts, and the absence of heart disease. But when this group of symptoms is incomplete, or, later, inclines to that of the contracted kidney, or when amyloid infiltration complicates the parenchymatous inflammation, the differential diagnosis is often very difficult or impossible. More important even, for therapeutic purposes, than the diagnosis of the variety of Bright's disease, is the early recognition of the renal lesion, and the etiological diagnosis. Unfortunately, most cases come under observation only when dropsy has already set in; but in insidious cases this symptom has been preceded by a period of (perhaps unobserved) albuminuria, during which an accurate diagnosis may have been impossible. Only frequent examination of the urine and careful consideration of the etiology can assure an early diagnosis.

The *Prognosis* of chronic parenchymatous nephritis is very unfavorable, recovery being one of the rarest events. Early recognition of the disease, in a case due to removable or curable causes, as syphilis, malaria, or protracted suppurative processes amenable to surgical treatment, permits a more hopeful view. But if dropsical symptoms have lasted a longer time, or if the character of the urine discloses a high degree of functional disturbance (and hence extensive anatomical lesion), the prognosis is nearly fatal.

When the urine indicates that contraction has set in, a long duration with temporary improvement of the symptoms may be predicted, but not recovery. Among the complicating inflammations, pneumonia has nearly always proved fatal.

The *Treatment* follows the lines indicated for the treatment of acute nephritis. Rest in bed cannot be enforced as thoroughly or continuously, but the same relief can be extended to the kidneys by methodical warming of the skin by means of woollen clothing, uniformly warm temperature of the room, or a dry, equable climate, warm enough to admit of outdoor life. The diet may be nutritious from the beginning; an exclusive milk-diet, faithfully carried out, is of the utmost benefit. Highly-seasoned dishes and spirituous liquors should be prohibited. When the urine is scanty, heavy, and sedimentitious, the free use of simple liquids, pure natural springs (Waukesha), or distilled water (flavored by aromatics or impregnated with carbonic acid gas) is to be recommended. Excesses should be avoided; regular habits of diet, exercise, and sleep, are beneficial, while over-exertion of body or mind is injurious.

Anæmia is so prominent a symptom that tonics and analeptics are usually required—cod-liver oil, and easily assimilated salts of iron (*e.g.*, Basham's mixture, *Mistura ferri et ammon. acet.*, one tablespoonful three times a day). Attempts to limit the loss of albumen by acetate of lead, chloride of iron, or tannin, have failed; the tannate of sodium, more easily borne by the stomach, and highly recommended, has been shown to have no influence over the albuminuria. [16]

One of the principal objects of treatment is the dropsy. The removal of water can be accomplished by diuretics, diaphoretics, or cathartics. The latter are not often available, because of their deleterious influence upon digestion and nutrition; hydragogue cathartics (colocynth, croton-oil, elaterium) are unsafe, as a rule, and should be employed only when the dropsy involves imminent danger to life. Irritant diuretics are all to be avoided; diuresis is most safely promoted by saline diuretics (acetate of sodium, acetate, citrate, or bitartrate of potassium, in large doses, 8.0 to 16.0 Gm. = ʒ ij. to ʒ iv. per day), aided, in case of enfeebled heart, by digitalis, caffein, or camphor. Infusion of digitalis with cream of tartar is a favorite prescription. The use of these salines is not to be persisted in if increased flow of urine does not follow it. Diaphoretic measures are indicated when the dropsy is general and increasing, the patient being not too feeble, and free from fever and uræmic symptoms. In case the

urine is bloody they are preferable to diuretic treatment. Two efficient means of diaphoresis are at hand: (1) Hot baths, hot packs, and warm blankets, used systematically, or, in less urgent cases, the improvised hot-air bath (patient sitting in a tent of blankets fastened around his neck, with a spirit-lamp under his chair); and (2) the hypodermic use of pilocarpine, an exceedingly valuable remedy in this disease. To obviate the tendency to collapse it has been suggested[17] to combine the pilocarpine or jaborandi (one-third drachm of the fluid extract every three hours, by the mouth) with nux vomica and digitalis. A milder and continuous diaphoresis can be obtained by acetate of ammonia or citrate of potassium.

The results of the "dry method," as practised by Oertel and others, limiting the daily allowance of liquid to 500 Gm. = one pint, have not been satisfactory in all cases, and experience is needed to determine the indications for this method.

When these means fail to reduce the dropsy, it becomes necessary to remove the effusions by mechanical means—scarification, acupuncture, drainage-tubes, or tapping the peritoneal cavity (consult article Dropsy). Recently, *early* tapping in abdominal dropsy has been warmly recommended by Ewald.[18]

CONTRACTED KIDNEY.—*Synonyms:* Granular atrophy, red granular kidney, gouty kidney, renal cirrhosis, chronic interstitial nephritis, renal sclerosis (Leyden), *rein artériel* (Lancereaux), *cirrhose glandulaire* [for the contracted kidney of lead-poisoning], and *c. vasculaire* [for the arterio-sclerotic kidney] (Cornil et Brault); Ger., *Schrumpfniere.* An eminently chronic disease, of characteristic symptoms and course, terminating in extensive atrophy of the secreting-apparatus of the kidney. Many cases of nephritis end in granular atrophy, whatever may have been the point of departure of the original lesion. Clinically, the primary or "genuine" contracted kidney often cannot be distinguished from the secondary contracted kidney, the result of chronic parenchymatous nephritis, except by evidence of the latter having preceded it. Nor is there any fundamental anatomical difference between them. The kidney is diminished, even to half its normal size, firm, tough, with uneven "granular" surface often studded with small cysts. The genuine contracted kidney is "red," sometimes darker than normal, sometimes a lighter buff; the secondary contracted kidney is more often yellowish white, owing to greater anæmia and fatty degeneration. The granules are essentially portions of nearly normal parenchyma surrounded by a contracting connective tissue enclosing the shrivelled remains of secreting tubes. The atrophy is confined mainly to the cortical portion, where many Malpighian bodies and convoluted tubes have collapsed and perished; the place of the destroyed parenchyma has been taken by a fibrous cicatricial tissue more or less vascular.

It was generally held, formerly, that the round-cell infiltration and new-formation of intertubular tissue, and its subsequent contraction, are the primary factors in the disease, causing, by pressure, the atrophy of the epithelial structures. But recent observations make it probable that the interstitial processes are themselves dependent upon previous degenerative changes—atrophy or degeneration—of the epithelium. Weigert[19] asserts the "pathogenic principle" that whenever fatty degeneration and destruction of the capsular and tubular epithelium lead to collapse of the Malpighian bodies and the uriniferous tubes, they are followed by interstitial inflammatory swelling, formation of connective tissue, and cicatricial contraction. This is equally true when chronic parenchymatous nephritis is the starting-point of the epithelial lesions, as when the latter are caused by chemical irritants, as poisons (lead), infectious material (in scarlatina), blood-dyscrasiæ (gout), or by primary lesions of the blood-vessels.

The renal blood-vessels, especially the smallest arteries, are found diseased, the lesions consisting either in hypertrophy of the muscular coat, as first pointed out by G. Johnson; or in general thickening of both arteries and capillaries, as described by Gull and Sutton under the name of arterio-capillary fibrosis; or in a true endarteritis (Friedländer). While under these circumstances the arteries may be of normal calibre, or even dilated (Thoma), the efferent vessel of the glomerulus and the capillary network of the tubes are narrowed, or even obliterated; hence anæmia of the cortical substance and degeneration of the epithelium of the glomeruli and convoluted tubes. This "arterio-sclerosis" is not confined to the kidneys, but is often found in many other organs, and, indeed, sometimes affects the entire arterial system.* In the secondary contracted kidney these changes are commonly absent. Hypertrophy of the left ventricle, with little or no dilatation, is almost invariably found in conjunction with contracted kidney, and is commonly regarded as the consequence of the resistance to the blood-current, either in the renal vessels alone or in the systemic arteries generally.†

Etiology.—Genuine contracted kidney is not a frequent disease. An erroneous conception of its frequency is fostered by the voluminous literature on the subject, and by the animated discussion of its interesting pathology. The disease is rare in youth,‡ more frequent in middle age and advanced life. It is *not* pre-eminently "a disease of old age." Of Dickinson's 308 cases, 25 died under thirty, 219 between thirty and sixty, and only 64 over sixty years of age. The male sex is more frequently affected, the ratio being more than two to one. Occupation influences the development of the disease only in so far as it involves the more immediate causes. Dickinson regards granular kidney as almost confined to temperate regions, and most frequent in climates similar to that of the British Isles. In rare instances an individual disposition can undoubtedly be traced as an hereditary tendency to renal disease (Tyson). Mental anxiety, depression, and worry predispose to granular atrophy (Allbutt). Edes[21] found the most typical cases among middle-aged, active, anxious business men.

The best-ascertained causes of contracted kidney are chronic lead-poisoning (probably through the influence of lead salts upon the blood-vessels) and gout. In Great Britain gout is an especially prolific cause, and British writers frequently designate the disease as "gouty kidney," a term which most continental authors reserve for the kidney with actual uratic deposits. These may be lacking in the contracted kidney of gouty persons;[20] and, on the other hand, the actual *nephritis arthritica* may exist without any other manifestation of gout.[22]

In many cases general arterial disease, however induced, is the proximate cause of the renal disease; the connection between the two will be referred to in the next section.

Chronic disease of the urinary passages may cause contracted kidney—*e.g.*, urethral stricture with its sequelæ, cystitis and pyelitis, and renal calculus; also stricture of the ureter.[23]

Syphilis is among the rarer causes of contracted kidney (see amyloid kidney, below).

Symptoms and Course.—Beginning insidiously as an exceedingly chronic process, contracted kidney may exist for many months, even years, without any symptoms that attract attention to the kidneys. Often symptoms on the part of other organs—palpitation, dyspepsia, dyspnœa, headaches, or disturbance of vision—first impel the patient to seek advice; not seldom apoplexy or uræmic convulsions seize him in the midst of apparent health. The polyuria meanwhile has been a source of congratulation: the kidneys act so freely!

The cardinal symptoms of contracted kidney are abundant secretion of urine of low specific gravity, albu-

* Lancereaux seems to regard the arterio-capillary fibrosis of Gull and Sutton as the expression, in the renal and other small arteries, of general atheromatous disease (Trans. Internat. Med. Congress, 1881, vol. i., p. 380). But the two processes differ in that the former is free from the tendency to fatty degeneration and calcareous deposits so universal in atheroma.

† Gull and Sutton's disease of the arteries, hypertrophy of the heart, and retinitis albuminurica, have been met with in a case of parenchymatous nephritis not very far advanced, and without cirrhosis (F. Fränkel, Arch. f. path. Anat., Bd. ciii., p. 244, 1886).

‡ Filatoff (Jahrb. f. Kinderheilkunde, xx., p. 209) observed a case of arterio-sclerotic contracted kidney in a boy aged twelve, and thinks that all cases occurring in childhood depend on vascular lesions. Gull and Sutton mention a case in a girl aged nine.

men and casts in small amounts, hypertrophy of the heart, and, later, uræmia. Dropsy is absent as a rule.

The urine, in the stage when a positive diagnosis is possible, or in secondary atrophy, when the process of contraction has come to predominate, is very characteristic. Its quantity is increased, often to double the normal; much larger amounts, even ten litres in twenty-four hours, have been observed. The night urine is apt to be especially abundant. The frequent urination, rather than the quantity passed, alarms the patient. Polyuria is not an early symptom, however; it sets in gradually, as the arterial tension rises and the heart becomes hypertrophied.[24] The urine is pale, clear, of specific gravity 1.005 to 1.012; rarely higher. The albumen is always small in amount, never rising above one per cent., sometimes disappears for weeks at a time, and in a few cases is absent throughout. The casts, too, are few in number, mostly small, hyaline, or pale granular, with here and there a leucocyte or an altered epithelial cell adhering; but very large hyaline casts are also found now and then. The very scant sediment contains, besides, a little renal epithelium and some leucocytes, and only exceptionally red blood-corpuscles. In the urine of secondary contracted kidney casts occur in greater diversity and abundance.

Toward the end, or in case of complications when the hypertrophied heart loses its functional power, the amount of water diminishes, the specific gravity rises, the percentage of albumen and the number of casts increase, and the urine may assume almost the character of the urine of chronic parenchymatous nephritis.

The great majority of cases, both secondary and primary, are accompanied by hypertrophy of the left ventricle of the heart, and this is of the utmost consequence as regards the course and symptoms of the disease. The blood-pressure is accordingly raised. The pulse is characteristically hard, tense, usually also full, the artery being felt as a hard cord.

The relation of the renal disease to these cardio-vascular symptoms is the subject of much theoretical discussion. One party in the controversy considers the renal affection as the primary one, leading to retention in the blood of urinary constituents, the impure blood causing contraction of the peripheric arteries of the body and consequent rise in blood-pressure, hypertrophy of the muscular coat, or sclerosis of the systemic arteries, and hypertrophy of the left ventricle. Others (Gull and Sutton, Mahomed) regard the general arterial changes—arterio-capillary fibrosis, endarteritis — as the primary lesion which causes the heart-hypertrophy, and which may or may not involve the renal vessels; the nephritis, when present, being the result of the extension of the general endarteritis to the small vessels of the kidney. This is probably true of most senile contracted kidneys. There can be no doubt of the occurrence of general arterio-sclerosis without renal complication (Mahomed's "Bright's Disease without Nephritis"[25]), as well as of cases in which the point of departure of the nephritis is a primary change in the renal arteries. Frequently, hypertrophy of the heart and high arterial tension precede all indication of renal disturbance; but this is by no means the case in all instances of contracted kidney, and the high diagnostic and prognostic value does not attach to the hard pulse *per se* that Mahomed claims for it.[26] Cases, moreover, are known in which very small kidneys and large hearts were found without any vascular lesion whatsoever.

The probable order of events in true arterio-sclerotic kidney is this: An (unknown) irritant circulating in the blood causes (inflammatory) changes in the walls of the systemic blood-vessels, involving thickening of their coats and rigidity, increased resistance to the blood-current, rise of blood-pressure, and hypertrophy of the left ventricle. The vascular lesion usually affects the renal vessels in an eminent degree, causing greater permeability to liquids, polyuria. Secondarily, changes are induced in the parenchyma and stroma of the kidneys, which lead to gradual contraction. The cardiac hypertrophy in a measure compensates for the gradual reduction of the secreting area, and for a time keeps up the free flow of urine.

When the nutrition of the patient is defective, the hypertrophy of the heart often fails to develop. When the hypertrophied heart suffers in its nutrition (as from disease of the coronary arteries), it becomes subject to fatty degeneration and secondary dilatation.

The cardiac hypertrophy manifests itself in most cases in a number of secondary symptoms, which are frequently among the first observed, as palpitation, dyspnœa, attacks of angina pectoris, violent headaches, vertigo, cerebral congestion, and, above all, cerebral hæmorrhage. Apoplexy occurs in more than sixteen per cent. of all cases. Hæmorrhages of other organs, also, are apt to accompany contracted kidney, notably severe and obstinate epistaxis. The occurrence of these hæmorrhages, their intractable character, and their danger are favored by the morbid condition of the blood-vessels.

The phenomenon that serves to complete the clinical picture of contracted kidney is uræmia. It occurs late, as a rule, when the hypertrophied heart is losing its power and general debility becomes marked; more often in the chronic form, causing various nervous, digestive, and respiratory symptoms—increasing apathy, drowsiness, and coma, or else sleeplessness. Troublesome "rheumatic" and neuralgic pains (sciatica), periodical headaches, and sudden amaurosis, which as suddenly disappears again, are counted among its symptoms. Sometimes it sets in suddenly with epileptiform convulsions, the first obvious symptom of the renal malady. If the course of the disease is not terminated by death from secondary or extraneous causes, the patient commonly succumbs to chronic uræmia ending in deep coma, interrupted, perhaps, by general convulsions or a maniacal seizure. The rare attacks of acute uræmia are due to accidental relative insufficiency of the heart's action, and patients may survive them for years. During the uræmic period the skin often excretes urea, which is found in the clammy sweat, or in crystals upon the skin, in the hair, or in the beard.

Dropsy is a subordinate symptom. It occurs toward the fatal end, a consequence of failure of the heart rather than of the renal affection directly. When present earlier, it is commonly confined to slight œdema about the ankles, on the dorsum of the foot, or about the knuckles.

Complication with inflammations of other organs is frequent in contracted kidney, as in other forms of nephritis. Bronchitis is the most frequent, pericarditis the most fatal, of these complications. Intractable catarrhal affections of the respiratory and mucous membranes are frequent enough to be of value in the diagnosis. The same is true of the disturbance of vision by albuminuric retinitis, which is much more frequent in this than in all other renal affections, occurring in about one-fourth of the cases. It is apt to appear early in the case, so that the ophthalmologist is often the first to discover that the patient is suffering from Bright's disease. Once established, the retinitis rarely improves, but commonly increases slowly and steadily.

In the earlier stages, sometimes extending over many years, the general nutrition is very good; but as the disease progresses emaciation sets in, and the serious nature of the malady is expressed in the sallow and sunken features of the patient, the suffering countenance, and the dry and shrivelled skin.

Diagnosis.—The group of symptoms of contracted kidney, when complete, is very characteristic. When the symptoms on the part of the urine, the circulation, and the nervous system are all present, the diagnosis can hardly be doubtful. Close observation of a case of chronic parenchymatous nephritis will likewise readily establish the fact of advancing contraction. But in no form of renal disease is an early diagnosis so important, and yet so difficult. Both albuminuria and polyuria may be little marked, inconstant, or even absent; if in such a case the arterial tension is not very high, and cardiac hypertrophy not demonstrable, the diagnosis is impossible. Certain groups of symptoms, however, are very suggestive—*e.g.*, periodical headache, dyspepsia, and hard pulse, with or without albuminuria; or hard pulse, frequent palpitation, muscular weakness, and polyuria, with or without

albumen; or albuminuric retinitis, dyspnœa, with pale, abundant urine and traces of albumen, especially in corpulent individuals or persons of gouty tendency. The absence of albuminuria, or of polyuria, does not necessarily militate against the diagnosis of contracting kidney.[27] The scantiness of albumen and of morphological elements in the urine serves to distinguish it from other renal affections. "An albuminuria in persons who have for some time had a high degree of dropsy cannot well be owing to genuine contracted kidney" (Bartels).

Careful and continued examination of the urine is indispensable, particularly accurate measurement of the daily amount and the specific gravity, for weeks at a time.

The age of the patient has no diagnostic significance, since the disease occurs in youth as well as in advanced years. The allied affections of the aged deserve some mention here. True arterio-sclerotic kidney is frequent in old age, but this period of life is also subject to similar renal affections classed under the name *senile kidney*, a more or less atrophied kidney, granular or smooth. Either form may show atheromatous disease of the renal arteries with, however, little or no interstitial contraction. The smooth senile kidney causes no conspicuous symptoms, and in the granular form polyuria is often absent, albuminuria not constant, and uræmia very rare.

Prognosis.—All past experience teaches that contracted kidney is invariably fatal. The absoluteness of this unfavorable prognosis is, however, modified somewhat by the uncertainty of the diagnosis. For it must not be forgotten that cases of slight albuminuria and distinctly increased arterial tension, have been known to recover so far as to present unbroken health and freedom from albuminuria for many years. Hence the fatal prognosis should not be pronounced early.

On the other hand, the prognosis as to prolongation of life is commonly favorable. The duration of the cirrhotic form of Bright's disease is counted by years; it has, in cases, exceeded ten years. The danger to life begins when the balance between the remnant of active parenchyma and the power of the heart is disturbed, when the cardiac hypertrophy no longer suffices to compensate for the renal deficiency, and uræmia, and perhaps dropsy, sets in. At any time, however, the patient with contracting kidney is more liable to be cut off by apoplexy or by inflammations of other organs than are other persons of the same age.

Decided lessening of the urinary secretion is an indication of impending uræmia, and points to the fatal end.

Treatment.—When the disease can be ascribed to a definite cause, rational treatment of the lead-poisoning (iodide of potassium), the gout, or the syphilis (corrosive sublimate), is to be instituted with all possible energy. The disease itself is amenable to no remedy. The prolongation of life, however, and the comfort and efficiency of the patient depend largely upon judicious treatment and management. He should lead a very regular life and avoid, not only excesses, but whatever involves undue action of the heart, all bodily and mental over-exertion or fatigue, all emotions, especially anxiety and anger, and should make but a very temperate use of alcoholic stimulants, coffee, or tea. The diet must not be rich, but simple, and should contain little albuminous material; eggs should be eaten sparingly or not at all; white meats, poultry and fish, are preferable to red meats. A milk diet is desirable in this as in other renal affections. Withal there must be nothing debilitating in the treatment. Warm clothing and a suitable climate must be insisted upon. If a choice of climate is possible, dry hills are to be preferred to high altitudes or the sea-side.

So long as the heart's power is good, and urgent symptoms are absent, medicinal treatment is rather to be avoided, and no attempt should be made to achieve the impossible. General measures can be directed only toward limiting the formation of nitrogenous products of metamorphosis, by a diet such as has been indicated, and toward regulating the action of the heart, allowing it neither to fall below a certain measure nor to exceed it. In this way the most imminent dangers, uræmic intoxication on the one hand, and apoplexy on the other, are best guarded against.

The first symptoms likely to call for interference are those which result from the high arterial tension. Congestion about the head is to be met by cold applications, derivative treatment by the bowels, or even, if need be, venesection. The bowels should always be free. Dyspeptic symptoms are often relieved by tepid baths; but cold baths, and particularly sea-bathing, are dangerous in this as in other forms of Bright's disease.

Headache, vertigo, dyspnœa, and asthmatic attacks are often relieved by drugs which lessen the arterial tension, as alkaline nitrites, amyl nitrite, and, above all, nitroglycerine, which, in small doses frequently repeated (one to four drops of a one-per-cent. alcoholic solution), affords the means of maintaining a lowered blood-pressure,[28] while at the same time it does not reduce, but rather increases, the amount of urine.[29] Marked improvement and mitigation of distressing nervous symptoms have been observed[30] from the use of chloride of gold and sodium (0.005 Gm. = gr. $\frac{1}{12}$, in pill, after each meal), as suggested by Bartholow. Narcotics (morphia, chloral) may be required to combat these symptoms.

When the compensating power of the heart begins to fail, when its beat becomes frequent and irregular, and uræmic symptoms increase, the heart is to be sustained by tonics—digitalis and strychnia. Iron is not to be recommended in this disease under any circumstances.[31]

When uræmic stupor or coma sets in, the hypodermic use of pilocarpine (see above) is, perhaps, the only means of staying the rapid progress of the case toward the fatal end.

AMYLOID DISEASE OF THE KIDNEY. — *Synonyms:* Lardaceous kidney; waxy kidney; depurative infiltration of the kidney (Dickinson). Amyloid, or lardaceous, degeneration may either affect hitherto healthy kidneys or be superadded to one of the forms of chronic Bright's disease. While pure amyloid disease of the kidney is comparatively rare,* complication of chronic parenchymatous nephritis by amyloid deposit is frequent. The disease is always part of a constitutional affection invading other organs also, as the intestine, spleen, liver, lymphatic glands, and thyroid body. The renal arteries, including the glomerular loops and the arteriolæ rectæ, are infiltrated with amyloid material (see article Amyloid Degeneration). The epithelium and basement membrane are infiltrated, here and there, only in cases of great intensity. The vascular change interferes, in time, with the nutrition of the epithelium, causing granular swelling and fatty degeneration, which have often been taken for evidence of inflammation. In an early stage the kidney appears normal to the naked eye; later it is much enlarged, especially in its cortex, anæmic, smooth, tough, friable, of waxy translucency, the cortex pale yellow, the pyramids pale only in streaks—the "large waxy kidney." Complications with cirrhotic processes result in the "lardaceous contracted kidney," smoother and paler than the red granular kidney, and not extremely small. In all cases the anatomical diagnosis is assured only by the chemical tests for amyloid substance.†

Etiology.—Part of a constitutional cachexia, the amyloid kidney depends upon the causes of the former. Chief among these are (1) protracted suppuration, above all ulcerative pulmonary phthisis, chronic suppurative diseases of the bones and joints (caries and necrosis), gunshot wounds of bones, ulceration of the bowel, chronic ulcer of the leg; and (2) chronic syphilis. The latter commonly leads to the contracted form of waxy kidney.

It is more especially a disease of middle age. Of Dickinson's 61 cases, 41 died between the ages of twenty and fifty years, and only 6 over fifty. The greater frequency in middle life, as well as among males, is accounted for

* But Stewart relates that he has seen in Edinburgh a considerable number of cases of waxy disease perfectly uncomplicated (Trans. Internat. Med. Congress, 1881, vol. ii., p. 110).

† Aqueous solution of iodine (one-half per cent.) and potassium iodide (one per cent.), followed, or not, by dilute (five per cent.) sulphuric acid, giving a port-wine color with amyloid; or a one-per-cent. solution of methyl violet, staining the affected vessels rose-red, the healthy tissue violet-blue.

by the fact that persons of this age and sex are most liable to the special causes of the underlying cachexia.

Symptoms and Course.—The symptoms referable to the amyloid disease of the kidney are so intimately blended with the symptoms of the diseases upon which it depends, as well as with those of the inflammatory and cirrhotic processes so often present in the amyloid kidney, that a characteristic clinical picture is not to be expected. The affection is always slow, and in the beginning gives rise to no conspicuous symptom of its own; but, as the infiltration gains in extent, it influences the character of the urine in a rather pronounced manner. As a rule, amyloid kidneys secrete urine abundantly. According to Grainger Stewart,[24] in pure waxy degeneration polyuria is an early symptom, and exists from first to last. Over 3,000 c.c. daily have been noted. Yet the daily quantity is variable—never reaches the extreme amount sometimes observed in contracted kidney, and occasionally sinks far below the normal. In uncomplicated cases the urine is very pale, very clear, and of low specific gravity, as low as 1.003, commonly 1.005 to 1.012. The amount of albumen in the urine is usually large—one per cent., and often much more. Bartels found the average daily loss of albumen to vary from five to twenty-two grammes. Yet cases have occurred in which albumen was absent and the urine normal. In the beginning the albuminuria is apt to be slight and intermittent. The presence or absence of albuminuria in pure amyloid disease depends on the degree to which the glomerular vessels are degenerated (Litten). Bloody urine is exceptional; but the scant sediment sometimes contains a few red corpuscles as well as white. Hyaline casts are found sparingly; large waxy casts giving the iodine reaction are very rare.

In the mixed forms of amyloid and parenchymatous nephritis the urine is less copious, more concentrated, more highly albuminous (to five per cent.!), and contains more sediment, in which are found a greater variety of casts, especially oily and dark granular casts.

Pure waxy kidney, in contrast with the true Bright's diseases, is not attended by hypertrophy of the heart. Accordingly we miss the hard pulse, as well as the secondary symptoms of cardiac hypertrophy, the cerebral congestions, the dyspnœa, the hæmorrhages, the apoplexy. Dropsy, on the other hand, is a frequent concomitant of waxy kidney. When it occurs, it is likely to be persistent and irremediable. It is usually confined to anasarca of the lower extremities and ascites. The dropsy and also the anæmia are due to the general cachexia rather than to the renal lesion. Uræmic symptoms are of the rarest occurrence.

Diarrhœa is a frequent complication, due to amyloid disease of the intestine; often profuse, unmanageable, and a most ominous symptom. Less frequent, but no less obstinate, is vomiting. Inflammations of other organs, such as complicate Bright's disease, are rare in this.

The *Diagnosis* is based chiefly on the presence or previous existence of chronic ulcerative processes with profuse discharge, or of inveterate syphilis, on an abundant, pale, clear, but highly albuminous urine, the presence of dropsy, and the absence of cardiac hypertrophy and high arterial tension. Simultaneous enlargement of the liver or spleen is a valuable pointer. Unless all or many of these indications concur, it is best not to venture upon too positive a diagnosis. The combined forms are rarely recognizable as such during life.

The *Prognosis* is very unfavorable. Even when the original disease is amenable to surgical or other treatment, recovery from the waxy kidney is unlikely. The duration of the latter is always protracted, but depends chiefly upon the disease of which it is the consequence. Prolongation of life and amelioration of symptoms for a number of years are most likely in young patients in whom the cause can be removed.

Treatment.—Our only efficient means against the disease consist in preventive measures. The cure of the cachexia by surgical interference, when possible, and the energetic treatment of protracted syphilis offer the only chance of averting the invasion of amyloid infiltration.

The disease once established, its treatment coincides entirely with that of the general disease, as there is no prospect of restoring the damaged renal tissue by specifics. The recommendation by Dickinson, on theoretical grounds, of alkalies has not been sustained by others. Tyson suggests extract of beef, with the same intention of supplying potash salts. Iron and other tonics suggest themselves in the usual anæmic condition of the patient.

Diffuse Affections of the Kidney depending upon Lesions of the Circulation.—Active Hyperæmia of the Kidneys presents itself either as a toxic hyperæmia, the consequence of irritant poisons in the blood, or as "fever-kidney." The most important kidney poisons have been enumerated in the etiology of acute nephritis. Cantharides, by the mouth or skin, oil of turpentine, especially copious inhalation of its vapor, and the extensive use of corrosive sublimate[32] in dressings and vaginal injections for antiseptic purposes, as practised of late, deserve especial mention as causes of renal hyperæmia. Albuminuria is frequent, yet by no means constant, in acute fevers, especially in acute infectious diseases and pyæmic processes, probably as the direct effect of irritation of the kidney by morbid products in the blood. Both the toxic and the febrile forms, which present the same anatomical lesions of hyperæmia with cloudy swelling of the tubal epithelium, may progress directly into an abortive (*néphrite passagère*) or an actual nephritis. The post-mortem lesions accordingly show transitions to catarrhal and hæmorrhagic forms of nephritis, with desquamation of epithelium, formation of casts, bloody urine, etc.

The clinical symptoms of febrile albuminuria are of small importance. The urine does not differ from ordinary fever-urine, except by the presence of small amounts of albumen and perhaps a few hyaline casts, with now and then white and red blood-corpuscles and renal epithelium.

Active hyperæmia from other than febrile causes yields at first a copious, dilute, and pale urine, sometimes albuminous, sometimes also bloody. It may be evanescent and of little import, or it may be the forerunner of acute nephritis.

Passive Hyperæmia of the Kidneys is of more consequence, because it leads to characteristic structural changes—so-called "cyanotic induration." It is symptomatic of general venous stasis with general arterial anæmia, "cyanosis," the result of relative or absolute weakness of the heart, such as is commonly brought about by valvular lesions, or by obstruction of the pulmonary circulation. Most frequently venous congestion of the kidney and its anatomical consequences are produced by emphysema or cirrhotic changes in the lungs, or by mitral disease in the stage of insufficient compensation.

Early, the kidney is swollen, hard, and gorged with blood; later, the interstices are broadened, the interstitial connective tissue becomes tough and distinctly fibrous, the whole organ is but little enlarged, if at all, very hard, and purple in color. The epithelium is not affected at all, or undergoes moderate fatty degeneration. Ultimately, some amount of cicatricial contraction may take place.

Cyanotic induration may be complicated by nephritis, notably in cases of valvular disease.

Symptoms.—The urine is diminished in quantity, concentrated (sp. gr., 1.025 to 1.035), high-colored, depositing urates or uric acid. Albumen appears in it in most cases, but only in small amounts (up to one-half per cent.). The sediment may contain a few hyaline casts, and perhaps some red blood-corpuscles.

The dropsy which accompanies indurated kidney is a result of the general venous congestion; it lacks the characteristics of renal dropsy, but partakes of the character of cardiac dropsy—beginning in the lower extremities and dependent parts, and ascending; the upper extremities and face, as a rule, are unaffected.

The *Diagnosis* of congested or indurated kidney depends on the presence of cardiac disease or obstruction of the pulmonary circulation, with general cyanosis, on the mode of invasion and the localization of the dropsy, and on the scanty, heavy urine, containing but little albumen and a few transparent casts.

The *Treatment* must be directed mainly against the

original disease, toward improving the power of the failing heart. Digitalis in large doses (0.06 to 0.12 Gm. = gr. j. ad ij. every three hours) frequently succeeds in this. Caffeine is equally, or even more, efficient in this direction (Lépine, Riegel); its effects are more immediate, and it is better borne. It must likewise be given in full doses (1 to 1.5 Gm. = gr. xv. ad xx. a day). Direct diuretics are of no use, if the heart's action cannot be increased; vegetable alkalies are among the safest, and may be used in combination with digitalis. Diaphoresis may be practised by hot-air baths or hot packs, while pilocarpine is not well borne by patients with weak heart. Active catharsis may sometimes be of use and necessary, but is commonly dangerous by reason of its debilitating effect.

The Renal Disease of Epidemic Cholera results from anæmia of the kidneys, in consequence of the inspissation of the blood and the slowing of the blood-current during the algid stage, and expresses in the highest degree known to us those changes with minor degrees of which we are familiar in cases of sudden and severe anæmia, as after rapid losses of blood, or of water by the bowel, and, experimentally, after constriction or ligation of the renal arteries. During the algid stage of cholera the urine is scanty or suppressed; the anuria may last for days, and, if it persist for over five days, is accounted a fatal symptom. The scanty urine contains albumen and casts. During convalescence the more abundant urine rapidly resumes its normal character, except in the unfavorable event of a "typhoid stage." In this case the urine remains much diminished in quantity, contains little urea, but some albumen, and its dense sediment shows great numbers of hyaline, granular, and oily casts, and renal epithelium in a state of fatty degeneration. The severe symptoms on the part of the nervous system, which give this stage its name, are probably uræmic.

The anatomical lesions consist chiefly in fatty degeneration of the tubal epithelium; the glomerular apparatus and the stroma enjoy almost complete immunity. The kidneys are somewhat large, the enlarged cortex is soft and of a pale buff color, the cones are dark red. There is no evidence of nephritis, and it seems that transition to Bright's disease has never been observed.

The Renal Affection of Pregnancy occurs most frequently in primiparæ—the more so the older the patient—and in twin pregnancy. It is manifested by albuminuria, dropsy, and eclamptic convulsions. Exceptionally, puerperal eclampsia occurs without albuminuria, and, indeed, without renal lesion; the great majority of cases, however, is distinctly connected with changes in the kidney. These were commonly held to indicate nephritis, but this view is not supported by later researches.*

Post-mortem examination reveals an anæmic kidney—the cortex pale buff-colored and moderately swollen, the pyramids brown, the parenchyma homogeneous and opaque, the epithelium in various stages of fatty degeneration, some of the tubes clogged with casts, but no interstitial infiltration. The fatty change in the renal cells is explained by the anæmia, but there is no sign of either inflammation or venous congestion.[33]

The original theory, which sought to explain this lesion by venous congestion caused by the pressure of the enlarged womb upon the renal veins, is not borne out by the topographical relation of those parts any more than by the character of the renal lesion. More plausible is the theory of Halbertsma,[34] that the anæmia of the kidney is caused by obstructed flow of urine from compression of the ureters by the gravid uterus, and both normal and morbid anatomy furnish it support; the relations of the uterus to the ureters are such that the former, in its growth, must often encroach upon and stretch the latter, and dilatation of the ureters has been found under these circumstances. Other authors assume a spasm of the renal arteries as the cause of the renal lesion, and spasm of the cerebral arteries as the cause of the eclamptic attack.

The symptoms of the renal affection preceding convulsions arise in the latter months of pregnancy, and consist chiefly in general anasarca and changes in the urine. Partial dropsy, as œdema of the feet and legs, may be present without any kidney disease. The urine is albuminous, diminished in quantity, of high specific gravity, but rather pale. It is seldom bloody. Its scanty sediment contains hyaline, epithelial—sometimes granular—casts, and renal cells in fatty change and filled with oil-globules. The albuminuria is moderate at first, increases toward the end of pregnancy, and reaches its highest degree during labor. After labor it diminishes rapidly, and disappears, as a rule, in eight or ten days.[33]

Leyden points out that this lesion, while ordinarily ending in rapid recovery if the patient survives the eclampsia, does, in rare cases, pass into a chronic stage. It has been observed also to cause, even before convulsions have set in, premature separation of the placenta.[35]

The discovery of the group of symptoms indicated calls for prophylactic measures against the impending convulsions. The dropsy may be treated by energetic diaphoresis, by means of hot baths and packs (which are not contra-indicated by the pregnancy), but not by pilocarpine.

G. Baumgarten.

* Women who suffer from Bright's disease may, of course, become pregnant and have uræmic convulsions during, or at the end of, their pregnancy; but in this case the Bright's disease and the pregnancy have no necessary connection with each other.

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KIDNEY, HYDRO-NEPHROSIS OF.

Definition.—Distention of the cavity of the kidney with fluid which is not purulent.

Causes.—Hydro-nephrosis may result from obstruction offered to the free flow of urine through the ureters or the urethra. When one ureter alone is obstructed the lesion affects the corresponding kidney; when the obstruction affects both ureters or the urethra the hydronephrosis is double. The obstruction may be in the pelvis of the kidney, in the ureter, in the bladder, or in the urethra, or it may be produced by pressure from without upon the ureters or bladder.

Tumors in the pelvis of the kidney may obstruct the opening into the ureter. More commonly a calculus lodges there and produces more or less complete obstruction. In Fig. 1915 is represented the kidney of a patient who presented the symptoms of chronic Bright's disease, with, however, the peculiarity of passing considerable blood in the urine at times. At the autopsy one kidney showed the lesions of chronic diffuse nephritis; in the other a stone was found lodged in the mouth of the ureter, as shown in the cut. There was also considerable dilatation of the pelvis and calyces of the kidney. In this instance the obstruction was not complete at all times, and the irritation of the stone caused bloody urine, but some hydro-nephrosis was produced; had the patient lived, an extreme degree of this condition might have ensued.

The ureter is sometimes inserted into the pelvis obliquely, in such a way as to form a sort of valve, which closes more or less completely under the pressure of the urine. Other obstructions in the ureter are congenital atresia or narrowing of these tubes, twists or turns in them which cause narrowing of their calibre. Cicatricial narrowing, due to inflammation following the passage of a stone, is said to occur. Lodgement of a stone in the ureter may be the cause of the obstruction. Cicatricial stricture may follow injury to the ureter. Obstruction may be caused by a valve-like insertion of the tube into the bladder. Pressure upon the ureters from without may be caused by abnormalities of the renal artery, and it may also be exerted by the growth of tumors in neighboring organs, as the uterus, ovaries, intestines, lymphatic glands, or pancreas. Pelvic abscess, or abscess connected with the vertebræ or following injuries, may also cause pressure. Cicatricial bands, the result of pelvic or general peritonitis, sometimes compress the ureters. It is said that uterine displacements may do the same, but evidence of the truth of this statement is slight.

Obstruction may occur in the bladder in cases of tumors involving the orifices of the ureters, or partly blocking the urethra. Stone in the bladder sometimes produces a similar result. Enlargement of the prostate not infrequently

Fig. 1915.—Stone Causing Hydro-nephrosis. (From a Photograph.)

causes a double hydro-nephrosis. Stricture of the urethra, congenital or acquired, may produce the same effect.

Besides those due to demonstrable obstruction to the flow of urine, cases of hydro-nephrosis occur in which no such obstruction can be found. Patients with polyuria of long standing sometimes have dilated kidneys, due, no doubt, to the pressure of the rapidly secreted urine. Others, who have not had polyuria during life, are found to have hydro-nephrosis, with no cause demonstrable, upon autopsy.

In order to produce a high degree of hydro-nephrosis it is not necessary for the obstruction to be complete and permanent. As Dickinson points out, complete obstruction often results in atrophy of the kidney without hydronephrosis. The most favorable conditions are when the urinary passages are narrowed, but still permeable, or when, as sometimes happens, if a stone be lodged in the ureter, the obstruction is intermittent, the obstacle being removed for a time and then again blocking the passage.

Lesions.—In the less-marked cases there is dilatation of the pelvis of the kidney, with more or less atrophy of the secreting structure. If the obstruction be in the ureter, the tube above it is dilated ; if at or below the entrance of the ureter into the bladder, the former is dilated throughout its whole length. The dilatation of the ureter may be extreme. As the process advances in the kidney the pyramids yield under the pressure of the accumulating urine. The tubes dilate. As time goes on, more and more of the renal structure atrophies and disappears. Finally nothing is left but a cyst, subdivided, by the fibrous septa which exist in the kidneys, into larger or smaller pouches. Even these septa in extreme cases are said to disappear. With the microscope a thin layer of secreting structure can, usually, be seen lining the cyst. The fluid of the cyst is sometimes pale yellow, sometimes more or less brown, probably from the presence in it of altered blood. It contains, in most instances, urea and the salts usually found in the urine, with sometimes other bodies, as cholesterine. In size these cysts vary greatly, sometimes being but little larger than a normal kidney, sometimes filling the whole abdomen. In the celebrated case described by Mr. Glass the cyst contained nearly thirty gallons (Roberts). Several times hydronephrosis has been mistaken for ascites. As the growth proceeds neighboring organs may be displaced, and adhesions to some of them are, not infrequently, formed. If, after

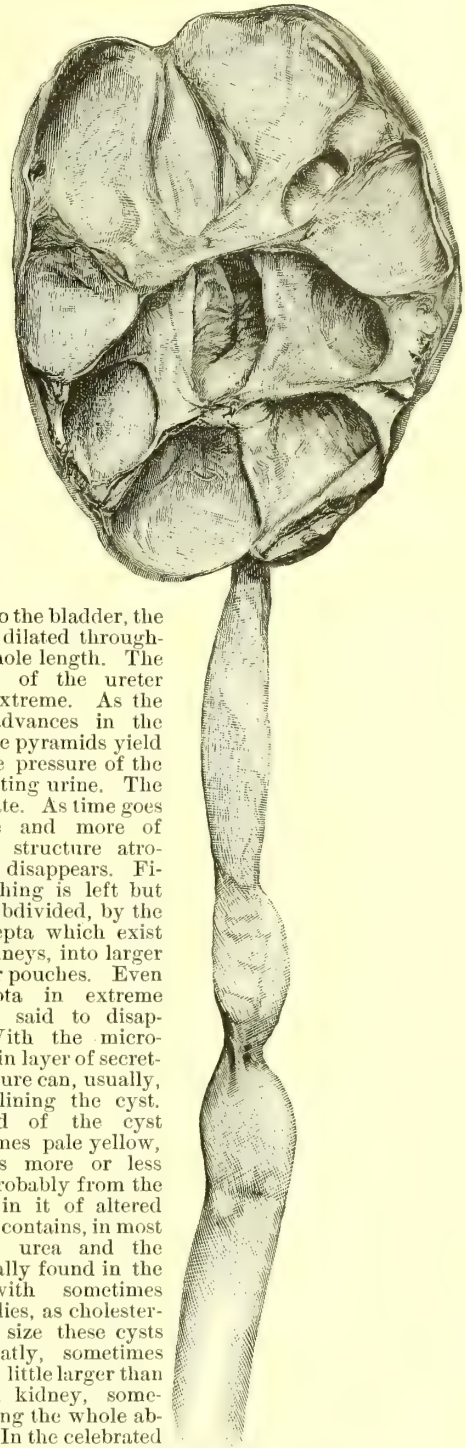

Fig. 1916.—Represents a kidney removed from the body of a patient who died at Roosevelt Hospital. The ureter is dilated ; the cyst has been laid open by a longitudinal incision, opposite the pelvis. Hardly any renal tissue remains. The subdivision into pouches by fibrous septa is well shown. (From a Photograph.)

pronounced hydro-nephrosis has been produced, the cause be removed, the sac is apt to shrivel and become more or less obliterated. The opposite kidney increases in size, in order to do the work of both.

SYMPTOMS.—Congenital double hydro-nephrosis, due to atresia of some part of the urinary passages, may cause death of the fœtus *in utero*. If the child be born alive it survives but a few days. It has a swollen abdomen and passes no urine.

In many cases in adults, due to stricture of the urethra, enlargement of the prostate, cancer of the uterus, or pelvic tumor, a double hydro-nephrosis is found which gives no symptoms, and the lesion is rarely much advanced.

In single hydro-nephrosis no symptoms may be noticed until the patient's attention is attracted by an increase of the size of the abdomen, or until a medical examination reveals the presence of a tumor. Sometimes the earliest symptoms are those produced by the presence of a renal calculus, with perhaps attacks of renal colic. Occasionally the patient notices abdominal swelling, which subsides coincidently with the passage of a large amount of urine. Abdominal pain of severe character is occasionally met with. More often a feeling of distention or weight is all that is observed. By its pressure on the intestines the tumor may cause obstinate constipation; by pressure on the diaphragm dyspnœa may be produced. In many instances, however, the only symptoms are the tumor, with perhaps a little feeling of abdominal discomfort. The characteristics of such a tumor are its situation, its shape, its contents, and the sensation which it conveys to the examining hand. It is usually situated in the lumbar region. Of course, if very large, it may fill so much of the abdomen as to make the point from which it originates doubtful. There is often more or less fulness in the loin on the affected side. On percussion the cyst is dull or flat, save where, as is usually the case, the colon or perhaps some coils of the small intestines lie over it. In the loin there is no resonance near the vertebral column, such as is often found with other tumors. In shape it somewhat resembles a kidney. Its long axis is generally parallel with that of the body. If it is sufficiently large, and if the abdominal walls are sufficiently thin, a thrill may be produced by gently striking it with the finger. This sign is rarely obtained, but fluctuation can usually be distinguished by palpation, and the tumor feels elastic. It is ordinarily immobile. It is not often tender. Aspiration draws fluid having more or less of the character of urine. Quite often the tumor suddenly diminishes in size, either with or without an increased flow of urine, and then increases again. This, when it occurs, is the most characteristic sign of a hydro-nephrotic tumor, but it is not noted in all cases. Sometimes it may be made to diminish by gentle but long-continued rubbing. It grows very slowly, in most instances not attaining a very large size.

Hydro-nephrosis does not often terminate fatally when it is single. Death may ensue from exhaustion caused by the suffering produced by the tumor, or as a result of the pressure of the sac upon neighboring organs. Sometimes suppuration occurs in the cyst—pyo-nephrosis. In such cases the pus may burrow in any direction and cause rupture of the cyst, sometimes into the peritoneum with immediately fatal results, sometimes into neighboring organs, sometimes externally. The presence of pus is usually announced by fever, chills, and sweating, and pain or tenderness in the tumor. Like accumulations of pus elsewhere, this abscess may cause little or no fever, nor pain in some cases. The cyst rarely ruptures into the peritoneum, or elsewhere, without having suppurated.

Death may be caused, in cases of single hydro-nephrosis, by the stoppage of the ureter of the healthy kidney by a calculus. In such cases sudden complete anuria, followed sometimes by extreme prostration, sometimes by coma or convulsions, precedes the fatal termination.

In the majority of the cases, death is not directly due to the cyst. A period of twenty to thirty years may elapse, during which the patient may be very comfortable. In some a spontaneous cure takes place, the cyst emptying itself and never reappearing.

DIAGNOSIS.—This lesion has been mistaken for ascites, ovarian cyst, hydatid cyst of the liver, of the kidney itself, or of some other organ, and for sarcoma or other tumor of the kidneys. Aspiration of the fluid will usually settle all doubts as to the nature of the swelling. It can only be mistaken for ascites in very severe cases. Usually it is readily recognized as a tumor with distinct outlines, and does not resemble fluid lying free in the peritoneal cavity. From ovarian cysts it is to be distinguished by its situation and by an examination of its contents. Ovarian cysts appear in the lower part of the abdomen, and grow upward; hydro-nephrotic swellings appear in the lumbar region, and grow downward. The fluid of the hydatid cyst is characteristic, and the discovery in it of hooklets will reveal its nature. From malignant growth of the kidney it is to be distinguished by the history, by the absence of cachexia, and by the more evident fluctuation.

The URINE in hydro-nephrosis often is entirely normal. Sometimes it temporarily contains blood. As I have mentioned, it is in certain cases suddenly much increased in amount. It may also be suddenly suppressed if both ureters be completely occluded. It may be modified by the occurrence of chronic nephritis in the unaffected kidney in single hydro-nephrosis, giving rise to albumen and casts, or a cystitis may load it with pus and, perhaps, blood. Sometimes the same condition that produces the hydro-nephrosis may cause temporary attacks of hæmaturia, as, for example, a stone in the kidney or ureter. When pathological changes occur in the urine, with the one exception of the before-mentioned sudden increase in its amount, they are the result not of the hydro-nephrosis, but of some complication.

TREATMENT.—Unless the tumor gives rise to severe symptoms by reason of its size, or unless pyo-nephrosis occurs, too much interference with it is to be avoided. Often years may be passed in relative comfort if nothing is done. Gentle but prolonged rubbing may be found more or less effective in evacuating the fluid, and should be tried daily. Some cases seem to have been cured by this measure. If pain or symptoms of pressure upon neighboring organs appear, aspiration of the fluid will give temporary, and perhaps permanent, relief, and if done with an absolutely clean needle, introduced through thoroughly cleaned skin, the operation seems free from danger. Suppuration may follow if the skin or the needle be dirty. If the pressure symptoms become so urgent as to require a radical cure—if great pain be present and if aspiration has failed to relieve it, and especially if pyo-nephrosis sets in—more severe surgical measures may be indicated. The operations which have been tried for the permanent relief of the condition are incision in the loin, followed by the establishment of a urinary fistula; the removal, through such an incision, of a stone in the pelvis of the kidney which had produced the lesion; and the removal of the cyst through an opening in the loin, or in the anterior abdominal wall.

Incision for the removal of renal calculus which has caused pyo- or hydro-nephrosis, or pyelitis, is an operation which has been quite frequently done. It certainly seems to be the most rational treatment for hydro- or pyo-nephrosis due to this cause.

Lumbar incision, with a view of emptying and draining, may possibly be the best treatment in certain cases. It is to be remembered, however, that this operation is frequently followed by prolonged suppuration, with all its dangers, or by the inconvenience of a permanent renal fistula.

Removal of the diseased kidney by laparotomy or lumbar incision has been successfully done. Though the mortality after this operation is great, increasing knowledge of its technique, no doubt, will reduce it. When one considers the ultimate results of incision and drainage, complete removal seems really to be nearly, if not quite, as safe.

For the details of these operations the reader is referred to the article on Kidney, Surgery of.

Of course, if the hydro-nephrosis be due to some obstacle in, or pressure upon, some part of the urinary pas-

sages, the indications are clearly to remove the cause if possible. Most of these patients present themselves for treatment before much hydro-nephrosis is established. Stricture of the urethra, enlargement of the prostate, tumor of the bladder, and the other ordinary causes of urinary stasis—each of these usually presents its peculiar symptoms and requires its appropriate treatment. Congenital double hydro-nephrosis, unless due to atresia of the urethra, is not curable.

The indications for treatment may be summarized as follows :

If no severe or dangerous symptoms occur, the disease calls for no treatment except efforts to empty the sac by gentle manipulation.

If severer symptoms present themselves, repeated aspiration may be tried. This probably will give only temporary relief.

If the fluid become purulent, or if life be endangered by the presence of the sac, or if great suffering render life unbearable, an operation may be required.

Conditions which are likely to produce urinary stasis should be, if possible, alleviated or cured before much harm has been done to the kidney, and, even after a certain amount of hydro-nephrosis has been produced, removal of the cause will usually render this harmless.

J. West Roosevelt.

KIDNEY, MORBID ANATOMY OF THE DIFFUSE DISEASES OF. I. Acute Parenchymatous Nephritis.—We find, in the kidneys of people dying of the disease called in this Handbook Acute Parenchymatous Nephritis, lesions sometimes confined to the epithelium of the tubes alone, sometimes involving also the other structures—the stroma and blood-vessels. It is convenient to describe these two classes separately.

There are a certain number of cases of acute Bright's disease in which the lesion is confined to the epithelium. In these the kidneys are increased in size, the capsule is not adherent, the surface is smooth, the cortical portion is thicker than normal, the pyramids remain nearly of normal size and color. The cortex varies in tint; it is sometimes dirty white, pinkish, yellowish-pink, yellow, or nearly normal. The Malpighian bodies occasionally are more prominently visible than normal, because of the contrast between the red glomeruli and white cortex around, but quite often they are pale and hard to see. The medullary rays are usually rendered indistinct. Sometimes small hæmorrhages are scattered through the cortex, forming red streaks and clots.

The microscope shows degeneration of the epithelium, principally of the convoluted tubes. The cells are swollen and granular. Many of them are detached from the basement membrane and lie in the tubes. Some of the nuclei have lost their sharpness of outline, and in many places have disappeared. The tubes are, here and there, filled with bodies which resemble, and probably are, hyaline casts. Besides the casts there is a good deal of granular detritus, derived from broken-down cells, and often blood-corpuscles. The epithelium of Bowman's capsule is swollen. The epithelium of the straight tubes is affected in severe cases. There is no change in the stroma, and none demonstrable in the vessels, save that some of them are, no doubt, ruptured, giving rise to the small hæmorrhages mentioned. In old cases, and in some recent ones, marked fatty as well as granular degeneration is to be seen.

The urine, when the lesion is confined to the epithelium of the kidneys, is usually nearly normal in specific gravity and diminished in quantity. It contains a variable amount of albumen, in mild cases a mere trace ; in severe ones albumen may be abundant. Casts are not numerous, and are usually hyaline and granular ; blood may be found, and a considerable amount of granular detritus.

In certain cases of acute Bright's disease, especially those following scarlatina, and in certain so-called idiopathic cases, every structure in the kidneys is more or less altered. The kidneys are large. The capsule is not adherent. The surface is smooth. The cortex is much thickened, and is sometimes redder, but usually paler, than normal. The pyramids look redder than usual in contrast to the pale cortex. The general appearance resembles marked examples of the before-mentioned type.

Under the microscope the epithelium of convoluted and straight tubes is found degenerated, as in the cases before described.

The epithelium of Bowman's capsule in many cases is not only swollen, but also an active proliferation of the cells takes place. By this proliferation the tuft may be compressed and the whole Malpighian body obliterated. This lesion is the "glomerulo-nephritis" of certain authors (see Fig. 1917). In other cases, instead of proliferation of the cells of Bowman's capsule, we find that there is a great increase in the nuclei on the vascular tuft. It is said that new round-cells, in these cases, may be seen between the vessels of the tuft, often in such numbers as to compress them. This is the "glomerulo-nephritis" of some other authors. This term, "glomerulo-nephritis," has been used in many different ways, for we find a third set of authorities, who call cases in which there is but slight lesion demonstrable, and that confined to the epithelium of the convoluted tubes, "glomerulo-nephritis."

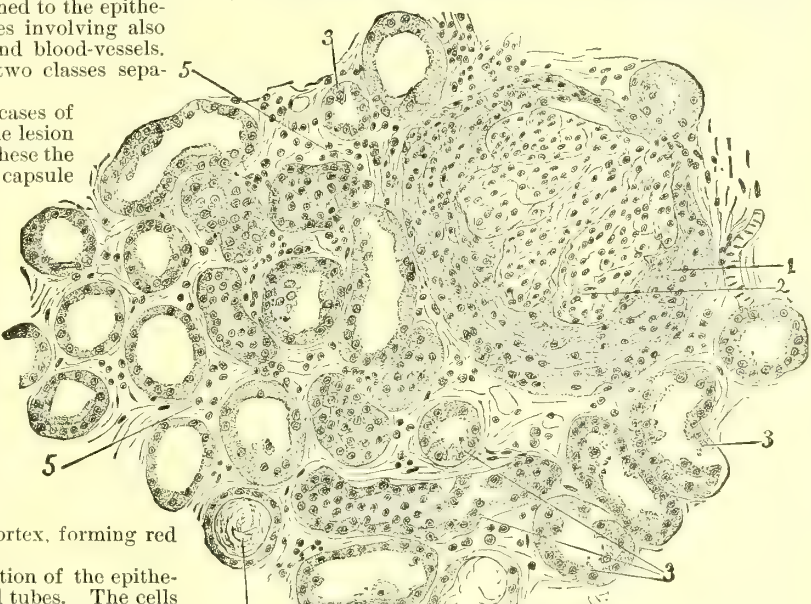

Fig. 1917.—Acute Nephritis. 1, Cells of Bowman's capsule proliferated and compressing, 2, the tuft ; 3, degenerated epithelium ; 4, casts ; 5, new cells in the swollen stroma. Many of the tubes are dilated, the epithelium flattened.

In Fig. 1918 is represented a kidney which shows a marked increase in the nuclei of the vascular tuft. It is from a case of scarlatinal nephritis.

Besides the changes about the Malpighian bodies others are observed. The stroma is œdematous, and numerous indifferent round-cells may be seen in it, sometimes scattered, sometimes grouped together, but never in sufficient numbers to form abscesses. The tubes are often dilated and contain granular matter and casts. The epithelium is granular or fatty, and in many places is detached from the walls. In certain cases it is found here and there in a condition of coagulation necrosis. Some

authors think that hyaline casts are formed from degenerated epithelium. In one kidney that I have seen this seemed to be the origin of these bodies. (For further discussion of the origin of casts, see Microscopy, Clinical.) Smaller or larger hæmorrhages may be seen in the tubes and Malpighian bodies, and in the stroma.

The urine, in cases with this extensive lesion, is diminished in amount, or suppressed. Its color is dark, sometimes almost black, because of the presence of blood. Its specific gravity may be lowered or increased, but the total amount of solids excreted in it is diminished. Albumen is abundant, the urine sometimes becoming solid on boiling. Granular matter, blood, epithelium, and granular, hyaline, epithelial, and blood casts are to be found.

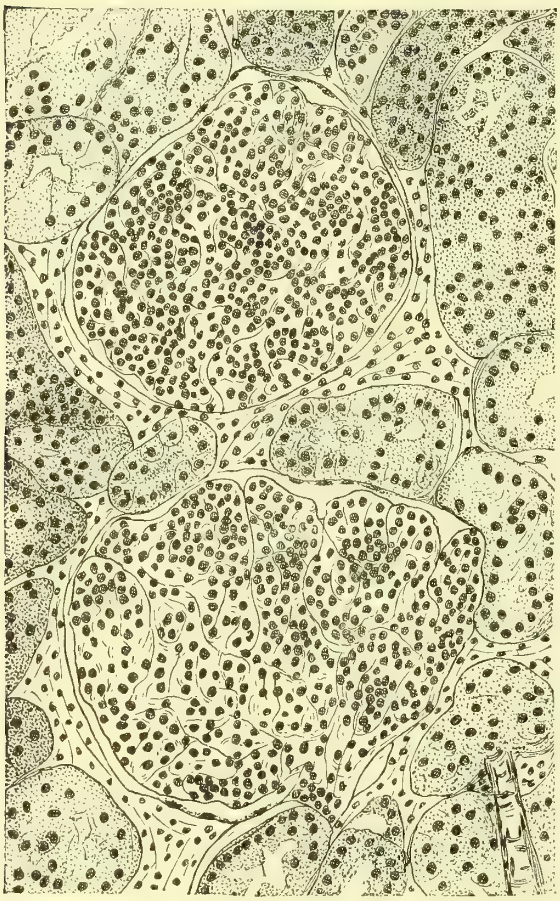

FIG. 1918.—Showing Increase of Nuclei in the Tuft, with Infiltration of the Stroma in the Neighborhood of the Malpighian Bodies, with New Cells. Degeneration of the Epithelium of the Convoluted Tubes.

In old cases which are becoming chronic, fatty casts may be seen.

I do not think that during life the diagnosis between the purely parenchymatous and the more diffuse form of acute Bright's disease can be made, if the former be severe. I do not know whether in the diffuse form the changes in the epithelium are the earliest to occur or not. Whether the two types represent essentially the same morbid process or not is, in certain cases, not clear. It seems probable that the type with lesions confined to the epithelium is, in many instances, only a degenerative process, and distinct in its nature from the diffuse form. Thus, in almost all the essential fevers—typhus, typhoid, measles, etc.—some parenchymatous change is common, and is of little importance. The same may be said of pneumonia and some other acute inflammatory disorders. On the other hand, in diphtheria and yellow fever, while the lesion is often purely parenchymatous, if indeed it be not always so, severe symptoms of renal disease, and death from this cause alone, often occur. In scarlatina the lesion is often of the diffuse type, but it may be confined to the parenchyma ; yet either form may cause death. According to Delafield the diffuse lesion "occurs as an idiopathic disease, or as a complication of scarlatina or acute phthisis." Other authorities give a larger number of causes. It seems fair to say that there are a good many cases in which parenchymatous change is found in the kidneys which is unimportant from a clinical standpoint, but which is not to be distinguished *post mortem* from that discovered in the kidneys of certain people who die with marked renal symptoms. There is considerable evidence to show that the forms of nephritis occurring with scarlatina are due to the specific action of the scarlatinal poison on the kidneys. Many authors make a special class of cases of scarlatinal nephritis, and describe certain lesions as peculiar to this disease. They do not, however, all agree as to exactly what these peculiar lesions are. It seems better, for the purposes of this article, to simplify as far as possible the descriptions of the lesions, and to avoid too much subdivision.

A mild form of purely epithelial change is frequent in typhus and typhoid fevers, remittent fever, measles, pneumonia, cerebro-spinal meningitis, acute tuberculosis —in fact, in almost all acute disorders accompanied by fever.

A severe form may occur as an idiopathic disorder, or after exposure to wet and cold. In diphtheria, yellow fever, or acute yellow atrophy of the liver, a very severe type is common. Poisoning by phosphorus, antimony, arsenic, carbolic acid, bichloride of mercury, cantharides, the strong mineral acids, and a number of other irritants, often produces an acute nephritis with lesions of the epithelium alone. In some cases of the diseases named and of poisoning by irritants, changes are described involving the stroma and vessels as well as the epithelium.

Scarlatina may be complicated by nephritis with either epithelial or diffuse lesions. Acute phthisis, according to Delafield, is sometimes complicated by diffuse nephritis, as has been mentioned. This diffuse type may also arise after exposure to wet and cold, and without known cause, and occasionally in connection with fevers other than scarlatina.

II. CHRONIC PARENCHYMATOUS NEPHRITIS.—The lesion described under this heading is so called because of the predominance of epithelial changes, and not because these are the only changes, or even the first ones. In the great majority, if not in all, of the cases of so-called chronic parenchymatous nephritis, there are lesions of the blood-vessels and stroma as well as of the epithelium. Cases of purely epithelial lesion are described by Delafield and some other authorities. Most authors, however, think that in this type of kidney all of the structures are involved. Some think that the epithelial changes precede those of the stroma and vessels, but most are of the opinion that there is no proof of this, and believe that all structures are affected simultaneously. English observers, for the most part, following the lead of Stewart and Dickinson, regard the epithelial changes as the first and essential ones, those in the stroma and vessels being secondary. They therefore adopt the name parenchymatous nephritis as being appropriate to this lesion, and that of interstitial nephritis for the cases of granular, contracting, or small kidney, in which the interstitial changes are most prominent. They think that, in the latter, these changes in the blood-vessels and stroma are primary, and that the epithelium is only secondarily destroyed. They regard the two processes as essentially different, but admit that the large white kidney of their parenchymatous nephritis, after at first showing only changes in the epithelium, finally undergoes extensive interstitial change and begins to contract. In most cases of large white kidney, as observed in New York, new tissue may be seen in the stroma, with thickening of the blood-vessels, even if death occur very early in the disease. It cannot be proven that the epithelial changes precede the others. It would, from a strictly anatomical standpoint, be perhaps better to call this lesion

chronic diffuse rather than chronic parenchymatous nephritis. Inasmuch as the symptoms produced by this form of chronic nephritis have been described under the latter title in this HANDBOOK, and as the most marked changes are in the epithelium, it is simpler to let it stand. Clinically the disease, in most cases, runs a different and more acute course than when the interstitial lesions predominate. For this reason it is well to divide it somewhat sharply from the atrophic form.

In this form of chronic Bright's disease the gross appearance of the kidneys varies somewhat with the duration of the affection. In the earlier stages the kidneys are increased in size. The capsule is not adherent, or only adheres slightly in a few places. The surface is smooth. The enlargement of the glands is largely due to the great thickening of the cortex. This is pale, sometimes white, sometimes yellow, or pink, or mottled with combinations of these colors. In some of the kidneys the markings of the cortex are lost, in others they may be seen. The Malpighian bodies are often only visible as yellow dots in the cortex ; sometimes, however, they remain red. The pyramids preserve their normal appearance, or show yellow streaks of diseased tubules. In consistence the glands are soft.

In later stages of the disease the kidneys decrease in size ; the capsule becomes adherent ; the surface is rougher ; tube after tube has been destroyed ; the interstitial changes have become pronounced, and a real atrophy takes place.

Under the microscope the epithelium is found in a condition of granular and fatty degeneration. The tubes are more or less filled with granular detritus, detached cells, and casts. In places groups of tubes are dilated, in others they are compressed by the growth in the interstitial tissue. The latter shows a great increase in the number of nuclei and is thickened. In some cases the thickening of the interstitial tissue is pretty evenly distributed through the cortex, but much more frequently it is only found in patches here and there. The patches may easily be overlooked in a superficial examination. The blood-vessels are frequently thickened. The Malpighian bodies show in places proliferation of the cells of Bowman's capsule and a thickening of the vessels of the tuft. Some of the tufts are obliterated by the growth of new connective tissue around them, and by the thickening of the vessel walls. The vascular changes are most marked in the patches of new connective tissue. It is not uncommon to find moderate waxy degeneration of the vessels here and there.

Delafield describes a form of large kidney with nothing but parenchymatous changes. This lesion has not been found by most authorities, although certain English authors think it common.

The urine, in cases of large kidney, is generally decreased in amount from the onset. Its specific gravity may be higher or lower than normal. The total amount of solids excreted in it is usually diminished. Albumen is abundant. Casts of all sorts are numerous. Blood may also be found. Toward the end, or during exacerbations of the disease, the urine may be entirely suppressed for some time.

Associated with this kidney lesion is found often a large amount of dropsy of the subcutaneous tissue and the serous cavities.

The blood is thin and watery.

Hypertrophy of the heart is not rare, but is not so common as in cases with the contracted kidney. The same may be said of degeneration of the great vessels, and of cardiac valvular disease.

Cerebral hæmorrhage occurs in some cases. Neuro-retinitis is quite often found.

Œdema and congestion of the lungs, and bronchitis and emphysema are common. Pneumonia is not rare. Phthisis is a common complication.

Cirrhosis of the liver is sometimes found.

There seems to be a peculiar liability to inflammations of serous membranes—pleurisy, pericarditis, peritonitis, and meningitis—among sufferers from chronic parenchymatous nephritis.

III. THE CONTRACTED KIDNEY.—As I have mentioned, the large white kidney in its later stages may diminish in size. All authors agree that a form of kidney disease exists in which there is no stage of enlargement. This form is called by different authors the atrophic, the small red, the granular, or the gouty, kidney. It is also called chronic diffuse nephritis, or chronic interstitial nephritis. The lesion is more frequent after middle life than in youth, and it is by far the commonest form of chronic Bright's disease seen in New York. It is essentially chronic in its course, and for this reason, if for no other, is worthy of being considered as a disease distinct from that called in this article chronic parenchymatous nephritis. The microscopic changes are the same as in the large kidney, but the interstitial tissue and vessels are here more extensively diseased than the parenchyma, and form the most prominent features of the lesion.

The kidneys are usually reduced in size. The capsule is adherent, the surface finely or coarsely granular. In some instances the kidneys are of normal size, and the capsule is but little adherent, the surface being smooth, yet the lesion may be well marked upon microscopic ex-

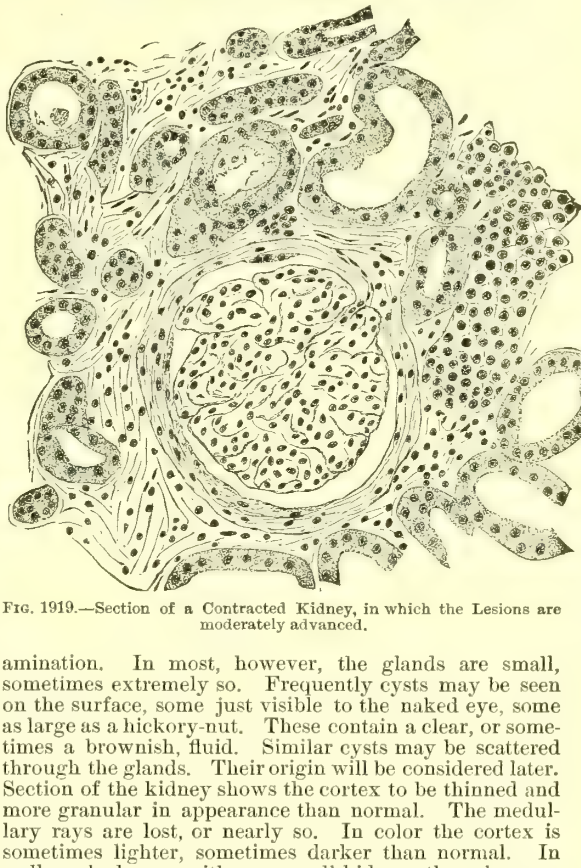

FIG. 1919.—Section of a Contracted Kidney, in which the Lesions are moderately advanced.

amination. In most, however, the glands are small, sometimes extremely so. Frequently cysts may be seen on the surface, some just visible to the naked eye, some as large as a hickory-nut. These contain a clear, or sometimes a brownish, fluid. Similar cysts may be scattered through the glands. Their origin will be considered later. Section of the kidney shows the cortex to be thinned and more granular in appearance than normal. The medullary rays are lost, or nearly so. In color the cortex is sometimes lighter, sometimes darker than normal. In well-marked cases with very small kidneys the color may be a dirty yellow. The pyramids are often but little altered in appearance or size ; but in very advanced cases they, too, are small and pale. Often whitish-yellow streaks of urates are seen in them. The larger and smaller arteries are frequently thickened, and stand open. The *venæ stellatæ* in some cases are more, in others less, visible than normal.

Under the microscope the interstitial tissue is, in many places, much increased in amount. In some kidneys this increase is quite uniform, but in most cases, as in chronic parenchymatous nephritis, the new connective tissue is distributed in patches here and there, with relatively healthy tissue between. As a result of the formation of new connective tissue, and of the tendency of this to contract, the tubules are variously deformed. Some are

much compressed or even obliterated; others, probably because of constriction exerted by the contracting tissue at a point nearer their outlet, are dilated. Usually groups of tubules are thus dilated. The same occurs to some of the Malpighian bodies, the capsule dilating, and the tuft being compressed and in time obliterated. The cysts mentioned in the description of the gross anatomy are probably formed from such dilated tubes and Malpighian bodies. The obstruction which has caused the dilatation becomes complete, fluid is still poured out into the tubes behind it, the walls of some of the tubes atrophy, and a cyst is formed, lined with flat epithelium. Some of the cysts are simply dilated Malpighian bodies.

The epithelium, in dilated tubes, is flattened or entirely destroyed; in the contracted ones it is deformed by the pressure. More extensive lesions of the epithelium than those which mere pressure effects are to be seen. Much of it is in a condition of granular or fatty degeneration, and is detached from the tube-walls. Casts are found in many places.

The vessels are frequently thickened. In some cases the media is most affected, in others there is periarteritis and disease of all the coats. Quite large vessels may be thus obliterated. The Malpighian bodies are usually much diseased. The walls of vessels of the tuft are thickened. Sometimes the tuft is thus rendered impervious and atrophies. The cells of Bowman's capsule


Fig. 1920.

may increase in number, and this, with the contraction of the new tissues in the vicinity, may so press upon the tuft as to cause its atrophy. Fig. 1920 shows this. If this process progress sufficiently far, the whole Malpighian body is reduced to a little ball of fibrous tissue.

The vessels of some of these kidneys show a certain amount of waxy degeneration.

The urine is, in the earlier stages, usually increased in amount. The specific gravity is low. Albumen may be absent, or present in very slight amount. Granular and hyaline casts are usually present in small numbers. Toward the end of the disease the amount of urine passed is reduced, albumen becomes more abundant, and casts more numerous and of all forms. The urine may be suppressed in severe cases.

Numerous lesions are associated with this form of renal disease.

The heart is often hypertrophied, especially its left ventricle. The valves are frequently the seat of chronic endocarditis. The arteries throughout the body are often thickened, and may be calcareous. Cerebral apoplexy is frequently the cause of death in these patients.

The frequency of the coexistence of hypertrophy of the left ventricle, disease of the vessels, and contracted kidneys, has led some observers to think that the vascular disease was the primary lesion, the others secondary. Gull and Sutton, in their well-known papers, advocate such a view. Very many cases of small kidney occur in which the general vascular change cannot be demonstrated. In explanation of the hypertrophy of the heart various theories are held. Some observers claim that the kidney lesion is primary; that obstruction is offered to the flow of blood through these organs by the changes in them. As the blood does not enter the kidneys readily, an increased amount remains in the arteries, and there is a consequent rise of arterial tension. By reason of the increased work thus thrown upon it, the heart hypertrophies. To prove this theory, it must be shown that the renal lesion really is primary, and that the obstruction to the blood-current in the kidneys can really raise the general blood-pressure.

It is the opinion of certain authors that the hypertrophy of the heart is secondary to dilatation or disease of the endocardium. Others, like Gull and Sutton, attribute it to disease of the vessels. Others, again, regard the hypertrophy and vascular disease as consequences of non-elimination, by the kidneys, of poisons generated in the body, the kidney lesion being primary.

The theory advocated by Mahomed, though not originated by him, is one of the most plausible. The primary cause of the cardiac, vascular, and renal lesions is thought to be spasm of the arterioles or capillaries. Obstruction is thus offered to the flow of blood, and the arterial pressure is raised. The heart hypertrophies to overcome the increased resistance. The tension is still more raised, and the vessels and kidneys become diseased in consequence of this increased tension.

It is most probable that the lesions in the kidneys, and those commonly associated with them, are all due to some common cause. This theory of the evil effects of high arterial tension furnishes such a common cause. It remains to be shown that high tension exists in all cases, and that it precedes the lesions. When this is done, the cause of the high tension must be sought for, and it may perhaps be found, in some substance, the result of faulty metabolism, circulating in the blood and producing the vascular spasm, either by direct irritation of the vessels or by its effect on the vaso-motor nerves.

Pulmonary emphysema is frequently associated with the contracted kidney. Cirrhosis of the liver is also often found. These two lesions, together with those of the heart and vessels, are by far the most frequent complications.

Dropsy of the serous cavities, especially hydrothorax, is frequent. General subcutaneous œdema is not so common as with the large kidney. Moderate œdema of the dependent parts of the body is not unusual, and extreme general anasarca may be present.

In the lungs œdema and congestion are common. Bronchitis occurs in many cases. Pneumonia is found in quite a large number. Emphysema, as has been stated, is very common. Phthisis possibly occurs more frequently in people with diseased, than in those with healthy, kidneys.

Neuro-retinitis, more or less extensive, is present in a large number of cases.

As with the large kidney, acute inflammations of the serous membranes are rather frequent.

The joint lesions of gout are seen in some cases. This form of renal disease is one of the recognized sequelæ of that disorder.

IV. The Amyloid Kidney.—Waxy degeneration of the vessels is not unusual in the two forms of chronic Bright's disease described. Under certain circumstances this degeneration attains such a prominence as to deserve a separate description. In cases of prolonged suppuration, of phthisis, and of syphilis, and in some others, extensive waxy degeneration may occur in the liver, spleen, kidneys, and gastro-intestinal tract, and sometimes in the vessels of other parts of the body. When this degeneration affects seriously the kidneys it is accompanied by a chronic diffuse nephritis. In such cases the kidneys are enlarged; the capsule is not adherent; the surface is smooth. On section the glands resemble closely the large kidney, but have a peculiar appearance, as if made of wax. The microscope shows lesions of stroma and cells similar to those observed in chronic nephritis, but the

vessels are extensively waxy. In marked cases the basement membrane of the tubes is also similarly diseased.

The liver and spleen are usually enlarged, and show the same amyloid change. The vessels of the stomach and intestines are stated often to be similarly degenerated.

The heart is rarely hypertrophied. General anasarca is common. The same acute inflammatory processes occur with this lesion as with those in which waxy changes are not so pronounced. Cerebral hæmorrhage is rare. Neuro-retinitis occurs in some cases.

The urine is usually at first increased, later diminished, in amount. Its specific gravity is low. Albumen is present, usually in considerable amount. Casts are generally few, and mostly of the waxy and hyaline types. It must be noted that *waxy* casts have nothing to do with *waxy* kidneys. The name is applied to those which in appearance resemble wax. They are probably only casts which have remained for some time in the kidneys before being washed away in the urine. Some of them show the waxy reaction with iodine, but most of them do not.

V. Active Hyperæmia of the Kidneys.—*Post-mortem* evidence of this condition is rare. As is the case in most congestions, the death of the patient causes the injection of the vessels to disappear. Probably, congestion precedes the occurrence of any degenerative or exudative lesion in cases of acute inflammation of the kidneys. It is also probable that an active hyperæmia may exist at times and produce symptoms, without being followed by any inflammatory process. There is often marked congestion of the kidneys, as well as of the other organs, in people who have been long comatose before death. This is a passive hyperæmia.

Active hyperæmia is caused by toxic doses of cantharides, turpentine, and other irritants. Active hyperæmia without inflammation is to be sought for during life, not at the autopsy table.

VI. Passive Hyperæmia of the Kidneys.—When there is obstruction to the return of venous blood through the renal veins, from whatever cause, passive hyperæmia in the kidneys is produced. This condition in time produces changes in the renal tissue, causing chronic diffuse nephritis.

When the congestion has not existed for too long a time the kidneys are increased in size, very hard, and dark-red in color. The capsule is not adherent, the surface is smooth. Under the microscope the venous radicles and capillaries are gorged with blood. In older cases the size is reduced. The capsule becomes adherent in places, and the surface finely or coarsely nodular. The cortex becomes thinner. The color remains dark and the substance firm. Instead of this change the glands may remain large, and become softer. The color is dirty pink. The capsule does not adhere. This form of kidney, dependent upon heart disease, was, I believe, first described by Delafield. I have seen several instances of it. The microscope shows engorged veins and capillaries, thickened and dilated vessels, and new connective tissue in places, with groups of compressed or dilated tubes; granular degeneration of the epithelium, and epithelium variously deformed by pressure. Casts and detritus are also found. Chronic diffuse nephritis, preceded by chronic venous congestion, may thus be secondary to valvular cardiac disease, dilatation of the heart, pericarditis, pleuritic effusions, pneumo-thorax, pulmonary emphysema, large aortic aneurisms, tumors or aneurisms pressing upon the inferior *vena cava* or the renal veins, thrombi in the veins between the kidneys and heart, ascites, and any other lesion which obstructs venous return. It is said that the pregnant uterus may, by its pressure upon the renal veins, cause passive renal congestion. It is difficult to imagine how this can be, when one considers the anatomical relations of the parts.

Classifications of Bright's Diseases.—The lesions just described are those commonly called collectively Bright's disease. An entirely satisfactory classification of the different lesions has never been made. The greatest confusion prevails, owing to the use of different terms by various authors to designate the same lesions. A list of synonyms is therefore useful. The commoner ones are as follows:

I. Acute Parenchymatous Nephritis: Acute Bright's disease, acute nephritis, nephritis, acute diffuse nephritis, acute interstitial nephritis, the first stage of nephritis, the inflammatory form of Bright's disease; catarrhal, croupous or desquamative nephritis; glomerulo-nephritis, scarlatinal nephritis.

II. Chronic Parenchymatous Nephritis: The large kidney, the large white or mottled kidney, the second stage of Bright's disease, chronic diffuse nephritis, the inflammatory form of Bright's disease.

III. The Contracted Kidney: The small, or small red, or granular, or gouty kidney; cirrhotic kidney, chronic interstitial nephritis, chronic diffuse nephritis, renal sclerosis, atrophic kidney.

IV. The Amyloid Kidney: The waxy kidney, lardaceous or depurative disease of the kidney, chronic diffuse nephritis.

The earliest classifications of renal disease were based on the idea that the lesions were inflammatory and of common origin, and that they went through stages of congestion, of inflammation with the deposition of new tissue, and then of contraction.

Frerichs lent to this view the weight of his authority. It was soon evident that cases of contracted kidney in most instances gave no history of any acute stage. This upset the former theory, and the contracted kidneys were classed separately. Many different classifications followed. Without pausing to consider the more unimportant, it is well to give a summary of those which are most frequently employed.

Virchow thought that there were three forms of Bright's disease, one originating in the tubes, one in the interstitial tissue, and one in the vessels, and that these three forms were often mixed.

Rosenstein classified as follows: I. Passive hyperæmia. II. Catarrhal nephritis. III. Diffuse nephritis. IV. Waxy disease.

His catarrhal nephritis corresponds to the form described in this article as the milder acute parenchymatous nephritis. The diffuse nephritis includes the marked cases of acute Bright's disease, and the two chronic types without marked waxy change.

Bartels' classification is: I. Hyperæmia, *a*, active; *b*, passive. II. Ischæmia of the kidney and its results (the renal affection of cholera). III. Parenchymatous nephritis, *a*, acute; *b*, chronic. IV. Interstitial inflammation or connective-tissue induration (genuine contraction, renal cirrhosis). V. Amyloid degeneration.

The classifications which have most influenced English-speaking people are those of Grainger Stewart, Dickinson, and Johnson.

Grainger Stewart recognizes three forms: I. The inflammatory form with three stages: inflammation, fatty degeneration, and atrophy. II. The waxy form with three stages: vascular, then degeneration of the tubes, followed by atrophy. III. The contracting form.

Dickinson: I. Disease of the tubes, tubal nephritis. II. Granular degeneration, or disease of the interstitial tissue. III. Waxy disease, or disease of the vessels.

Johnson's classification is more complex: I. Acute desquamative nephritis. II. Chronic desquamative nephritis. III. Waxy disease. IV. Non-desquamative degeneration. V. Fatty degeneration.

The classification of Delafield is: I. Passive venous congestion. II. Acute parenchymatous nephritis. III. Chronic parenchymatous nephritis. IV. Acute diffuse nephritis. V. Chronic diffuse nephritis. VI. Acute interstitial nephritis. VII. Chronic interstitial nephritis.

As acute interstitial nephritis, Delafield describes a peculiar and rare lesion in which there is "accumulation of white blood-cells in the capillary veins and in the stroma between the tubes, while the epithelium of the tubes is but little altered" (Delafield and Prudden, "Handbook of Path. Anat. and Hist.," p. 387).

The name is usually applied to suppurative nephritis, an entirely different lesion. The chronic interstitial ne-

phritis of the same author is a lesion which, he says, is analogous to cirrhosis of the liver, the interstitial vessels showing the most marked changes.

None of the classifications with which I am familiar is satisfactory. The one adopted in this article was merely chosen because it had been selected by the writer treating of the clinical aspects of the diseases. So much confusion already exists from the want of agreement in names used by various authors, that it seemed simpler to make the clinical and pathological nomenclature agree.

The future will probably show that there are many more forms of renal disease than have as yet been recognized. Many disputed points will, no doubt, be settled. For the present, amid so many conflicting opinions, the truth is hard to see. In writing this article the author has avoided, as much as possible, disputed points and fine distinctions, but he believes that many different disease processes are concerned in producing the different renal lesions. Our knowledge is, as yet, insufficient to separate them. For practical purposes he thinks that at present we may speak only of acute Bright's disease and chronic Bright's disease. And acute Bright's disease may be classified into two clinical types—one with slight degeneration of the epithelium, and with hardly any symptoms save slight alterations in the urine ; the other with lesions either of the epithelium alone, or of all the renal structures, and accompanied by severe symptoms and marked alterations in the urine.

In chronic Bright's disease we have cases running a rather rapid course, with marked dropsy, diminished urine containing much albumen and many casts ; and in these cases we expect to find the epithelial changes more marked than those of the interstitial tissue and vessels, and the kidneys of the type called chronic parenchymatous nephritis. There are other cases which run a slower course, with, at first, an increased amount of urine of low specific gravity, containing little or no albumen and few casts, and with at first little or no dropsy ; and in these the contracted kidney is usually present. Occasionally the contracted kidney produces symptoms resembling those usually presented by the other type, and *vice versa.* Finally, in sufferers from prolonged suppuration or syphilis, when renal symptoms appear marked, waxy degeneration of the kidneys is usually found.

In all of these chronic cases the lesion, as found post mortem, is usually, if not always, diffuse, involving epithelium, stroma, and vessels—as the lesions are seen in New York, at least.

The purely tubal form described by some English writers, and the purely interstitial type, must be extremely rare. In spite of the similarity of the lesions, it seems to the writer that there is strong evidence that the *disease* characterized by atrophic kidneys, with predominant interstitial overgrowth, is entirely different from the one with large kidneys and extensive epithelial change ; and the kidney with very marked waxy degeneration is also to be regarded as representing a disease process distinct from the other two.

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The literature of the subject is enormous. The reader is referred to the works of Rosenstein, Klebs, Wagner, Conheim, Bartels, Cornil and Ranvier, Delafield and Prudden, Grainger Stewart, Dickinson, George Johnson, Millard, Tyson, Charcot, Traube, Trousseau, Mahomed, Weigert, and many others, whose writings have been studied in preparing this article. *J. West Roosevelt.*

KIDNEY, NEW-GROWTHS OF THE. Renal new-growths may be primary or secondary. Except in the case of the benign new-growths the primary forms are of far greater importance than the secondary, and may be conveniently classed under three general heads :

1. Malignant new-growths : (*a*) Carcinoma ; (*b*) sarcoma.
2. Benign new-growths : (*a*) Fibroma ; (*b*) angioma ; (*c*) lipoma ; (*d*) villous tumors ; (*e*) osseous growths ; (*f*) myxoma ; (*g*) glioma.
3. Infectious granulomata : (*a*) Tubercle.

In addition to these primary new-growths, of which carcinoma, sarcoma, and tubercle also occur as secondary deposits in the kidney, there are a few other forms which usually only appear secondarily, and are of little clinical importance ; such are syphilomata, lymphadenomata, and leucæmic tumors.

The benign growths are always primary, while the malignant new-growths are, in the majority of cases, secondary, although they do occur in the primary form, and then constitute the most important class of renal tumors. Primary malignant growths of the kidney are usually unilateral, and form tumors of considerable size. They produce a more or less characteristic group of symptoms, by which their presence and nature can be determined, and which eventually constitute the cause of death. The secondary malignant growths, on the other hand, are usually bilateral. They do not produce any considerable enlargement of the kidney, and do not present any symptoms, independent of the primary tumor, by which their existence can be determined. Their presence is generally first revealed at the autopsy, and they are consequently of little or no clinical importance. The benign growths are, for the most part, either very rare or entirely unaccompanied by symptoms. The primary malignant and benign growths will be treated separately. The latter class possesses very little clinical interest. Tubercle and syphiloma are classed as infectious new-growths, and will also be considered separately. The former is of great importance, while the latter occurs only as a manifestation of tertiary syphilis, and has but little interest. It is possible that lymphadenomata and leucæmic tumors will be eventually found to belong to the class of infectious new-growths.

PRIMARY MALIGNANT NEW-GROWTHS.—It seems advisable at the present time to consider together, under the head of malignant new-growths, carcinoma and sarcoma, as these malignant tumors were, until quite recently, considered to be all carcinomata, and we have as yet no means of making a diagnosis clinically between them. The sarcomata appear more frequently in children, and probably form the largest tumors occurring at this period of life. Secondary deposits are comparatively rare after renal sarcomata. On the other hand, carcinoma is more common in adult life, and in the majority of cases secondary growths are found.

Primary malignant growths of the kidney are very rare. Ebstein says : "Tauchou found only 3 cases of primary cancer of the kidney among 8,300 cases of carcinoma, which were recorded in the mortuary statistics of the Department of the Seine, during the years 1830 to 1840. The results given in the justly celebrated work of Marc d'Espine, on the mortality statistics of the Canton of Geneva, during thirteen years, are far nearer the truth than the not very credible statements of Tauchou. He found 2 fatal cases of cancer of the kidney among 889 deaths from cancer, that is, 0.3 per cent." Virchow found that about one-half of one per cent. of all the cases of malignant neoplasms occurred in the kidney. These statistics of cancer include cases of both carcinoma and sarcoma.

Etiology.—The original exciting cause of malignant growths of the kidney, as of malignant growths in other organs, is entirely unknown. As a predisposing cause age plays a very important part. Malignant new-growths of the kidney occur during two periods of life—infancy, or early childhood, and adult life. They are especially frequent in children under eight years of age, but during the period which intervenes from this age to adult life they are of rare occurrence. In adult life they are most frequent between the ages of fifty and sixty years. They differ from the malignant growths in other organs in the frequency of their occurrence during childhood. As regards the sexes, they are rather unequally distributed, males apparently being far more liable to them than females. The proportion of cases in male and female adults is about as three to one. It has been suggested that the greater frequency of malignant disease of the kidney in men may be explained by the decided susceptibility shown by the female genital organ to carcinoma.

In this, as in many cases of malignant growths in other

localities, the patient will often assign the origin of the trouble to some fall, strain, or blow, and there seem to be grounds for believing that such injuries in many cases bear a closer relation to the development of the disease than they are usually supposed to bear ; and possibly the same may be said of the coexistence of malignant new-growths and renal calculi. It seems at least possible that the irritation produced by a calculus or a blow may have been the immediate exciting cause of the disease. Renal carcinoma appears in some rare instances to have been congenital, and hereditary tendencies probably have considerable influence in the production of the disease.

Pathological Anatomy.—Renal new-growths of a malignant character are usually unilateral, although in rare instances they may develop simultaneously in both kidneys. The right kidney is apparently more often affected than the left. The growths are usually of the medullary type, scirrhous carcinoma being exceedingly rare, although all the transitions between the medullary and scirrhous types may be found. Sometimes the growth occurs in the nodular form, and sometimes it appears as a diffuse infiltration of the whole organ. These tumors usually originate in the cortical portion, and affect, first, the epithelium of the tubules ; later the connective tissue is involved. The minute portions of the suprarenal capsule, which are sometimes found on the surface or in the superficial cortical portion of the kidney, have been thought to be frequently the starting-point of renal cancer. In the course of the disease the capsule of the kidney is generally much thickened. When the organ is diffusely infiltrated, its form may be well preserved, even though the kidney has become enormously enlarged ; but when the new-growth assumes the nodular form, the gland is often greatly distorted. Sometimes the parts of the kidney not involved in the new-growth are more or less affected by some other form of renal disease, or they may be only atrophied from pressure.

The size attained by malignant growths of the kidney is sometimes enormous. An explanation of this fact is found in the comparatively long duration and malignant form of these growths, the frequency of sarcomata in this locality, and the yielding nature of the organs surrounding the kidney. In some cases the weight of the tumor in children has exceeded thirty pounds.

It will often be found that the tumor has contracted adhesions to surrounding parts, but occasionally it remains free. The growth is generally quite soft, and the surface is lobulated and of varying consistency. An indistinct sense of fluctuation is now and then conveyed to the fingers. Renal malignant growths are quite liable to degeneration, softening, and hæmorrhage, and not infrequently in the central portion are found one large or several small cavities filled with a dark brown or yellowish cancerous fluid. In a recent case observed by the writer, more than three pints of a dark, grumous fluid escaped when a renal cancer was cut. This fluid contained cholesterin crystals, fat globules, and pigment granules in enormous numbers, as well as quantities of epithelioid cells in various stages of fatty degeneration, and altered red blood-corpuscles. The walls of the sac were formed by a soft, friable, fungus-like, cancerous mass, supported by the distended and thickened fibrous capsule of the organ. These growths are often exceedingly vascular, and the cavities sometimes found in them may be partly filled with blood, or the cavities themselves may be the result of a disintegration of the growth from hæmorrhage.

In some cases the tumor has apparently taken its origin in the peri-renal tissue, and perhaps this may be the case when the growth is a sarcoma, or when the suprarenal capsule, or some displaced part of it, has been the original seat of the disease.

Sometimes the malignant growth is confined within the capsule, and the kidney remains free and movable, but more frequently there are extensive adhesions to surrounding parts. The neighboring organs may also be the sites of secondary deposits. The size of the tumor usually causes considerable displacement of the abdominal and thoracic viscera, and may greatly compromise the functions of the different organs. These changes in the relations of parts, of course depend entirely upon the side affected, the size attained, and the direction followed by the tumor in its growth. The colon almost invariably lies in front of the tumor, and is often adherent to it. Frequently the relations of the two are of value in the diagnosis of the source of the growth. This is especially true if the colon contains gas, and has not been flattened and emptied by pressure. Sometimes there is pressure upon the vena cava, a resulting œdema of the legs, and, rarely, ascites.

The pelvis of the kidney has been found, in the majority of cases, to be more or less involved by the growth, and the ureter occluded either by cancerous masses, by blood-clots, or by pressure from the original tumor. However, it is usually only affected secondarily, or late in the progress of the disease. Whatever is the origin of these malignant growths—whether they have their source in the epithelium of the convoluted tubes, or in the renal or peri-renal connective tissue—they are, in a large majority of cases, distinctly extra-glandular. It is probably due to this fact that hæmaturia is not a more constant symptom in this disease. This symptom apparently occurs only when the new-growth has ulcerated into the pelvis, and there is present here a fungiform cancerous mass. Calculi are not infrequently found in the pelvis of the kidney.

In nearly two-thirds of the cases there have been secondary deposits in other organs, and in a number of instances the renal vein has been invaded by the new-growth. The comparative rarity of secondary deposits, especially in children, is probably due to the fact that many of the cases of so-called cancer of the kidney in children are in reality cases of sarcoma.

When secondary deposits occur, they may be found in any part of the body. The retroperitoneal glands, the lungs, and the liver are most frequently involved. Then follow in order the spleen, mesentery, omentum, heart, the medulla of the bones, and the brain and spinal cord. The lower genito-urinary apparatus is rarely involved. Only once in more than sixty cases were the bladder, uterus, penis, and testicle each the seat of secondary growths. In a case recently observed by the writer the penis and prostate were secondarily affected, and the persistent priapism resulting from the infiltration of the corpora cavernosa and the corpus spongiosum was the first marked symptom of disease. There were also secondary deposits in the lungs, liver, spleen, heart, brain, membranes of the spinal cord, tongue, omentum, retroperitoneal glands, and the superficial lymphatic glands throughout the body. The probable explanation of the immunity of the lower genito-urinary apparatus to secondary deposits is that given by Dickinson, who suggests that the dissemination of the disease is through the medium of the lymphatics, in which the flow from the kidneys is away from the pelvic organs.

The cancerous growth may involve the intestinal tract, and the portion of the colon overlying the tumor is especially likely to be affected. In some instances the tumors have ulcerated through into the colon and discharged their fluid contents into the intestinal canal. Rarely they have ruptured into the peritoneal cavity.

The microscopical appearances of renal cancer do not differ from those of other carcinomata. There are all the transitions between the medullary and scirrhous types, the soft forms, however, being by far the most numerous. In a few rare instances primary cylindrical-celled epitheliomata have been described as occurring in the kidney.

The small and large round-celled, spindle-celled, and alveolar sarcomata may occur as primary growths, but the form usually found is the soft and malignant small round-celled type. A few cases have been reported of myosarcoma striocellulare, or that form which is largely composed of striated muscular tissue. Renal sarcomata are sometimes so soft as to present an indistinct sense of fluctuation. They may occasionally be distinctly encapsulated, and thus separated from the glandular portions of the kidney ; as a rule, however, the lines of separation are not distinct, but the growth diffusely infiltrates the

organ, spreads between, separates, and compresses the tubules, and surrounds the Malpighian bodies. There is generally a scanty intercellular substance, and occasionally the interstitial tissue presents such a distinct alveolar structure as to cause the tumor to be mistaken for a carcinoma. These growths are at times very vascular, containing numerous large, dilated, and thin-walled vessels, which are profusely distributed throughout the tumor. Hæmorrhages are frequent, and cavities are often found holding the remains of recent or old blood-clots. In other portions of the growth the evidence of previous hæmorrhage may exist in the form of blood-pigment and blood-crystals. The so-called scirrhous carcinomata seem, in the majority of cases, to have been sarcomata (Dickinson).

Varying degrees of interstitial and parenchymatous nephritis are sometimes found in the parts of the kidney not directly involved by the growth, or there may be amyloid degeneration or a simple atrophy of the unaffected parts. The other kidney at the same time is often decidedly increased in size, owing to a compensatory hypertrophy.

Clinical Symptoms and Physical Signs.—Malignant growths of the kidney are often very insidious in their development and obscure in their manifestations. Not infrequently the only sign or symptom for a long time present, that is suggestive of renal disease, is the presence of an abdominal tumor situated in the renal region. With this come, sooner or later, loss of appetite and strength, progressive emaciation, and the other symptoms which ordinarily accompany the cancerous cachexia. But these may not appear until quite late in the course of the disease, and if the tumor is small, so as easily to escape detection, the existence of the disease may long remain unsuspected. If, on the contrary, there is present an abdominal tumor associated with the cancerous cachexia and hæmaturia, the diagnosis is comparatively easy. But none of these symptoms, or only one of them, may be present. The discovery of a tumor in the renal region is the most important point in the diagnosis. The malignant growth first appears in the flank, and advances forward between the lower border of the ribs and the crest of the ilium. It then extends toward the median line, and upward into the hypochondriac region, displacing on the right side the stomach and spleen, or on the left the liver, and in a downward direction it extends into the iliac and inguinal regions. In some cases the tumor fills the entire abdominal cavity. The veins in the anterior abdominal wall are often considerably enlarged, but not in all cases. The colon almost invariably lies in front of the growth, and its position is an important diagnostic sign. Percussion over the tumor is dull, except when the colon lies in front of it.

The tumor feels smooth, or irregular and lobulated, and has thick, rounded margins. This latter characteristic is rather significant, since the edges of renal tumors are never sharp, as are those of splenic or hepatic growths.

Although the new-growths in these cases often attain a large size, it must not be inferred that this is the rule, as sometimes they occur in the form of scarcely palpable tumors.

There is usually no difficulty in determining the presence of a tumor, but it is not so easy in all cases to show that the growth is of renal origin. Two cases of renal cancer, within the writer's knowledge, have been operated upon for ovarian tumors, others have been mistaken for enlargements of the spleen and liver, for impaction of fæces, or for new-growths of the colon, small intestines, or stomach.

Pain is another symptom, and, perhaps, follows next in the order of frequency. This does not always exist, and children with large tumors are often free from it, but its presence in adults is quite constant. Sometimes, especially in the smaller growths, it is persistent and severe, while again it may be entirely wanting from the beginning to the end of the disease. In one of the cases that has fallen under the observation of the writer there was no pain whatever, and, although the tumor was of considerable size, the patient was unconscious of its existence, as there was nothing to attract attention to the abdomen. When pain does occur, it is usually dull and persistent, rather than acute. It is not increased by movement, differing in this respect from the pain produced by a calculus. It is often increased by pressure, and there may be considerable tenderness. The pain does not generally follow the line of the ureter and testicle, as in renal calculus, and is more or less localized in the lumbar region. In some cases the pressure exerted by the tumor has produced erosion and absorption of the bodies of the vertebræ, exposure of the spinal canal, and compression of the spinal cord, followed at first by paralysis of the bladder, and finally by paraplegia, paralysis of the sphincters, and incontrollable bed-sores. In a few cases these complications have been the immediate cause of death. When erosion of the vertebræ exists there will be pain in the spinal region, accompanied by tenderness upon pressure over one or more of the lower dorsal or lumbar vertebræ. Occasionally the pain radiates downward, producing a severe and persistent sciatica, or it may lead a superficial observer to suspect disease of the hip.

When hæmaturia is present it is a symptom of great importance. Its occurrence, along with the existence of an abdominal tumor in the renal region, creates a very strong presumption of the presence of a renal malignant growth. Hæmaturia occurs at some time in the course of the disease in about fifty per cent. of the cases. Roberts found it present in thirty-one out of fifty-nine cases, and Ebstein in twenty-four out of fifty cases. The frequent complication of renal calculi with malignant new-growths renders it probable that the hæmaturia is sometimes due to this cause.

The comparative infrequency of hæmaturia is probably owing to the fact that the new-growths are usually distinctly extra-glandular and do not connect with, or open into, the tubules of the kidney in any way, so that this symptom is only present when ulceration into the pelvis of the kidney has taken place. When hæmorrhage has once begun it is usually continuous, and often profuse enough to produce great anæmia. In rare instances there has been a single hæmorrhage early in the disease, constituting perhaps the first intimation of the presence of a tumor, or renal hæmorrhages at long intervals have occurred. It is possible that such hæmorrhages as these are to be explained by the accompanying calculi.

When hæmaturia occurs, the renal source of the bleeding is usually at once apparent from the character of the urine. The blood is thoroughly mingled with the urine, and clots, if present, are small and more or less decolorized. In rare instances there have been obstruction of the ureter by blood-clots, and a consequent fatal suppression. One of the distinguishing characteristics of this form of hæmaturia is its apparently complete independence of any exciting cause. It occurs indifferently in the morning or at night, whether the patient is maintaining a horizontal position, or whether he is moving about and exercising. In this respect it differs very decidedly from that form of hæmaturia which is produced by stone.

When hæmaturia does not exist the urine is normal, unless the new-growth is complicated by some other form of renal disease. The tumor is extra-glandular and the urine passed is secreted by the normal kidney structure. Casts and pus are generally absent, and, if present, are accidental. The "cancer cells," which were formerly supposed to be quite constant and characteristic of the disease, are conspicuously absent. Diagnoses based upon the presence of any such supposed evidences of new-growth are almost invariably found to be erroneous; hence no reliance can be put upon them. These "cancer cells" are probably derived from the normal epithelium of the urinary tract. In rare instances cancer particles showing an alveolar structure may be found in the urine. These, of course, are pathognomonic of malignant disease in some portion of the urinary tract.

Digestion is sometimes considerably disturbed, especially early in the course of the disease. Loss of appetite, nausea and vomiting, and persistent constipation, or constipation alternating with diarrhœa, are the symptoms most frequently found. Icterus may occur, and when

present is due to pressure upon the ductus communis choledochus by a tumor of the right kidney. There is, as a rule, no perceptible change in the pulse, although it may be slightly retarded. The disease is generally unaccompanied by febrile complications, yet late in its course there may be some rise in the temperature.

The remaining symptoms are accidental. They relate to the extension of the disease to other organs, or to some complications. The spinal symptoms before referred to are the most characteristic.

Dickinson alludes to a form of asthmatic or laryngeal dyspnœa which sometimes occurs as a result of the implication of the lung by secondary growths.

The duration of the disease greatly varies. In twenty-five cases which the writer has found recorded as occurring in children the average duration was between seven and eight months. The minimum duration, in a case reported by Roberts, was nine weeks, and the maximum slightly more than a year. In adults the average duration in thirty-six cases was about two years, the extremes ranging between five months and seven years. Seven of the persons afflicted died within six months, thirteen within a year, and nine within three years; three lived four years, three six years, and one seven years.

From these figures it will be seen that malignant growths of the kidney are of longer duration than are many other forms of malignant growths. This is undoubtedly due, as Dickinson has suggested, to the large proportion of sarcomata to be found among these tumors.

Diagnosis.—It is often very difficult, and sometimes impossible, to make a positive diagnosis of malignant disease of the kidney. Probably no other form of abdominal tumor has been the source of so many errors in diagnosis. Malignant growths of the kidney have been mistaken for almost every form of abdominal tumor, and in not a few instances have been operated upon under a misapprehension as to their nature. Yet, in the large majority of cases, if the anatomical relations are kept in mind and repeated and careful examinations are made, the probable nature of the growth can be satisfactorily determined.

In nearly all cases a palpable tumor exists in the renal region. It may be evident upon the most superficial examination, or the most careful scrutiny may be required to demonstrate its presence. The method to be followed in determining the presence of an enlargement of the kidney was pointed out by Sir William Jenner, and is as follows: One hand is placed below the patient's last rib, behind and just outside of the great lumbar muscles, while the other hand is placed in front, and below the free border of the ribs. The kidney now lies between the fingers of the two hands, and after securing abdominal relaxation by directing the patient to draw deep breaths, the bulk of the organ, if much enlarged, can, in a thin person, be readily appreciated. This is a far more certain means of diagnosing slight enlargements than is afforded by percussion. If now, with a tumor in this region, there also exists profuse and persistent hæmaturia, the diagnosis becomes easy. Roberts says: "As a positive sign, associated with abdominal tumor, hæmaturia—profuse, spontaneous, and recurrent—is of the highest significance; but its absence signifies comparatively little. In nearly half the cases collected by me hæmaturia was wholly absent from first to last, and in those cases in which hæmaturia was noted, intervals of many weeks or months elapsed in some of them, during which the urine was perfectly normal." Enlargement of the kidney is to be distinguished from tumors of the liver, spleen, or ovaries, and from fæcal impaction. An important point, as regards the relation of the tumor to the colon and intestines, should be noted here. The kidney is retroperitoneal, and consequently, when enlarged, carries in front of it the colon, and, sometimes, coils of the small intestines. Aside from the kidneys, only growths of the retroperitoneal glands and suprarenal capsules have this relation to the peritoneum. Tumors of the right kidney usually have the ascending colon in front and to the left side of the growth, while those of the left kidney have the colon directly in front. In the discrimination between hepatic tumors and those of the kidney, it will usually be found that the renal growths can be separated from the liver, and that the edge of the hand can be introduced below the free border of this organ, and above the growth. The area of liver dulness does not extend down continuously from above, as is the case when the liver is enlarged from the presence of a new-growth, but below the normal area of dulness comes a more or less marked area of wholly or partly tympanitic resonance, and then the tumor-dulness. Renal new-growths are usually not movable, as they become surrounded by adhesions, and consequently do not move with respiration. The reverse is true of hepatic tumors. In renal tumors the area of dulness is broken by the colon passing perpendicularly over it. This is not the case with similar growths of the liver.

A splenic tumor can usually be distinguished from a renal tumor by the absence of the colon in front of it, by its sharp, rigid, notched border, by its extension higher toward the axilla, and by the presence of resonance between it and the spinal column. More than this, splenic tumors are usually quite freely movable, and the history will suggest a cause for the splenic enlargement and its nature.

The distinction between an ovarian and a renal tumor is sometimes a more difficult matter. It rests upon the absence of the colon or intestines from the front of an ovarian growth (this, however, is not an invariable rule, for sometimes the intestines become adherent to ovarian tumors and are carried in front of them), and upon the more globular form, central position, and usually cystic character of the ovarian tumors. Further, if the tumor is connected with the uterus, or the latter is situated high up, the ovarian nature of the growth is rendered probable. If the tumor extends into the pelvis, it is probably not of renal origin. A large renal tumor usually depresses the uterus.

There should be no difficulty in distinguishing a renal growth from fæcal impaction. The history, the effects of treatment, the situation, and the character of the tumor ought quickly to dispel any doubts.

But when a tumor is once shown to be of renal origin, the problem is not completely solved. Instead of being a malignant growth, it may be a hydatid, hydronephrotic, or purulent cyst. The character of the urine, the presence in it of pus, blood, or hydatids, and the solid nature of malignant growths, usually make this distinction easy. In any cystic abdominal growth the microscopical and chemical examination of the fluid drawn by an aspirator or hypodermatic syringe will greatly aid in forming the diagnosis.

If, in connection with a careful physical examination and the determination of the anatomical relations, the history and progress of the case and the accompanying symptoms are considered, a diagnosis of malignant growth of the kidney can usually be made with considerable certainty.

Prognosis.—Only a few words are necessary under this head. The ultimate prognosis is always fatal, unless the malignant growth is removed. As regards duration of the disease, as previously stated, it is much longer in adults than in children, the average duration in the former being about two years, and in the latter about eight months.

Treatment.—There is only one measure of treatment that offers the slightest hope of recovery or of any considerable prolongation of life, and this is early extirpation of the kidney. Unfortunately, owing to the insidious nature of the disease, the presence of a tumor is often not suspected until it has attained considerable size, and until there are extensive adhesions or a secondary implication of other organs or tissues; and even then it may be impossible to make a diagnosis positive enough to justify operative measures. When secondary deposits have taken place, surgical interference is, of course, useless. Up to the present time a comparatively large number of operations for the removal of malignant growths of the kidney have been performed, and the results, as regards immediate recovery, prolongation of life, and future im-

munity, have been sufficiently favorable to render the resort to extirpation at least justifiable, in view of the absolutely unfavorable prognosis without such interference.

Czerny, in 1881, at the Medical Congress in London, reported four cases of removal of kidney for tumors in infants. These were as follows · Mr. Jesup, of Leeds, in 1877, removed, by means of the lumbar incision, a kidney affected with "encephaloid" disease from a boy, two and one-half years of age, and although there was considerable hæmorrhage, and the operation was not performed antiseptically, the child made a good recovery, but died of a recurrence eight months afterward (*Lancet*, 1877, vol. i.). Kocher, of Berne, had a case of "adeno-sarcoma," which he removed in 1878, by the abdominal incision, from a boy two and one-half years of age. In this case there was considerable hæmorrhage, antiseptic precautions were not observed, and the child died of septic peritonitis (*Deutsche Zeitschrift für Chirurgie*, Bd. xix., 1878). Czerny removed the left kidney, for tumor, from a girl aged eleven months, by the abdominal incision. There was little hæmorrhage in this case, but the patient died of septic peritonitis on the third day after the operation. This is the youngest case on record (*Deutsche Med. Wochenschrift*, 1881). Hüter, of Greifswald, operated in 1876 on a girl, four years of age, for the removal of a renal tumor weighing five pounds. A median abdominal incision was used. Hæmorrhage was exceedingly severe, and caused the death of the patient during the operation.

Mr. Godlee reported a case before the London Clinical Society, in 1885, in which a sarcoma of the right kidney, weighing about a pound, had been removed from a child, twenty-two months of age, by an abdominal incision made along the border of the rectus. The operation was performed with full antiseptic precautions; little hæmorrhage occurred, and the child made a rapid recovery. Five months later a recurrence of the growth appeared in the right inguinal region and quickly caused death ("Transactions of the Clinical Society of London," vol. xviii., 1885). In the same article Mr. Godlee reports a case operated on by Mr. Heath, of London, in which the patient was a little girl, and the tumor was of large size. There were many adhesions ; it was impossible to remove the entire growth, and the child died.

Hicquet records a case of removal of a renal tumor from a girl six years of age. At the time the patient was first seen, in February, 1880, the tumor was no larger than a hen's egg. In August, when the operation was performed, it filled the greater part of the abdominal cavity. The median abdominal incision was used, the child made a good recovery, and five months afterward no recurrence had taken place.

Botevi, of Orvosi, removed, by an abdominal incision, a renal tumor, weighing about eight pounds, from a child whose age was not recorded. The child died of septic peritonitis on the third day.

A case has come under the writer's observation in which a renal tumor of large size was removed from a little girl. The operation was begun under the impression that the growth was of ovarian origin. Good recovery was made, and no return of the growth had occurred at the end of several months. Mr. Croft also reports a successful removal of the right kidney for round-celled sarcoma in a boy three years of age (*Lancet*, May 23, 1885).

Bergman, in a recent article (*Berlin. Klin. Wochen.*, No. 46, 1885), has collated forty-nine cases of nephrectomy for malignant growths. In these cases there were thirty deaths and nineteen recoveries, making a mortality of 62.8 per cent. Thirty-seven of the operations were performed by an abdominal incision, and of these twenty-four resulted fatally, making a mortality of 64.8 per cent. A lumbar incision was used in eleven cases, out of which there were five deaths, or 45.4 per cent. The subsequent course of the disease was ascertained in seventeen out of the nineteen cases which recovered from the operation. In ten of these death occurred within a few months from either a recurrence or a generalization of the growth. In the remaining six cases the patients were well at the end of seventeen, twenty-two, twenty-three, twenty-eight, thirty-five, and sixty months respectively.

Bergman reports also sixteen nephrectomies on children, with nine deaths. The subsequent history of five of those who recovered was learned, and four out of the five died soon after the operation. In one case the patient was living fourteen months later.

These statistics are certainly not very favorable to the operation, yet in twelve per cent. of the cases in adults there was no return after a considerable period of time, and the probabilities are that with earlier diagnosis and removal the percentage of immediate recoveries would be larger, and the number of patients rendered permanently free from the disease would be considerably increased. The chances of future immunity are much greater after the removal of renal sarcomata than after the removal of carcinomata.

As regards medical treatment there is little to be said. The means to be employed should be directed toward the support of the general nutrition of the patient, and the relief of any threatening symptoms or complications that may arise.

Benign New-Growth of the Kidney.—The majority of these are of but little importance.

The *fibromata* occur in the form of small nodules of dense connective tissue. They are most frequently met with in cases of chronic interstitial nephritis, but they also occur, apart from this condition, in otherwise perfectly normal kidneys. They rarely reach the size of a pea, and have no significance. A few cases of large fibrous tumors have been described ("London Path. Trans.," vol. xx., p. 244).

Cavernous angiomata, similar to those often found in the liver, rarely occur in the kidney. They sometimes are present in both kidney and liver in the same case, and occasionally form tumors as large as a walnut.

Small lipomata have been described as occurring just underneath the capsule, but they have no importance.

Villous tumors of the kidney are exceedingly rare. Dickinson describes a remarkable case of this kind, reported by Mr. Campbell de Morgan ("London Path. Trans.," vol. xxi., p. 239). These tumors resemble very closely villous tumors of the bladder, which are comparatively common. The seat of these growths seems to be usually the pelvis of the kidney. They are too rare to deserve more than this brief mention.

Osseous growths.—According to Roberts true bone may be found in the fibrous septa which separate the com partments of a sacculated kidney.

Sometimes a fibrous or cartilaginous tumor grows in the substance of the kidney, and subsequently ossifies, transforming a large part of the organ into a bony mass (Roberts).

Myxomata have been met with as small nodules, or in a larger form combined with sarcomata—myxo-sarcomata. The smaller forms have no clinical significance (Ebstein).

Gliomata, according to Virchow, occur as soft white, very tender, and translucent nodules, sometimes attaining the size of a small cherry. They are present in the cortical substance, and are attended by no symptoms.

Tubercles of the Kidney.—Renal tuberculosis may be primary or secondary. The primary form is of by far the greater importance, and constitutes a disease which manifests itself by more or less characteristic symptoms, and, in the vast majority of cases, eventually terminates in death. In the secondary form the renal lesions are comparatively insignificant, and produce no symptoms by which their presence can be determined. The disease in these cases constitutes only a minor complication of a tubercular affection of some other organ.

Etiology.—The primary cause of renal tuberculosis is the same as that of all other forms of tuberculosis—namely, the presence of the tubercle bacillus. It is impossible to say why in one case tubercular disease affects the lungs ; in another, the intestines ; and in a third, the lymphatic glands or the kidney. It may, perhaps, be due to the different modes and avenues of entrance of the tubercle bacilli in different cases, or to some inherent weakness in the respective organs which makes them es-

pecially liable to the development of this disease, when the specific cause has once gained admission to the living body. Probably both of these factors have much to do with the determination of the site of the disease. It has been suggested that genito-urinary tuberculosis may be transmitted by a person affected with it to one of the opposite sex during coitus. This seems especially probable as regards the transmission of the disease from the male to the female in cases of tuberculosis of the male genital apparatus. Nephrophthisis, as it is sometimes called, occurs oftener in men than in women, the proportion being about two to one. Cases may be met with at all ages, but the majority occur during middle life. The following table from Roberts gives the precise age in thirty-one cases: Under ten years, 4 cases; from ten to twenty years, 5 cases; from twenty to thirty years, 6 cases; from thirty to forty years, 9 cases; from forty to fifty years, 5 cases; from fifty to sixty years, 2 cases.

The youngest case noticed was that of a child, aged three years and six months, and the oldest (mentioned by Dittrich, and not included in the above table) was a man aged seventy-one.

Renal tuberculosis seems to occur more frequently in persons whose families are subject to other forms of tuberculosis.

Primary renal tuberculosis is a very rare affection. The secondary forms are much more common than the primary, and, according to the statistics of the Pathological Institute at Prague, they occur in a little more than five per cent. of all tubercular subjects. Secondary renal tuberculosis occurs much more frequently in tubercular children than in tubercular adults.

Pathological Anatomy. — Tubercles and tubercular masses may appear in the kidney under three conditions: First, as a part of a primary genito-urinary tuberculosis; second, as a part manifestation of a general tuberculosis; and third, as deposits secondary to tuberculosis of the lungs, intestines, lymphatic glands, etc.

The first form, namely, the renal lesions of a primary genito-urinary tuberculosis, is of the greatest importance. The other forms will first be briefly considered.

In general miliary tuberculosis there are often present in the kidneys small, gray, miliary tubercles, in greater or less numbers. These may be found in any portion of the kidney, but are usually most numerous and distinct on the surface, just underneath the capsule. They give rise to no symptoms, and have no especial interest. There may also be, in one or both kidneys, deposits of tubercles or tubercular masses, which are secondary to a tuberculosis of the lungs, intestines, etc. In such cases the deposits occur in the form of the small, gray, miliary tubercles, or, more frequently, as small, caseous masses in the cortex or medulla. Sometimes these masses have the appearance of yellowish streaks, or they may occur as irregular nodules. Occasionally only one or two cheesy masses of considerable size are found. The symptoms to which such deposits as these give rise are very slight, and are not at all characteristic, resembling only the symptoms of renal irritation produced by other causes. Finally, we may have a form of renal tuberculosis, secondary to tuberculosis in some other organ, in which the renal symptoms produced and the lesions found are practically identical with those to be described as occurring in the primary form, but in which the process is usually not so far advanced.

Primary nephrophthisis always implicates, besides the kidneys, other portions of the genito-urinary apparatus. It may begin in the kidney or its pelvis and extend down the ureter to the bladder, the vesiculæ seminales, and the testicle, or, on the other hand, it may originate in the testicle or bladder and extend thence up along the urinary tract to the pelvis of the kidney, and finally to the gland itself. When it occurs primarily in the kidney the tubercular masses are usually deposited first in the cortical portion. Here they appear as irregular, yellowish, cheesy nodules of various shapes, which gradually coalesce into masses of larger size, and extend downward into the pyramids. These cheesy masses undergo the same changes here that they do in other parts of the body—that is, they soften, break down, and suppurate, forming abscess cavities in the kidney substance. These abscesses may be very small and numerous, or they may be few in number and of considerable size. They may form closed cavities, or, what is more frequent, they may ulcerate through and open into the pelvis of the kidney, thus discharging their contents into the urinary tract, where they are mingled with the urine. The walls of the cavity are found to be of friable, cheesy matter, with more or less external fibrous tissue composed of the thickened capsule of the organ. This process of caseation and softening may go on until the entire gland has been implicated and has broken down, leaving only a large abscess cavity. Sometimes the tubercular process extends down into the ureter and prevents the escape of urine or pus; thus may be formed a pyonephrotic tumor. In a case of primary renal tuberculosis, recently observed by the writer, there was nothing left of the right kidney but the thickened fibrous capsule, lined by a friable, cheesy mass. In the other kidney there was partial destruction of the pyramidal portion, produced by ulceration extending up into the gland from the pelvis. The tubercular process had extended down the right ureter, greatly thickening its walls, and partially obstructing its lumen. The disease had also implicated the bladder to a slight extent.

Kidneys affected by tubercular disease may be unchanged as regards size, or may be considerably enlarged. In other cases, owing to the excavations and destruction of the gland tissue, they may be shrunken. The process in the ureter and bladder usually begins as a deposit of isolated tubercles, or as a diffused round-celled infiltration of the submucous tissue, which afterward becomes cheesy, or softens, and breaks through the mucous membrane. The outer walls of the ureter and bladder are often infiltrated with round cells, and are much thickened. There may be distinct tubercles present here.

The vesiculæ seminales, vasa deferentia, and the testicles are also frequently involved in the tubercular process.

In other cases the primary seat of the disease is in the lower portion of the genito-urinary tract, and especially in the testicle, and extends thence upward along the ureters to the pelvis of the kidney, and finally to the kidney itself. In these cases the tubercular deposits are more often found first in the pyramidal portion of the kidney, and the process extends by the gradual eating away of the pyramids. Later, however, caseous masses and abscess cavities appear in the medulla.

Clinical Symptoms.—Miliary tubercles and small caseous masses in the kidney give rise to no characteristic symptoms. The slight symptoms of renal irritation, such as indefinite lumbar pain and albuminuria, which may be produced are found in various other forms of renal disease. The presence of such symptoms in a person affected by a primary pulmonary or intestinal tuberculosis can, at most, only arouse the suspicion of secondary renal disease of the same character. When the disease is of longer standing, and is more advanced, there may be loss of appetite, emaciation, anæmia, and failing health and strength. The lumbar pain becomes more marked, and is of a dull, persistent character. As the disease advances there will probably be hectic fever, night-sweats, and progressive emaciation, and in case of obstruction to the outlet of pus, perhaps symptoms of septic poisoning. In rare instances uræmia supervenes, and constitutes the immediate cause of death. Aside from these general constitutional symptoms, there are many others which may be referred to various other organs, and which occur as the manifestation of a secondary implication of the respective organs. Not infrequently general miliary tuberculosis develops, and pulmonary and intestinal complications often occur.

The local symptoms are the most important in aiming at a diagnosis, but it is generally impossible to determine absolutely the nature of the disease before softening of the tubercular masses has taken place; then most positive evidences are often present in the urine. Not a small proportion of the local symptoms are referable to

the implication of other portions of the urinary tract. Suppurative pyelitis and cystitis are the most important of these complications. The frequency of micturition is generally increased, especially if the bladder is affected, when urination also becomes painful. The quantity of the urine, however, is somewhat diminished. Tenderness on pressure over the affected kidney is a very constant symptom, and there may be paroxysms of severe pain supervening upon the constant dull pain which is generally present. Not infrequently the presence of a tumor in the renal region may be detected. This may be due to an enlargement of the kidney, to the presence of pyonephrosis, or to a combination of both these conditions. Tubercular deposits in the testicle and prostate are not infrequent, and may assist in the diagnosis.

The results obtained from careful examination of the urine are of the most importance in arriving at a diagnosis. As a rule, early in the course of the disease, and sometimes for long periods of time before the development of marked symptoms, the urine contains albumen, pus, and occasionally blood in larger or smaller quantities. A suppurative pyelitis is undoubtedly the most frequent cause of these changes in the urine. Hæmaturia may occur, but is not profuse, as it often is in renal cancer. After ulceration into the pelvis has taken place other marked signs of the disease are found in the urine. It contains large quantities of granular material, minute cheesy particles, and occasionally fibres of yellow elastic, or fibrous connective tissue. In a few instances tubercle bacilli have been found. The presence of these, of course, absolutely determines the nature of the disease. They are probably not found, however, until after the cheesy masses have broken down. Sometimes the urine contains no blood at any time in the course of the disease, pus alone being present. "There are two conditions possible, however, in which the urine is perfectly normal, *i.e.*, where only one kidney is affected and the ureter is either plugged or compressed, the mucous membrane below the point of obstruction being normal; and when both kidneys are affected, but the infiltration has not yet begun to break down" (Ebstein).

When the bladder is also affected the urine becomes alkaline from ammoniacal decomposition. It contains much mucus, and the greater number of the cells become transformed into a viscid mass by the action of the alkali. Epithelial cells from various portions of the urinary tract are also found. Casts of the renal tubules may be present, but they are accidental.

The paroxysms of severe pain which are sometimes present may be due to blocking of the ureter by cheesy masses. This condition also accounts for the occasional intermissions which occur during which the urine becomes quite normal. When the bladder is affected, all of the symptoms commonly present in cystitis may be found.

Finally, there is generally some affection of the alimentary canal. Independently of the existence of uræmia, there may be more or less persistent vomiting from a sympathetic disturbance, and occasionally profuse diarrhœa sets in near the close of life, even when there is no tubercular implication of the intestines.

Duration and Prognosis.—The duration of the disease varies from a few months to several years. It is exceedingly difficult to determine the exact duration, on account of the obscurity of the symptoms at the outset. The interval that elapses after the appearance of the first characteristic symptoms until death occurs may be as short as five months, or it may be prolonged to two or three years. The large majority of cases die within the first year. The *prognosis* is absolutely unfavorable. Reasoning *à priori,* it seems possible that the tubercular process may become stationary, and the cheesy masses be encapsulated or discharged through the urinary tract, but if this ever occurs it is certainly very rarely. Roberts mentions a case recorded by Dr. Bennett where recovery had apparently taken place.

Treatment.—There is absolutely nothing to be hoped for from treatment. There are no measures known which have any direct action in preventing the extension of tubercular processes, and extirpation of the diseased kidney offers but little hope of benefit, since there are almost invariably tubercular deposits in other organs. The treatment, then, should be symptomatic, and based on the general principles observed in other forms of tubercular disease.

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Hermann M. Biggs.

KIDNEY, PARASITES OF THE. In the kidney have been found bladder-worms, or cysticerci of the various tape-worms; the most common and important being that of *tænia echinococcus* or *hydatids,* also *strongylus gigas* (see nematodes), *bilharzia hæmatobia* (see *distoma hæmatobium,* and *pentastoma tænoides*). Microscopic parasites which inhabit the blood (such as filaria sanguinis) would be found in vessels of the kidney as elsewhere.

Ascaris lumbricoides has been found in the kidney as an intruder, as it might work its way into any part. Parasites found in the urine have not necessarily been in the kidney; they may have come from the bladder, or may have been introduced into the urine for purposes of deception.

We shall here speak of these parasites merely as to the symptoms which they induce by their presence in the kidney, and as to the treatment required for their expulsion. The presence of hydatids or other cysticerci in the kidney might be suspected from finding a tumor in the region of either kidney, more particularly the left; but concerning the nature of this tumor we should have to decide from other symptoms, and the only certain diagnostic sign would be the finding of hooklets or other portions of the cysticercus in the urine or in fluid withdrawn by the aspirator.

The peritoneum, over the seat of the tumor, usually becomes thickened, and the hydatid sac then opens into the pelvis of the kidney and discharges its contents by the bladder and urethra; but sacs have formed adhesions and have pointed in other directions, discharging by the bronchi and bowels. The course of the disease is chronic. Of the cases recognized many recover (see Roberts' "Urinary and Renal Diseases"); usually the vesicles are not all expelled at once, but at successive periods.

Medicines given internally would not be likely to have much effect. A spontaneous cure occurs in most cases, but, in order to hasten the process, it has been recommended (see Bartholow's "Practice of Medicine") that the fluid be drawn off with an aspirator and the sac injected with tincture of iodine or bile.

The presence of the other parasites above mentioned might be suspected from evidences of a foreign body in the kidney, but would be rendered certain only by finding the parasite or its eggs in the urine. As the parasites would be located in the pelvis of the kidney, they might be affected by the internal administration of medicines, such as oil of turpentine, balsam of copaiba, etc.

Chas. E. Hackley.

KIDNEY, SURGERY OF THE. In August, 1869, Gustav Simon, of Heidelberg, successfully removed a healthy kidney from a woman, on whom he had previously performed ovariotomy, a fistula of the ureter remaining as the result of the operation. Although isolated cases of tapping renal cysts and incising perirenal abscesses had been recorded, and although the kidney had been previously removed under a mistake in diagnosis by Wol-

cott, Esmarch, Peaslee, and Spiegelberg, the report of Simon's case marks the birth of renal surgery. No other department of surgery can boast of more rapid and progressive development. Physiological experiment, research in topographical anatomy, and clinical study have alike contributed to the cultivation of this field, in which many questions of a highly practical nature are rapidly approaching final solution. It is chiefly through the labors of Simon, Czerny, Langenbuch, Thornton, E. Hahn, and Henry Morris that this advanced position of renal surgery has been obtained; and that, with the exception of the generalized structural changes produced by acute or chronic Bright's disease, nearly all pathological conditions of the organ may be said to have come within the province of the surgeon. Injuries and displacement, purulent and cystic degeneration, stones and neoplasms of the kidney, have all been rendered the subject of surgical interference. Before discussing these various conditions and the surgical measures necessary for their relief, it is well to briefly consider the normal surgical relations of the organ.

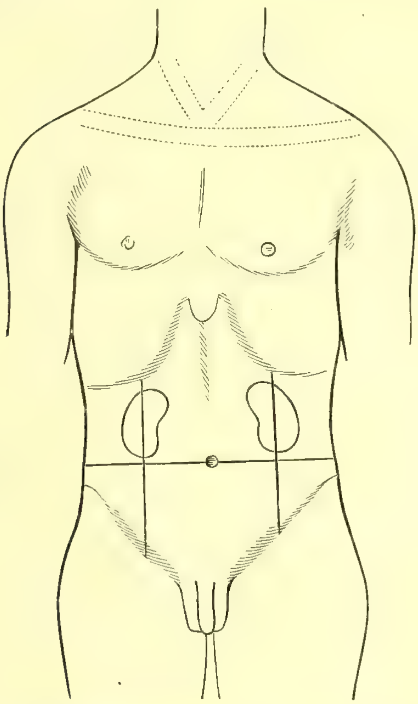

FIG. 1921.—Diagram showing Position of Kidneys relatively to the Anterior Abdominal Wall. (Morris.)

Topographical Anatomy.—The kidneys, two in number, are deeply seated in the abdominal cavity, and in close relation with its posterior wall, measuring from four to five inches in length, about two inches in width, and one to one and a half inch in thickness. They lie on each side of the vertebral column, resting upon the anterior surface of the *quadratus lumborum*, the anterior layer of the lumbar fascia being between them. The upper end of each gland rests upon the corresponding pillar and the two last costal attachments of the diaphragm. This septum separates the left gland from the eleventh and twelfth ribs, and the right from the twelfth alone. On the upper surface of the diaphragm the pleura extends down to the twelfth rib, and in exceptional cases, when this rib is absent or rudimentary, the pleura, nevertheless, reaches to the last dorsal vertebra. The lower and internal portion of each kidney rests slightly upon the anterior surface of the psoas muscle, its lower edge being nearly on a level with the third lumbar spine. The gland is fixed in this position by a very considerable layer of loose areolar tissue (*tunica adiposa*), within which the viscus itself, its blood-vessels, and the beginning of the ureter are embedded. Crossing the posterior surface of the organ obliquely, from above downward and outward, are the anterior branches of the last dorsal, the ilio-hypogastric, and the ilio-inguinal nerves. These relations amply account for the reflex pains so frequently observed in renal enlargements, irrespective of their nature.

The anterior surface of the right kidney is in relation, from above downward, with the inferior surface of the liver, the duodenum, and the ascending colon. The left kidney is in relation, in front, with the fundus of the stomach, the lower margin of the spleen, the end of the pancreas, and the upper portion of the descending colon. The practical importance of this relationship of the colon to the kidney will be shown farther on, in the consideration of renal tumors.

Loosely placed in front of both kidneys are the coils of the small intestine, the mobility of which is such that when the left or right lateral posture is assumed by a person with ordinary adipose development, the lower end of the right or left kidney can often be palpated through the abdominal wall.

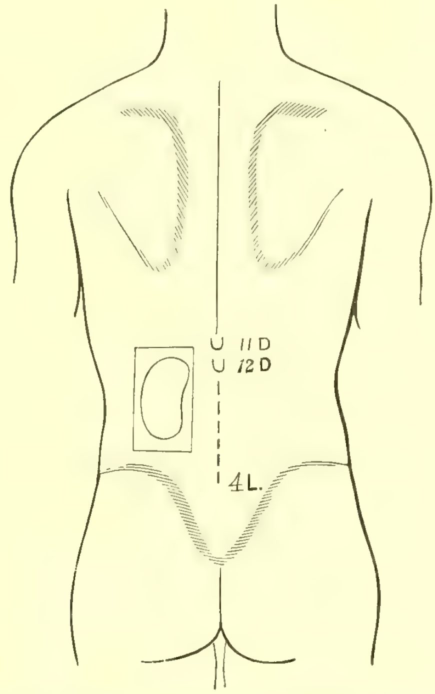

FIG. 1922.—Diagram showing Position of Kidney relatively to the Posterior Surface of the Body. (Morris.)

The relative positions of the kidney, with regard to the anterior and posterior abdominal walls, is well represented by the accompanying diagrams from Morris.[1] A horizontal line (Fig. 1921) through the umbilicus is below the lower edge of each kidney, and a vertical line carried upward from the middle of Poupart's ligament has one-third of the kidney to its outer side and two-thirds toward the median line. On the posterior surface of the body (Fig. 1922) the renal boundaries are fixed by the following lines: 1, A line parallel with and one inch from the spine, between the lower edge of the tip of the spinous process of the eleventh dorsal vertebra and the lower edge of the spinous process of the third lumbar vertebra; 2, a line from the top of this first line, outward, at right angles to it, for a distance of two and three-fourths inches. Two lines drawn parallel to these just described, and completing the parallelogram, fix the normal position of the kidney. The hilum of the kidney, with the blood-vessels above

and the ureter below, lies on a level with the first lumbar vertebra. Owing to the positions of the aorta and ascending cava, the right renal artery is longer, and the vein is shorter, than on the left side. The shortness of the right renal vein necessitates particularly careful manipulation in removing the organ lest the vena cava be lacerated.

Malformation of the Kidney.—In regard to position, form, and number, the kidneys are subject to certain anomalies which until recently possessed only scientific interest. The most common of the malformations is that in which there is a fusion of the two organs at their lower extremities, a "horse-shoe" kidney resulting. This fusion may be brought about by a connective-tissue band, or, what is more commonly the case, the connecting piece may consist of true gland-tissue. In this form of fused kidney the concavity ordinarily looks upward, the exceptions in which the concavity looks downward being among the greatest anatomical rarities. The arms of the horse-shoe gland are much nearer the vertebral column than are the normal kidneys, and the entire body occupies a much lower position. Both ureters are generally present, and pass down in front of the connecting band, although in a few instances the ureters were posterior to it.

From a more or less extensive union at one extremity the fusion of the kidneys may be continued upward, along their internal margins, until in the most marked instances the fused glands present the appearance of a placenta-like body with a single or double pelvis, but with separate ureters. Extensively fused kidneys, as a rule, occupy the median line of the body, resting on the sacral promontory or in the pelvis. In the former position they have, in persons who emaciated rapidly, been mistaken for neoplasms. The frequency of fusion of the kidneys has been computed from an examination of the records of 14,318 autopsies in Guy's, St. Bartholomew's, Middlesex, and the Great Ormond Street Hospital, which yielded nine instances of horse-shoe kidney, or about one in every sixteen hundred subjects. Only one entirely fused kidney (other than horse-shoe-shaped) was found in 8,178 inspections (Morris).

Differing from the "fused" or "solitary" kidney, as it is sometimes termed, is the "unsymmetrical" gland, whose fellow is congenitally absent. The single kidney is generally characterized by its abnormal size, and it is often displaced, being found either in the pelvis or in the iliac fossa on the corresponding side. In congenital absence of one kidney, the corresponding ureter is almost invariably absent. If present, it is rudimentary, beginning at the bladder and ending in a blind pouch above. Coexisting with congenital absence of one kidney, there has frequently been observed an imperfect development of the vas deferens, seminal vesicles, or uterine appendages of the same side.

The occurrence of congenital atrophy or absence of one kidney is far less frequent than is generally supposed. In 1878 Otto Beumer[2] was enabled to tabulate only forty-eight instances, including cases from E. Home, Rayer, Mosler, and others. Cases have since been recorded by Falk, Schwengers, Thieberger, Guttman, Petersen, Polk, and others. Nevertheless, the number of published cases of congenital absence or atrophy of one kidney does not exceed seventy. The great rarity of this anomaly is even more apparent from the statistics of autopsies made in four leading London hospitals, where of 11,978 subjects there were only three instances of absence or extreme atrophy of one kidney. The proportion in which it would be encountered would be once in about four thousand individuals (Morris). Nearly similar conclusions have been arrived at by Robert F. Weir.

When only one kidney is present, it is considerably increased in size and weight, with correspondingly large vascular and excretory apparatus. Of the forty-eight cases collected by Beumer, the kidney was healthy in twenty-six, which is conclusive evidence that a single kidney can perform the functions of two glands for years. In four instances a single enlarged but otherwise healthy gland was found in individuals between forty and fifty years of age. While a single kidney remains healthy, no indication of the anomaly is ordinarily discernible. On the other hand, the existence of disease in twenty-two out of forty-eight cases of single kidney establishes the fact that the increased function entails a very marked predisposition to disease, and particularly to chronic interstitial changes. Of the very greatest surgical importance is the fact that in ten out of these twenty-two cases calculi were found in the renal pelvis or in the ureter, and that in five cases death resulted from anuria in consequence of calculous impaction. The importance of bearing in mind the predisposition of the single gland to disease and displacement is practically illustrated by the remarkable case of Polk, who unwittingly removed the only kidney a patient had.[3] She survived eleven days, with complete anuria. The autopsy revealed the congenital absence of one gland.

Diagnosis.—It is quite natural that many plans should have been proposed to ascertain, when nephrectomy is intended, whether two kidneys are present, and the condition of the gland upon which a double duty is to be imposed. When temporary obstruction of the ureter of a diseased kidney recurs from time to time, the alternating excretion of normal and abnormal urine may give a positive indication of the presence of a healthy kidney. On the other hand, the presence of anomalies in the generative organs, in cases of renal disease requiring surgical interference, calls for special precautions to exclude the existence of a "single" kidney.

Simon, of Heidelberg, for this purpose, first suggested and practised catheterization of the ureters in women. This he accomplished by first dilating the urethra under chloroform anæsthesia. Grünfeld,[4] of Vienna, claims to be able to accomplish the same object by means of the endoscope and sound, while Newman,[5] of Glasgow, illuminates the interior of the bladder with an electric lamp for the same purpose. Very few operators have succeeded in examining the ureters, even in females. In males this procedure is entirely unfeasible, unless it be preceded by a perineal incision. Percussion likewise fails to give positive information as to the presence of a kidney, since the dulness of the lumbar muscles themselves is sufficiently great to be unaffected by the presence or absence of the gland beneath. In exceptional cases valuable points may be obtained from exploration of the abdomen, with the hand introduced into the rectum. But this method is associated with very considerable danger of laceration of the gut and rupture of the peritoneum. Numerous cases have been recorded in which death followed this procedure, and many more have doubtless occurred which have not been published.

The temporary occlusion of the ureter of the diseased kidney would give invaluable information as to the condition of the opposite gland. Weir recommends the use of Davy's lever for this purpose, while Sands advises compression of the ureter with the hand in the rectum. Dr. A. Tuchman[6] has devised a small forceps, fashioned like a lithotrite, between the blades of which he proposes to grasp the vesical end of the ureter, and to hold it while the urine continues to flow from the opposite ureter. Silverman,[7] of Breslau, has constructed a double catheter, one contained within the other. Attached to the inner instrument is a small gutta-percha balloon, which is filled with twenty cubic centimetres of metallic mercury after it has been introduced into the bladder. The balloon, thus distended, projects from an orifice in the outer cannula, and compresses the ureter. Silverman has used this somewhat complicated apparatus twenty-seven times in twenty-two subjects, five of whom were males. For physiological tests concerning the quantity of urine excreted the instrument answered admirably. It has not been tried in cases of disease. The most feasible method, probably, is that of Polk, who, after washing out and emptying the bladder, compresses the ureter with an **S**-shaped catheter, counter-pressure being made by one or two fingers pushed far into the rectum. As urine from a sound kidney is secreted at about the rate of a minim in four or five seconds, it will not require long-continued pressure to secure the amount of urine necessary for satisfactory examination.

Temporary exposure and compression of the ureter

and exploratory laparotomy have also been suggested as measures to determine the presence of a second kidney. Happily such extreme procedures are not readily adopted, and we are therefore compelled to rely upon what can be gleaned from a careful examination of the urine, and particularly as to whether the quantity of urine daily excreted falls far short of the normal.

DISPLACEMENTS OF THE KIDNEY.—Held in its normal position by the *tunica adiposa*, the kidney makes but a limited excursion of a little less than an inch during a deep inspiration. But in consequence either of rapid shrinkage of the perineal fat, relaxation of the abdominal wall, or an injury, the organ frequently leaves its anchorage and becomes the subject of more or less decided displacement. This condition has been made the subject of special study by E. Hahn [8] and Landau,[9] of Berlin, and Dr. Newman,[10] of Glasgow. According to the latter, renal displacements are to be divided into three classes: 1, Simple displacements without mobility of the organ; 2, movable kidney, in which the gland is still retroperitoneal, but decidedly mobile; and 3, "floating" kidney, in which there is a distinct meso-nephron by which the gland is loosely held to the posterior abdominal wall.

Simple displacements may be either congenital or acquired. In the former variety, as has already been seen, the misplacement is frequently associated with malformation. In these cases the position of the colon and the length of the ureters also deviate from the normal condition. In three hundred post-mortem examinations, Newman detected such simple malposition eight times, and in only three of these cases did the suprarenal bodies share the anomalous position of the kidney. When simple displacements are acquired, it is generally in consequence of pathological encroachments of contiguous organs, such as the liver and spleen, or from the increased weight caused by the growth of neoplasms. While the ordinary direction of the acquired displacement is downward, it may take place upward or laterally. In rare instances the displacement is complicated by axial rotation of the gland.

Both varieties of simple displacement generally escape observation during life, since they rarely give rise to grave symptoms. Sometimes the misplaced organ has been mistaken for an abdominal tumor, or has obstructed the natural progress of labor, but, as a rule, the autopsy alone reveals the true condition.

The second and third classes of renal displacements have been separated on anatomical grounds alone. The movable differs from the floating kidney in only two particulars. The latter is entirely covered by peritoneum, and, as in the cases of Hendersen, Lindsay Stevens, and Keetley, presents a complete meso-nephron; it therefore follows that the floating kidney is a congenital anomaly. The movable kidney is far more frequently encountered, and is probably always acquired. As a rule, in this condition, the gland is capable of less extensive movements than is the floating kidney, although the looseness and flaccidity of the subperitoneal connective tissue may be such as to permit, in some cases, the wandering gland "to encroach upon the opposite side of the belly." A differentiation of the two conditions during life is impossible, even if it were practically important, which it is not.

Wandering kidney is much more common in women than in men. Of 96 cases collected by Ebstein,[11] 82 occurred in females and 14 in males; Newman finds it in the proportion of one male to seven females. In the great majority of cases the displacement occurs on the right side, although, according to Landau, both glands are involved in about five per cent. of all cases. Again, it is more prone to affect women accustomed to hard work, and in whom the abdominal parietes have lost their resiliency from repeated pregnancies. Thus about forty-six per cent. of the cases observed are between the thirtieth and fortieth years, twenty per cent. from forty to fifty years, and, in all, eighty-one per cent. between the ages of twenty and fifty. The influence of the loss of elasticity in the abdominal walls in predisposing to this condition of the kidney appears to be shown by the fact that, according to Landau's tables, twenty-five per cent. of the patients had pendulous abdomen, thirteen per cent. suffered from descent, fifteen per cent. from retroflexion of the uterus, and seven per cent. from hernia. Rapid general emaciation from acute febrile diseases likewise predisposes to renal displacement. Cruveilhier believes that corsets predispose to this disease; a belief that is disposed of by the fact that wandering kidney occurs most frequently among the hard-working women of Germany, to many of whom a corset is an unknown article of dress.

Symptomatology.—The subjective symptoms of floating kidney vary enormously in different individuals. While productive of no harm, and only accidentally discovered in some persons, it may, in others, through the severity of the pain, the inability to work, and the gastric and mental complications, ultimately shorten life.[12] The sensation most frequently experienced is that there is something wrong or loose on one side of the abdomen. Patients complain of a sense of weight, or of a dragging pain which predisposes to strange fits of melancholy. The stomach participates largely in the subjective symptoms. There is almost always a loss of appetite, frequently associated with attacks of vomiting and of cardiac palpitation. The symptoms, which are to be explained by traction on the duodenum or the peritoneum, often lead to diagnostic errors. These are the less easily avoided since disturbances of the urinary secretions are generally absent. The neuralgic pains occasionally complained of are always on the affected side, and at times become excruciating. While they are generally felt in the lumbar region, they often follow the course of the ureter, simulating the pain of renal colic. Pain in the labia, the testicle, or along the course of the anterior crural nerve, is frequently present.

Alterations in the relations of the vascular and excretory apparatus of a floating kidney may be produced, and at times be followed by serious results. In consequence of temporary but frequent deflections of the ureter hydro-nephrosis may supervene, and torsion of the vessels may, as Dietl, Landau, and others have shown, produce strangulation with symptoms of collapse. Such grave symptoms usually supervene after severe and sudden exertions, and are followed by sharp pain, tympanitic distention of the abdomen, anxious expression of countenance, and rapid and thready pulse. Usually the kidney "rights" its position and these violent symptoms disappear.

The diagnosis of a floating kidney rests upon the detection of a tumor of about the size and shape of the kidney in the abdominal cavity. In many cases the discovery is first made by the patient. The tumor ordinarily glides easily from place to place, being felt at one moment in contact with the anterior abdominal wall, when, suddenly gliding from between the fingers, it is felt to slip backward into its normal position. This reposition of the gland is facilitated by the recumbent posture. When difficulties are encountered in feeling the tumor, bimanual palpation of the lumbar region, with one hand in front and the other behind, generally enables the examiner to grasp the kidney between the fingers and to feel the pulsations of the renal vessels.

Treatment.—The management of cases of floating kidney resolves itself into the palliative and curative. In the majority of cases the former alone suffices. Indeed, a statement made to the patient that the floating body is not a "tumor" often largely relieves the anxiety and conduces to his or her comfort. This is, however, greatly enhanced by the use of an elastic abdominal supporter, to which a smaller posterior and a larger anterior concave pad have been attached. Such an elastic bandage is more efficacious than an instrument fashioned like the ordinary hernial truss.

When the symptoms are not relieved by such retentive appliances, the surgeon has at his command either of two operative procedures for the permanent relief of the affection. The more severe of these, and until 1881 the only one, is nephrectomy. The other is nephrorrhaphy, or the suturing of the wandering viscus into its normal posi-

tion. This operation was first rudely practised by Greenville Dowell,[13] of Galveston, Tex., in 1879. It was refined into a recognized surgical procedure by E. Hahn, of Berlin, in 1881. Since the amount of excreting renal tissue is not diminished by nephrorrhaphy, the danger of the existence of a single gland does not come into consideration, and the life of the patient is rarely imperilled, it should always be given the preference over excision of the gland. Only one fatal result has thus far been recorded from it.[14] Nephrectomy is only permissible when nephrorrhaphy has failed, and the patient's life is still seriously threatened, or when the movable kidney is diseased and the fixed gland healthy.

There have been recorded twenty-two operations of nephrorrhaphy. The operators were Hahn, in five cases; H. Braune, in two; Dunning, Ceccherelli, Weir, Agnew, Esmarch, Gardner, Newman, Svenson, Bergmann, Bassini, Gilmore, de Paoli, Kuester, Jurié, and J. Greig Smith. In many of these the result was perfect, in only a few was there a partial success, and in the cases of Jurié, Gilmore, and Agnew secondary nephrectomy was rendered necessary.

The operation itself presents no great difficulties. The patient rests upon a pillow placed under the side opposite to the one to be operated upon. An incision is made in the lumbar region, as for nephrectomy. When the perirenal fat has been exposed, the kidney is pushed into its normal position, and retained in place by from four to ten catgut or silk sutures passed through the integument and muscular mass, on the one hand, and the fibrous capsule of the kidney, on the other. The wound is ordinarily treated by the open method, since the cicatricial tissue following the granulation process is most serviceable in retaining the kidney in place. As a last resource nephrectomy must sometimes be performed. According to Gross,[15] floating kidneys have been extirpated 22 times, with 13 recoveries and 9 deaths, or a mortality of 40.9 per cent. Of 19 ventral operations, 11 were cured and 8, or 42.10 per cent., died, whereas of 3 lumbar operations only 1 succumbed. In nephrectomy for floating kidney, *provided the diagnosis is certain*, preference should always be given to the lumbar operation, irrespective of the existence of a complete peritoneal covering for the kidney or the presence of a meso-nephron.

Injuries.—Injuries of the kidney may be divided into contusions and penetrating wounds.

Contusions are far more frequently encountered in civil practice than penetrating wounds. In military practice the reverse obtains. Hidden deeply in the recesses of the abdomen the kidney is not liable to injury. Of two thousand six hundred and ten inspections of persons dying of all kinds of injuries and diseases, there were thirteen instances of injured kidneys; of these, twelve were subparietal and one a penetrating wound (Morris). Resulting, as a rule, from a more or less severe fall or blow in the lumbar region, from the passage of a wheel over the body, or from a sudden twist or doubling up, these subcutaneous injuries of the kidney vary in degree from a slight bruise to a complete rupture or disorganization of the gland. Even in the mildest cases there is a considerable extravasation of blood in the circumrenal connective tissue, and blood has been found in the pelvis of the kidney even when there was no appreciable tear in the substance of the gland. In severer cases the capsule is ruptured, and the kidney itself is embedded in coagulated blood. When the peritoneum is torn at the time of the accident the entire abdominal cavity may be filled with coagula. The laceration of the kidney may be single or multiple. As a rule, the rent has a transverse direction, so that in the severest cases the gland is torn into an upper and lower portion, separated from each other by a clot. The ureter and bladder are not infrequently filled with soft coagula. Of thirty-four fatal cases of injury to the kidney, the bladder was filled with coagula in three. In a few rare cases the injury involved the upper end of the ureter, which was completely torn across. When very extensive subcutaneous lacerations of the kidney are found, the lesion is often only one of a number which, within a few hours, cause death. Fracture of a number of ribs, rupture of the lung, liver, or spleen, and damage to the spine and second kidney have all been witnessed as complications of subparietal injury. In fourteen out of thirty-four cases of fatal injury to the kidney, tabulated by Maas,[16] this formed only part of the damage inflicted. In one case both kidneys were injured, and in two there was an absence of a second gland.

Symptoms.—The evidences of renal contusions, while not always clearly defined, are generally sufficiently well marked for diagnosis. They are pain, diminution in the quantity of urine, hæmaturia, and the presence of a more or less decided tumor. Immediately after the accident the ordinary manifestations of an abdominal injury are present. The patient is pale and covered with cold perspiration. The pulse is quick, feeble, and small. There are usually nausea and vomiting. When the suppression of urine incidental to this condition of shock passes away, the urine, which is probably reduced in quantity, usually contains considerable blood, hæmaturia being the most constant symptom of renal injury. The blood-clots expelled are often casts of the ureter or pelvis. If they have been retained in the latter place for any length of time the blood-corpuscles are washed from them, and they are then emitted as white, fibrinous masses. Again, large coagula may be retained or may accumulate in the bladder, where they excite a cystitis which often entails great suffering. In very exceptional cases the coagula so completely block up the ureter that hæmaturia is not present. In a case of this nature, in which the urine remained clear, Verneuil correctly based his diagnosis on the gradually increasing quantity of urine passed from day to day as the uninjured kidney grew accustomed to double duty.[17] The pain complained of is deep-seated, being either in the lumbar or hypogastric region, or following the course of the ureter. Often there is a painful retraction of the testicle toward the external abdominal ring. Palpation over the injured side is always very painful, and frequently a distinct tumefaction, if not a circumscribed tumor, can be felt in the hypochondrium or loin. This is always of rapid formation, dull on percussion, and, when inflammatory changes ensue, gives rise to the rigidity of the abdominal muscles so characteristic of peritonitis from other causes.

Prognosis.—While severe contusions of the kidney often terminate fatally from hæmorrhage or the severe inflammatory processes that follow the extravasation of urine and blood, it is certain that the prognosis is not so unfavorable as many authors have been led to suppose. Simon[18] was enabled to gather 10 cases, of which 3 recovered and 7 died; 4 in consequence of hæmorrhage, 2 from abscess, and 1 from anuria, a second kidney being absent. Bloch[19] collected 40 cases, of which 17 terminated favorably. Finally, Maas[20] tabulated 71 cases, of which 37 recovered and 34 succumbed; of this number, 16 proved fatal from injury to one kidney only. Where the immediate cause of death could be ascertained it was found to be due to primary hæmorrhage in 6 cases, to secondary hæmorrhage in 4, and to abscess in 4.

Treatment.—Absolute rest in bed is the first essential in the management of these cases. This, with the application of ice-bags and the hypodermatic administration of ergot and morphia, in most cases effectually controls the bleeding. When the clots are large, and by filling the bladder give rise to violent tenesmus, the viscus should be frequently washed out through a large catheter, the Bigelow evacuator being admirably adapted to this purpose. To facilitate the healing process as much as possible, the kidneys should be relieved of excessive work. Therefore the diet must be light, altogether fluid, and limited in quantity. Close attention should be given to the condition of the bowels, since fatal hæmorrhage may occur from straining while at stool. Should the hæmorrhage continue notwithstanding this treatment, and it become evident that a fatal issue is merely a question of time, an exploratory lumbar incision is plainly indicated, and if marked disorganization of the kidney be found, nephrectomy is demanded. If the vesical tenesmus still continue, median cystotomy may subsequently be made.

This course was first pursued by Rawdon,[21] nephrectomy being performed on the seventeenth, and cystotomy on the twenty-first, day after the injury. The patient died on the fortieth day from suppuration of the opposite kidney, probably induced by the prolonged retention of disintegrating coagula in the bladder. A case of nephrectomy for injury was also recently recorded by Dr. von Arx,[22] of Switzerland. The operation was deferred to the twentieth day. It is probable that if in similar cases operative procedures should be resorted to at an earlier period the result would be less unfavorable. When rigors and elevations of temperature, pyuria, and increased tumefaction in the loins indicate the existence of inflammation in the injured part, recourse must be taken to the treatment appropriate in cases of renal or perinephritic abscesses.

Penetrating wounds of the kidney, resulting most frequently from gunshot or bayonet injuries, have long been the subject of discussion among writers on military surgery. As early as 1536 Gittler published a formal treatise on the subject. Chopart cites instances of recovery related by Fallopius, Dodonæus, Valleriola, and La Motte. Morgagni describes the case of a tailor stabbed in the right kidney, March 24, 1742, "on the very day the resurrection of our Saviour was celebrated—a circumstance which made the fact more heinous."[23] Hévin and Rayer treat of renal wounds in an explicit manner.

In penetrating renal wounds the direction of the wound plays an important *rôle*. Penetration from the rear may ensue without injury to other organs or to the peritoneum; in anterior wounds the peritoneum must necessarily be injured, and other viscera are often implicated. In wounds of the right kidney the liver, in those of the left the stomach and intestine, would most likely be involved. That wounds of the kidney may be received from in front without injury to the overlying viscera is illustrated by the following case of Baudens:[24] A young girl accidentally discharged a revolver while cleaning it. The ball entered above and a little to the left of the umbilicus. No wound of exit was found. The accident was immediately followed by paralysis of the left leg and hæmaturia. Recovery ensued, with slight manifestations of peritonitis, but the leg-paralysis became permanent. It is probable that the missile, after perforating the kidney, lodged in or near the vertebræ. No symptom of injury to the intestine was at any time observed.

Fully ninety per cent. of penetrating wounds of the kidney are the result of gunshot injury. The remaining cases occur from sabre thrusts and wounds produced by scythes, pitchforks, or knives. In one instance a pitchfork entered the rectum, and after perforating the gut injured the left kidney.[25]

The symptoms of penetrating wounds of the kidney greatly resemble those of subparietal laceration. Two pathognomonic signs are generally present: They are hæmaturia and the discharge from the wound of urine, either clear or tinged with blood. In rare cases, however, both of these symptoms may be absent. If only the cortex is injured, hæmaturia is not necessarily present, and unless the tubular part of the gland or its pelvis be involved, there need be no discharge of urine from the wound.

The records of the late civil war contain twenty-six alleged instances of recovery from shot wounds of the kidney. Hæmaturia is reported as present in fifteen of these cases. The escape of urine by the external wound could rarely be inferred from the meagre memoranda of the attendant symptoms. Urinary fistula of long duration is reported in one case only.

The prognosis of penetrating renal wounds varies greatly. While many succumb to hæmorrhage or peritonitis during the first week, and others to exhaustion from protracted suppuration, many cases doubtless recover. Lesgouest[26] has published a case that is convincing. A Russian soldier at Inkerman received a shot wound of the kidney and of the knee. He succumbed to the latter after long suffering. The autopsy revealed a depressed stellate cicatrix of the kidney, the fibrous tissue of which traversed the entire thickness of the gland. G. Simon also reports three recoveries which came under his observation in the Franco-German War. In the latter cases suppuration continued from six weeks to two years.

The treatment of these cases differs but little from that of the contused variety. When there is any reason to believe that foreign matter exists in the wound, digital exploration should be carefully made with a view to its removal. This is sometimes accomplished *per vias naturales*, as in the case narrated by Hennen, in which an officer passed a piece of cloth, *per urethram*, seven months after having been shot through the kidney. When urinary infiltration and abscesses result in the vicinity of the wound, free incision and drainage constitute important elements of treatment. In exceptionally grave cases extirpation of the gland will be required. In large incised wounds of the loin partial closure is advisable to prevent prolapse of the kidney, which may or may not be injured. Should this take place an effort at reposition must be made, the external wound being enlarged if necessary. If the organ is injured, or cannot be replaced, it should be removed after preliminary ligation of its vessels. Three successful cases of this nature have been recorded by Brandt, Marvaud, and Hamilton (Gross).

Perirenal Abscess.—The areolar tissue around, and particularly that behind, the kidney is often the seat of inflammatory changes which lead to suppuration. Although abscesses in this region were recognized by many writers of antiquity, it remained for Rayer to give the first systematic description of perinephritis. The field explored by him was rapidly cultivated by Hallé, Demarquay, Trousseau, and more recently by Kraetschmar, Bowditch, Duffin, Nieden, and Gibney.

In the *etiology* of this affection the important fact has been determined that it is rarely primary. In a few cases, mostly recorded by older writers like Rayer, Bland, and Gueneau de Mussy, the disease developed after exposure to cold while the body was overheated. In other instances it has followed the acute infectious diseases, particularly small-pox. But the causes most frequently active in the production of perinephritis may be divided into—1, traumatism; 2, diseases of the kidney or of other parts of the urinary apparatus; and 3, extension of disease from contiguous parts. The relative frequency of these cases is shown by the statistics of Duffin. Of 26 cases, 2 were the result of severe injury to the loin, 2 occurred after childbirth, 8 resulted from kidney disease, 1 from renal abscess following lithotrity, and 1 from vesical irritation. In the remaining 12 no disease of the urinary tract could be discovered. In 5 of them a "sprain" of the loin may have been the exciting cause. In 17 out of 166 cases, tabulated by Nieden,[27] the perinephritis was of traumatic origin. In the etiology of this disease it is important to remember that it occurs more frequently in persons who are subject to low forms of inflammation than in the robust. In many there are pulmonary evidences of tuberculosis. In such individuals any overexertion, a slight sprain, or a blow on the loin, by producing an extravasation of blood, gives rise to the formation of a "cold abscess," just as slight injuries to the joints in the same subjects will be the starting-point of tubercular disease, which would not develop from a like trivial cause in a healthy individual.

Among the renal diseases which produce perinephritis, calculous pyelitis takes the first place. Of 166 cases collected by Nieden, 25 were of this nature. The calculus embedded in the renal pelvis ulcerates through its wall, and enters the perirenal fat at times, where, aided by the infiltration of urine, it speedily produces an abscess. Pyelitis and pyelo-nephritis, without the presence of a calculus, may also give rise to perinephritis, and the same complication follows tuberculosis and metastatic abscesses of the kidney. Perinephritis sometimes results from extension upward of disease in the lower genito-urinary organs. Chopart observed it as a sequel of castration, Hallé from retaining a catheter in the urethra, and Trousseau and Nélaton after lithotrity. In many of hese cases, doubtless, pyelitis was the immediate precursor of the perinephritis.

The venous and lymphatic relations of the various re-

gions of the retroperitoneal space are so extensive and close that inflammatory processes are easily carried from part to part. It is in this way that pelvic cellulitis, perimetritis, perityphlitis, psoas abscess, caries of the ilium, abscess of the liver, and even biliary calculi have been known to invade the circumrenal areolar tissue. Nor is it very uncommon for this tissue to be involved by stercoraceous abscesses before a fistula is finally established in the ilio-costal interspace.

Sex plays an important part in the etiology of perinephritis, since seventy per cent. of the cases occur in males. It is also a disease of adult life, being generally found between the ages of twenty and forty. Gibney,[28] in 1876, recorded nine cases occurring in childhood, and Nieden states that sixteen per cent. of all cases develop before puberty.

The *pathology* of perinephritis presents points of anatomical interest. When an abscess follows, it is almost always behind the kidney. In a few instances it has been found in front of or completely surrounding the gland. Perforation of such an abscess into the peritoneum has more than once resulted fatally. Abscesses which have developed behind the kidney often assume enormous proportions, it being quite common for them to contain a quart or more of pus, which, from its proximity to the colon, often has a decidedly fæcal odor. In exceptional cases from four to eight quarts were found imprisoned in the abscess. Their great size can only be accounted for by the resistance offered by the lumbar fascia, which is perforated with great difficulty. Far more frequently does the abscess open into the colon—six times in twenty-six cases (Duffin).[29] Abscesses of the right kidney have been known, according to Cruveilhier, to perforate the duodenum, thus giving rise to copious vomiting of pus, or to profuse diarrhœa. In a case of horse-shoe kidney it opened into the rectum. Either by direct implication of the diaphragm, or by extension along the sheath of the psoas, perirenal abscesses find their way into the pleural cavity, an exit being finally found through the bronchi. In yet other cases the pus takes a downward course, pointing in the iliac fossa, or even below Poupart's ligament. When a large abscess has formed around the kidney, this, if it was not the primary seat of disease, ordinarily becomes involved. Its parenchyma either participates in the suppuration, when urinary fistulæ are often established, or it becomes compressed. After the perinephritic abscess has opened, and its walls are collapsed, the kidney is often found embedded in a firm, fibrous, cicatricial tissue riddled with sinuses.

Symptoms.—"A diffused, dull, and deep-seated pain is generally the first manifestation of a perinephritis. It differs from the acute, sharp pain which immediately follows an accident to this region. The latter is exacerbated by the slightest movement, but disappears when the patient is at rest. The pain of a perinephritis is constant. In the hepatic or splenic regions, or in the flanks, there is always a sense of great discomfort, heightened at times into a sharp neuralgic pain shooting toward the genitalia. Movements of the thighs precipitate them."[30] The position of the patient is often characteristic of the disease. To relieve pressure he inclines toward the affected side; the thigh is fixed and motion in the hip limited. While walking he supports himself with the hand placed on the middle of the thigh, and when seated he rests on the sound side only. If, as is often the case, severe pains in the knee are complained of, the case might easily be mistaken for one of *morbus coxarius.*

The local symptoms are associated with an ill-defined swelling in the region of the kidney, exquisitely sensitive to the touch, but not easily yielding the sense of fluctuation. It is more a sensation of increased resistance. When suppuration is pronounced, fluctuation can be best elicited by bimanual examination. An œdema, or at least a fulness of the ilio-costal interspace, often presents itself long before the pus approaches the surface. In extreme cases the œdema may extend from the nates to the scapula. Since the harmlessness of exploratory puncture has been established, the recognition of these signs, so important to our predecessors, has diminished in importance.

The composition of the urine does not always throw light on the nature of the case. In the twenty-six cases collected by Duffin, urinary symptoms were absent in twelve. In the remaining cases there was pus in the urine in six, blood in two, two suffered from vesical irritation, and the rest had kidney disease without bladder signs.

The constitutional manifestations are almost always grave. Elevation of temperature, with loss of appetite, dry and coated tongue, constipation, and high-colored urine are common to this, as to other deep-seated inflammations. When pus has formed, rigors suddenly appear and are repeated at irregular intervals. Rapid and progressive emaciation, and night-sweats are added to the symptoms; so that the patient, often in a few weeks, sometimes not until many months have passed, presents the appearance of one with hectic fever from other causes.

The *prognosis* of perinephritis, always grave, is greatly modified by the cause, and even to a greater extent by the treatment. Resolution doubtless ensues in mild cases. Cases of traumatic origin, if recognized early, also present a favorable prognosis, whereas those that complicate puerperal or other septic processes generally assume great gravity. When the disease follows a renal affection, the prognosis depends entirely on the amenability of the primary disease to treatment. Perforations into the peritoneum, pleura, or lung, are almost invariably fatal, whereas those into the intestinal canal, after protracted suffering, occasionally end in recovery. When the abscess, either primarily or secondarily, involves the pelvis of the kidney, urinary fistulæ may develop and remain indefinitely.

Treatment.—Since resolution is possible in cases resulting from exposure or trauma, every effort should be made to bring it about. Absolute rest, the application of an ice-bag, mercurial inunction, and in traumatic cases local depletion by cupping or leeching, may be resorted to. The bowels should be kept regular by enemata, and opiates administered to relieve pain. In less acute cases, while evidences of suppuration are still in default, a number of blisters applied over the loins will often relieve the pain, and may prove of permanent service. When fever, increased suffering, and the local physical signs indicate the formation of an abscess, large poultices should be applied to hasten the suppurative process. Even before superficial fluctuation appears, aspiration should be resorted to with a view to empty the abscess as soon as detected. No one now questions the value of early evacuation in cases of perinephritic abscess. The older method of opening them with caustics has properly been discarded, and the choice must now be made between aspiration and free incision with drainage. Aspiration, however valuable as a diagnostic measure, cannot be relied upon as a final method of treatment, since, although patients have recovered from aspiration alone, in the vast majority of cases the abscess refills and valuable time is lost. Incision is therefore generally necessary. In whatever direction it is made, it should be sufficiently extensive to permit a thorough digital examination of the cavity. While most operators prefer a transverse incision, there are some who prefer an oblique incision running from near the tip of the last rib to the crest of the ilium. In either case the dissection should be a slow one; layer after layer being divided on a grooved director; hæmorrage being checked as the operation progresses. In greatly emaciated subjects the thermo-cautery may be advantageously used for opening these abscesses. When the operation is performed early, pus may be evacuated in only small amount, or not at all. Even in the latter case the depletion and relief of tension effected by the operation give remarkable relief. As in the case of a felon we do not wait until pus is ready to gush from the wound, so in cases of perinephritis the incision should be made first, and the pus will take care of itself.

When the flow of pus ceases, the abscess cavity should be carefully examined with the finger to determine the condition of the kidney, and whether or not a calculus is

present. It should then be washed out with an antiseptic solution, and partially closed with sutures after a drainage-tube of large calibre has been inserted. The further treatment must be in accordance with established surgical principles. The burrowing of pus must be carefully guarded against, and too early removal of the drainage-tube particularly avoided. The general treatment must, of course, be sustaining. Iron and quinine, liberal diet, and alcoholic stimulants are always indicated in these cases, to offset the depression arising from protracted suppuration and to avoid exhaustion. If the perirenal abscess is secondary to renal disease, this must be treated before hopes of relieving the former can be entertained.

NEPHRO-LITHIASIS.—This term and *pyelitis calculosa* are synonymously used to designate the presence of solid concretions in the pelvis or in the substance proper of the kidney. These concretions vary in size from the barely perceptible uric-acid infarctions which occupy the uriniferous tubules during the first days of life, to stones weighing ten ounces, as in a case recently observed in the Boston City Hospital.[31] In composition and shape there exists the same difference as in size.

In the *etiology* of this disease the essential feature is an abnormality in the composition of the urine which permits the deposition, in crystalline or amorphous state, of some of its constituents on the mucous lining of the renal pelvis or calyces. A second essential in the formation of a calculus is the presence of an organic basis, in the form of particles of mucus, minute blood-clots, or shreds of epithelium, which cement the inorganic matter together and permit the deposition of fresh material on the outside. When a small calculus is not attached to the walls of the pelvis it will ordinarily find its way into the ureter. As a rule, calculi are developed on the apices of the pyramids, where they are attached, until from their weight or a sudden jar they are forced into the pelvis, and that often at a period of their growth when they are too large to pass into the duct.

The most common form of renal calculus is the uric acid, which may exist alone or with superimposed layers of the phosphates. Assmuth found a uric-acid nucleus in all of nine renal calculi, and Ultzmann, in five hundred and forty-five cases, found a similar nucleus four hundred and forty-one times. The next most common calculus is the oxalate of lime, usually found in small stones (mulberry), or as the nucleus of a larger stone consisting mainly of phosphates or urates. When uncovered by other deposits, the mulberry calculus, as its name implies, presents numerous little excrescences, which make it the most irritating of stones. Phosphate of lime, or the triple salt of ammonia and magnesia, while frequently the covering of a uric-acid or of a mulberry calculus, is not often itself the nucleus of a stone. By impregnating masses of inspissated mucus or pus, they often give rise to the development of large but smooth stones which are very friable. At times the phosphatic calculus assumes most grotesque forms by sending prolongations from the pelvis into the renal calyces. Cystin, xanthin, parasites, and particles of a renal neoplasm have also in rare cases formed the nuclei of renal calculi. Their number varies considerably. The mulberry calculus is, as rule, single. Phosphatic calculi, being often of secondary development, are sometimes present in numbers varying from two or three to twenty or even more. In exceptional cases of pyelitis hundreds of minute particles, friable like mortar, are found distending the pelvis. As a rule, nephro-lithiasis affects only one side, and by preference the left. There is a large proportion of cases, however, in which both glands are simultaneously affected, or in which the disease develops first in one gland, and then, after a varying length of time, in the other. Men are more frequently the subjects of lithiasis than women, and in childhood the disease is quite common. It has repeatedly been observed *in utero*. After the twentieth year the tendency to it is decidedly diminished, but increases again after the age of forty.

As a stone may remain in the bladder for years without producing marked structural changes, renal calculi may also continue indefinitely in the pelvis or parenchyma without detriment. This, however, is not the rule. The effects on the kidney largely depend on the number, situation, and form of the calculi. Numerous calculi, or stones with a rough or uneven surface, more rapidly induce changes in the kidney than a smooth, oval calculus embedded in a calyx. Indeed, such a stone may become encapsuled and produce no noteworthy lesion of the gland itself. As a rule, the first changes produced by a renal calculus are in the mucous lining of the pelvis. They are of an inflammatory nature purely. The mucous surface loses its glistening appearance and in places becomes eroded. Adherent to it, and removed with some difficulty, is a tenacious thick pus, or even a fibrinous deposit. As the inflammation progresses, if there be no obstacle to the escape of urine, the wall of the pelvis becomes thickened in parts, while in others ulceration takes place until the perirenal capsule is at times perforated. In this way nature rarely effects a cure of the disease. With further accessions to the size of the calculus an obstruction to the flow of urine is formed. The pelvis is more or less rapidly distended by the accumulated pus and urine ; the papillæ are eroded ; the pyramids are gradually flattened ; the cortical substance diminishes in thickness, and often becomes the wall of a pyo-nephrotic sac. In other cases where there is no obstruction the inflammation extends to the substance of the gland, where numerous abscesses develop, and either by confluence form a large sac or, their contents becoming impregnated with lime salts, give rise to new calculi.

Symptoms.—The chief symptoms which direct attention to the possible existence of a renal calculus are pain and the appearance of blood or pus in the urine. The first varies greatly in its severity. Often the patient experiences only a sense of uneasiness or of weight in the lumbar region, exacerbated by violent exercise or involuntary movements. It is in one loin only that the pain is generally felt, although it may sympathetically affect the other, but only to a lesser degree. When the pain is severe it is almost always accompanied by frequent desire to urinate, and micturition is often painful. If the calculi are multiple, or small enough to enter the ureter, they give rise, ordinarily, to attacks of renal colic, characterized by sharp, shooting pains in the loin, testicle, bladder, or anterior surface of the thigh, the attending symptoms being nausea, vomiting, and dysuria. Such exacerbations of pain, known as renal colic, generally supervene suddenly and depart in the same way when the calculus enters the bladder or finds its way from the beginning of the ureter back into the pelvis. During or after the attack hæmaturia often supervenes. Pure blood is often passed ; sometimes in fluid form, again in coagula with the configuration of pelvis or ureter. The source of the hæmaturia is the renal pelvis, and its cause a change of position of the calculus and consequent wounding of the soft parts. Recurrent attacks of hæmaturia often continue from year to year, as perhaps the only evidence of a renal calculus.

When the calculus is of a size that precludes its entrance into the ureter, acute attacks of colic are not likely to supervene. But in this case the examination of the urine will generally lead to a correct conception of the case. In the beginning of the inflammatory changes in the pelvis the urine will contain only a small quantity of mucus, with a few epithelial cells that are, however, not characteristic. Later on, the urine becomes cloudy, and contains more or less pus. Its reaction still continues acid. On standing, the pus is deposited at the bottom of the glass, and the clear fluid remains above. In this regard the urine of a pyelitis differs from that of a cystitis, which rapidly becomes ammoniacal. If the deposit is examined early, crystalline or amorphous particles of composition like that of the stone will occasionally be found. The urine of supposed cases of renal calculus should be examined often. If normal and abnormal urine are secreted at alternating periods, there is the greatest probability that one kidney is affected with a calculus, which, from time to time, occludes the upper orifice of the ureter, and that the other kidney is sound. On this evidence alone, Simon extirpated a kidney, and the autopsy established the correctness of the diagnosis.

If, as a result of retention of urine or of pus, the pelvis is dilated, a tumor in the region of the kidney will be developed, but without either hydro- or pyo-nephrosis; the chronic inflammation of the kidney may produce palpable enlargement of the gland, which will be sensitive to the touch. When many stones are present, it may be possible, according to Piorry, to obtain crepitus on deep palpation. When the stone has produced suppurative changes in the kidney, evening elevations of temperature, occasional rigors, and progressive emaciation throw additional light on the nature of the case.

The diagnosis of renal calculus is often associated with insuperable difficulties. Extreme acidity of the urine, tuberculosis of the kidney, and neuroses of the retrorenal nerves may all give rise to symptoms closely simulating those of nephro-lithiasis. The first of these readily yields to dietetic and alkaline treatment. From the second the diagnosis can only be made by the more rapid progress of the tubercular disease, and by the lesser tendency to hæmorrhage and attacks of renal colic. From neuralgia of the nerves, in anatomical relation with the kidneys, renal calculus is ordinarily differentiated by the absence of other evidences of an offending body in the kidney. It is, of course, essential in every case that the bladder be carefully examined before a positive diagnosis is arrived at. This viscus should be thoroughly washed out by means of a double catheter, and then emptied. The first urine which then passes through the instrument will show whether the abnormal constituents are of renal or vesical origin.

Prognosis.—Many autopsies have shown that lithiasis, even to the extent of inducing total destruction of one kidney, does not of necessity shorten life. Both kidneys may even develop large numbers of small calculi, which pass *per urethram* without detriment. It is only when secondary changes are produced that death follows, from the slow and continuous absorption of septic material into the blood, from exhaustion, or more rapidly from suppression or retention of urine.

Treatment.—In the treatment of renal calculus surgical measures have largely superseded internal therapy. Regulation of diet, reduction in the quantity of animal food taken, and the use of the mineral waters of Waukesha, Buffalo Lithia Springs, Vichy, and of other resorts, often temporarily or even permanently relieve the symptoms. When this is not the case, the patient should be subjected to an exploratory incision in the loin, with a view to removal of the stone, and this operation should not be deemed complete until the renal tissue has been divided and the pelvis and calyces have been thoroughly examined. The exploration should be made early, since it may insure the integrity of the kidney. A striking fact in connection with this subject is the remarkable relief afforded in fifteen cases, more or less typical, of renal calculus in which the incision failed to reveal the stone.[32] It is possible that in these cases a slight mobility of the kidney which may have produced the symptoms was relieved by the operation, or that by the latter, as Mr. Annandale has suggested, the retroperitoneal nerves, a neuralgia of which simulated renal calculus, were stretched or divided.

In the treatment of renal calculus the conditions of the individual case will call for nephro-lithotomy, nephrotomy, or nephrectomy. The first of these can be performed as a formal operation only while the kidney is in a comparatively healthy state. The second operation is applicable in cases in which the kidney is considerably implicated, or even the perirenal tissue is involved. Nephrectomy, finally, must be reserved for extreme cases, in which the gland is so completely disorganized that hopes of its recovery cannot be entertained.

TUBERCULOSIS.—The kidney, either alone or in conjunction with other parts of the genito-urinary apparatus, becomes at times the seat of tubercular deposits. When the renal disease is only a manifestation of its thorough dissemination throughout the body, it presents no special interest to the surgeon. In cases, however, that are not rare, the disease remains localized for a varying period in one kidney. Although the terms "strumous" and "scrofulous" kidney have been synonymously applied to the condition about to be described, the disease is doubtless a true tuberculosis with localized deposits in the kidney.

Pathology.—Renal tuberculosis, as a rule with many exceptions, begins in one gland. According to Dickinson, of ninety-five cases, both kidneys were affected in forty-seven and one only in forty-eight. In many of the first category the disease doubtless remained localized in one kidney for a long time, the second gland being involved by infection from the bladder or from generalization of the disease.

It almost always begins in the mucous covering of the pelvis and apices of the pyramids. There tubercles are deposited in large numbers, where, by their confluence, large portions of the mucosa appear to be uniformly infiltrated. Secondarily, the pyramidal, and even the cortical, portions of the gland are infected from the pelvis. Here, as elsewhere, caseation follows in the tubercular deposits. Superficial ulcerations and minute abscesses empty their contents into the pelvis, whence they are drained with the urine. In the course of time the ulcerations become deeper, the abscesses increase in size and become confluent, until eventually the entire viscus may form a cyst within which are numerous irregular abscess cavities connected with each other. According to Rindfleisch,[33] each of these cavities corresponds to a Malpighian pyramid. Little of the cortical substance remains in advanced cases.

When the pelvis of the kidney near the beginning of the ureter is involved, the infiltration of the mucous membrane readily occludes the opening of the duct, and in this way readily produces pyo-nephrosis. Indeed, the most common cause of the last-named condition is tubercular pyelitis. Even when the disease does not lead to retention of pus, the kidney is always considerably enlarged, and, as a rule, markedly lobulated. More readily than elsewhere in the body, chalky deposits take place in the caseous masses, as a result of which renal tuberculosis is not infrequently complicated with calculus. Again, renal tuberculosis may induce perirenal abscess or tuberculosis of the bladder, prostate, or testicle, and in a small proportion of cases death may follow the acute eruption of miliary tubercles in viscera remote from the primary seat of the disease.

The *symptoms* of primary renal tuberculosis vary with the degree of the anatomical changes. Until caseation of the infiltrating masses supervenes, the symptoms are indefinite in the extreme. Pain in the loin, occasionally radiating toward the genitalia, and increased paroxysmally; tenderness on pressure over the kidney, and frequency of micturition are symptoms generally encountered, the last-named being one of the most important on account of its constancy. In the course of time the urine, which at first was normal, shows traces of pus, which increases in amount until a considerable deposit is found in the urinal. The pus mingles readily with the urine, unlike that of the alkaline urine voided from an inflamed bladder. Hæmaturia is also a pretty constant concomitant of tubercular pyelitis. The blood is usually passed in small coagula, very rarely in considerable quantity. An examination of the urine will probably from time to time reveal minute, cheesy masses, washed down from the seat of disease. The search for the specific bacillus may also become an invaluable auxiliary toward establishing a diagnosis. The presence of a marked renal tumor is not to be looked for except in advanced cases in which pyo-nephrosis complicates the pyelitis. In the last stages of the disease the systemic manifestations are identical with those produced by tuberculosis in other parts. Evening elevations of temperature, night-sweats, and progressive emaciation indicate the approaching end with sufficient clearness. In very exceptional cases the blocking of both ureters terminates life amid the evidences of uræmia.

Prognosis.—Tuberculosis of the kidney is probably always fatal, unless by timely interference exit is given to the pus, or the nidus of the disease is removed by more radical interference.

The *treatment* consists in the administration of remedies that assist in the constructive metamorphosis of tissue. Cod-liver oil, the hypophosphites, malt, etc., are always indicated, while opiates are occasionally called for to relieve the pain and vesical tenesmus. In extreme cases, and when it is clear that both glands are involved, our efforts are limited to these measures. In cases in which only one kidney is diseased, surgical procedures may often prolong life, and even restore health. The condition of the opposite kidney is always to be considered. How this is to be accomplished has already been described. It might be of service to add here that in one case of pyelitis, Bergmann,[34] after washing out the bladder, was enabled, by pressure over the diseased kidney, to force pure pus through a catheter, while, as a rule, the urine was only slightly clouded.

The surgical treatment of renal tuberculosis forces upon the surgeon a choice between nephrectomy and nephrotomy. According to Gross, "the kidney has been removed twenty times for so-called strumous disease; twelve of the patients recovered, and eight, or forty per cent., died. Thirteen of the operations were through the loin, and 7 of these, or 53.84 per cent., succumbed. Of the 7 ventral operations only 1, or 14.28 per cent., died. Previous nephrotomy had been resorted to in 8, with 5 recoveries and 3 deaths, or a mortality of 37.5 per cent., whereas primary extirpation was attended with a mortality of 41.66 per cent. Of the 10 cases of recovery, 8 were living and well at the expiration respectively of two months and twenty days, five months, five months, ten months, twenty-six months, thirty months, three years, and nearly four years."

When the limitation of the disease to one side can be established, extirpation affords the greatest measure of relief. When there is a doubt, preliminary incision of the gland, with drainage through the loin, should always be practised first, and in the opinion of Bergmann take the place of nephrectomy. Gross concludes that doubt as to the condition of the second gland can be best removed by the ventral operation, which in these cases is attended by a mortality of fourteen per cent., as against fifty-three per cent. for the lumbar operation.

Hydro-nephrosis is a term used since 1841 to designate, according to Rayer, "a chronic distention of the renal pelvis from obstruction to the flow of urine through the ureter." The obstruction may arise in any portion of the urinary apparatus below the upper end of the ureter. When the seat of obstruction is in the bladder, prostate, or urethra, the hydro-nephrosis is generally bilateral, and since it then, as a rule, is speedily fatal, it only slightly interests the surgeon. Unilateral hydronephrosis, however, belongs to his domain.

In the *etiology* of this disease there are congenital and acquired causes to be considered. Among the former are obliquity of insertion of the ureter into the pelvis, torsion of or an angle in the ureter, obliteration of the lumen of the ureter by a fold, by a calculus, or by the pressure of an aberrant lumbar artery. The most common acquired cause is the impaction of a stone in the upper end of the ureter; next in frequency is the contraction of a tubercular ulcer in the pelvis, or the occlusion of the ureter by a caseous deposit. Again, the exciting cause of hydronephrosis often comes from without. Pregnancy, ovarian tumors, malpositions, and neoplasms of the uterus may produce slight distention of the renal pelvis, in consequence of which the natural obliquity of the ureter is increased, and its lumen becomes permanently occluded. Patients not infrequently mention pregnancy as the starting-point of hydro- or pyo-nephrosis, and it is for this reason, probably, that the disease occurs nearly twice as often in females as in males.

Pathology.—The pathological changes of hydro-nephrotic kidney are almost altogether mechanical. Distention of the pelvis and calyces from retained urine causes a flattening of the pyramids, and ultimately a progressive atrophy of the pyramidal and cortical portions. Synchronous with this absorption of renal tissue there is an hypertrophy of the fibrous tissue of the pelvis, so that in extreme cases the kidney is converted into an enormous thin-walled sac containing from one to twenty or thirty (Frank, von Dummreicher) litres of clear serous fluid. The nature of the obstruction largely determines the condition of the renal parenchyma and the size of the tumor. If the obstruction is sudden and complete, as Cohnheim has shown, the intrapelvic pressure is such that the parenchyma rapidly atrophies and the size of the cyst is never enormous. If, on the other hand, the obstruction is of slow development and incomplete, parts of the renal cortex will escape pressure, and the secretion from them is essential to the formation of the largest cysts.

While the tumor is still small, normal or greatly diluted urine forms the contents of the sac. Since with the atrophy of the renal parenchyma secretion ceases, the fluid becomes more and more unlike urine, as it is largely made up of the secretions from the lining membrane of the pelvis and calyces. Should the cause of the obstruction be associated with or produce inflammation, pus in varying proportion will be found in the cyst. If the obstruction in the ureter is low down, the upper portion of this canal is often enormously dilated, and presents an appearance not unlike a segment of the small intestine. When the obstruction is near the upper end, its lower part is greatly reduced in size, and may become converted into a fibrous cord like the urachus.

The *symptoms* of unilateral hydro-nephrosis are not marked during its early stages. Indeed, the detection of a tumor generally affords the first sign of the abnormal condition. The urine is, as a rule, normal in quantity and quality, since the sound kidney gradually assumes the function of the other. A very characteristic symptom of hydro-nephrosis, which occasionally appears, is the voidance of enormous quantities of urine, after which the tumor temporarily decreases in size. When the latter increases rapidly, pain of a dull, aching character is often felt. From pressure on neighboring viscera, digestive derangements and dyspnœa may also be complained of. Through long continuance of symptoms due to pressure, the health may be seriously impaired and life threatened.

The *diagnosis* of hydro-nephrosis ordinarily presents no great difficulties. In one or other loin we find a markedly fluctuating, generally fixed, retroperitoneal tumor, situated below the liver or spleen, and behind or to the outer side of the colon. As it develops in size it extends from above downward and inward, reaching to or beneath the iliac crest and across the median line in front. Percussion in front, behind, and at the side yields a flat sound, unless the tumor be vertically crossed in front by the ascending or descending colon, when a band of resonance divides the area of dulness into an outer and inner segment. When the tumor is very large, the intestine is generally displaced toward the median line.

The most important aid to diagnosis is the use of the aspirator. If the needle be introduced midway between the last rib and the iliac crest, and about two and one-half inches from the spine, a mishap can scarcely occur. If the fluid removed is light yellow in color, with a specific gravity of 1.006 to 1.010, contains traces of urea or uric acid, and microscopic examination reveals the presence of epithelium from the pelvis, the diagnosis is absolutely certain.

The *prognosis* of hydro-nephrosis is determined by the rapidity of its growth, its pressure effects, and the resisting power of its sac-wall. While the tumor remains small, it may be carried about for years without detriment. When it grows rapidly and assumes great size, death results from exhaustion. Again, a small proportion of cases die from rupture of the sac and effusion of its contents into the peritoneal cavity. If the disease develops in a floating kidney the tumor may, as happened in a case reported by Billroth, fall across the ureter of the sound kidney and give rise to fatal anuria. In very rare cases the contents of the cyst are absorbed, and a spontaneous cure is effected.

The *treatment* of hydro-nephrosis is altogether surgical. A few instances have been observed in which gentle manipulation has sufficed to remove the cause of the obstruction and to relieve pelvic distention. These cases must be rare. When the sac is tense and thin-walled,

this treatment might readily prove dangerous. When the tumor is of sufficient size to become a source of risk, the surgeon has three measures at his command for the relief of the disease. The first of these is aspiration. If practised at the point of election in the ileo-costal interspace, or just in front of the last intercostal space on the left side, and a little below this on the right (Morris), there can be no danger from it. It has not been followed by a fatal result, and a single aspiration, by relieving pressure and permitting the ureter to adjust its position, has in more than one case been followed by permanent relief. As a rule, however, aspiration must be repeated often before it can be said to have been either a success or a failure. In the latter event iodine has been injected into the sac. This procedure is dangerous; and since it is doubtful whether any permanent good effects have followed it, it should be discarded.

When aspiration fails, recourse should be had to lumbar nephrotomy, and the cyst-wall should be attached to the margins of the wound by a number of deep silver-wire sutures. It is an essential of success and safety that the cyst shall be thoroughly drained. Lumbar incision, with drainage, has been practised in 25 cases, of which 21 recovered and 4, or sixteen per cent., died. In 14 of these cases the ventral incision was made, with 3 deaths, or a mortality of 21.42 per cent. In 11, lumbar nephrotomy was practised, with only 1 death, or a mortality of 9.09 per cent. Of 20 survivors, urinary fistulæ persisted in 11, or fifty-five per cent. In these cases nephrectomy is indicated as a final measure.

According to S. W. Gross, to whom the profession is greatly indebted for the best statistics on this subject, primary nephrectomy has been performed 21 times for hydro-nephrosis, including 5 cases of renal calculus. Of these 21, 13 recovered and 8, or 38.09 per cent., died. Of 17 ventral operations, 10 recovered and 7, or 41.07 per cent., succumbed, while of 4 lumbar operations only 1 ended fatally.

Pyelo-nephrosis.—Closely allied to the disease just described, both in the mechanical nature of its origin and in the physical manifestations produced, is pyelo-nephrosis, or, as it is often termed, renal abscess. In consequence of calculous pyelitis with obstruction, tuberculosis, trauma, or embolism, the pelvis or body of the kidney may become the seat of one or more abscesses. Again, what has for years continued as a hydro-nephrosis may, from injury or from the use of an aspirating needle, become converted into a pyo-nephrosis. In a very large proportion of cases pyo-nephrosis dates from pregnancy, which by compression of the ureter or renal pelvis gives rise to inflammatory changes which ultimately lead to large purulent accumulations.

The physical signs of pyo-nephrosis differ but little from those of hydro-nephrosis. The former rarely attains the size of the latter, but more frequently forms adhesions to contiguous organs and tissues, in consequence of which the purulent accumulation may be spontaneously voided. In pyo-nephrosis pyuria is very often present, and is a very valuable aid in the diagnosis of a renal tumor. The subjective symptoms differ materially from those of hydro-nephrosis, since in pyo-nephrosis constitutional manifestations, in the form of pyrexia, occasional rigors, exhaustive night-sweats, and progressive emaciation, are rarely absent.

The *prognosis* of this condition is bad unless surgical measures are resorted to. The patients die, as a rule, in from a few months to three or four years.

The *treatment* of pyo-nephrosis is necessarily operative. Aspiration has probably never effected a cure. Nephrotomy or nephrectomy must sooner or later be resorted to, and the first operation should always be practised. Incision, with drainage, has been performed in 72 cases, of which 59 recovered and 13, or 18.02 per cent., died. Of the 59 survivors, sinuses or fistulæ persisted in 19, or 32.20 per cent. It is in cases of this sort that secondary lumbar nephrectomy is indicated, the preliminary nephrotomy greatly reducing the mortality of the graver procedure. Thus, of 61 nephrectomies, without preliminary incision and drainage, 31, or 50.81 per cent., perished, whereas of 12 secondary nephrectomies only 1, or 8.33 per cent., died. "In other words, the mortality of removal of the kidney for suppurative disease is nearly twice as great as after nephrotomy, and a preliminary nephrotomy diminishes the risks of nephrectomy by more than forty per cent" (Gross). Doubtless secondary nephrectomy is often difficult of performance in consequence of the infiltration and increased density of the perirenal connective tissue. If, however, this tissue and the capsule be completely divided before enucleation is attempted, nephrectomy can be completed, even in these cases, without extraordinary difficulties.

Surgical Kidney.—There is a special form of suppuration of the pelvis and parenchyma of the kidney which results from long-continued and incomplete obstructive lesions in the lower urinary organs, and which often does not manifest itself until, after some more or less grave operation on the bladder, prostate, or urethra, the patient rapidly succumbs. The autopsy then reveals a condition of the gland resulting from obstruction to the flow of urine and infection from below. The obstruction is generally found in a tight urethral stricture, enlargement of the prostate, cystitis, or a tumor of the bladder. While it may involve only one kidney, both glands are generally diseased. Weighty authorities have objected to the term "surgical kidney" on the ground that proper and timely surgical interference would often prevent this condition. On the other hand, some of the primary causes, like malignant disease of the uterus or bladder, extreme hypertrophy of the prostate, or paralysis of the bladder, are irremediable. Again, other cases come under observation too late to be relieved by removal of the primary disease. On the whole, therefore, the term might be retained to designate the peculiar secondary condition of the kidneys about to be described.

Pathology.—The kidney is almost always increased in size; its capsule hyperæmic and adherent. When the latter is removed, the softened parenchyma of the gland is easily torn, and drops of pus often exude from the broken surface. In various parts of the surface abscesses, varying in size from a pin's head to a pea, are found. On section, these abscesses appear as elongated narrow cavities, which follow the direction of the uriniferous tubules. In the cortical substance they display less regularity. The pelvis and calyces are always distended, and their mucous lining is the seat of a muco-purulent inflammation. The pelvis and ureters often contain pus mingled with fetid urine, containing large quantities of the triple phosphates. The disease being always of an infectious nature, the abscesses and uriniferous tubules are filled with the micro-organisms which have found their way upward from the lower urinary passages. When the disease runs a less acute course the suppuration may be limited to the renal pelvis, while the parenchyma undergoes chronic inflammatory changes with hyperplasia of the interstitial connective tissue.

The *symptoms* produced by "surgical kidneys" are, unfortunately, not always clear. A dull pain and sensitiveness to pressure in the region of the kidney, and over the course of the ureters, are ominous symptoms when disease exists in the lower urinary organs. When suppuration ensues there may be severe rigors, or apparently insignificant chilly sensations, followed by irregular elevations of temperature, dry and coated tongue, loss of appetite, and constipation. The febrile attacks, which at first appear irregularly, recur with shorter and shorter intermissions until a low, continuous fever is developed, in the course of which muttering delirium and coma often appear shortly before death. Examination of the urine greatly facilitates the diagnosis. While it may be normal in quantity, it is generally scanty and turbid; its odor is often exceedingly offensive. There is a decrease in the amount of urea excreted, and the specific gravity is ordinarily diminished. The reaction is neutral or alkaline from retention in the diseased bladder. Not infrequently large quantities of ammonium carbonate and sulphide are present. The sediment is copious and consists principally of pus mixed with blood in greater or less quantity. Microscopically, numerous bacteria, molecular detritus,

epithelia from the kidney, and thick dendritic casts made up of bacteria are found (Pyelonephritis parasitica, Klebs).

The *prognosis* of this condition is necessarily bad; and when suppuration in both glands has supervened, death is inevitable.

Treatment.—Since the condition described is purely secondary, every effort should be made to prevent it. This can be done by not unnecessarily delaying the treatment of stricture, of prostatic enlargement, and of cystitis, from whatever cause this may arise. Above all things, the instruments used in the bladder and urethra must be kept absolutely clean, since, as Traube long ago demonstrated, the first manifestations of serious disease of the urinary apparatus often follow the first catheterization, and must be ascribed to the introduction of poison-germs from without. Irrigation of the bladder with mild antiseptic solutions, the administration of opiates to relieve pain, hot fomentations over kidneys and bladder, and occasional hot baths to promote the secretions of the skin are the chief measures at our command for adding to the comfort of the patient, and, possibly, to his lease of life.

TUMORS.—The kidney is not infrequently the seat of neoplasms, primary or secondary in character. Many of these, like the small cysts, the gummata, and adenomata, are of interest only to the pathologist. Tumors of larger growth possess a clinical interest that has been greatly enhanced by the remarkable advances recently made in abdominal surgery. The various tumors encountered in the kidney have already been described,[35] and it is pertinent here to consider only their differential diagnosis and treatment.

Diagnosis.—The anatomical relations of the normal kidney must guide us largely to the recognition of renal tumors. While the latter are small they can often be felt by bimanual examination in the normal position of the kidney, long before a tumor is visible. As a renal tumor increases in size it approaches the front wall of the abdomen, usually at a level with the umbilicus and several inches to one side. At the same time the tumor grows downward and forward toward the iliac crest, since less resistance to growth is offered in front than by the muscles of the loin. Palpation, however, often imparts a sense of fulness of the lumbar region, and in rare cases this region bulges slightly backward.

While the normal kidney, during a deep inspiration, descends somewhat, renal tumors are, as a rule, immovable, being unaffected by the descent of the diaphragm, and by attempts to move them on the part of the surgeon. This rule, however, has many exceptions; although the fixed position of an abdominal tumor, if other signs point in the same direction, lends a strong probability to the renal origin of the growth, it should never be taken as absolute evidence of such origin. Again, renal tumors usually present a rounded outline to the sense of touch. Externally, internally, and in front, palpation fails to reveal a sharp edge or margin to renal tumors. "The kidney," says Jenner, "is rounded on every side, and in disease never loses this peculiarity."

Changes in the urine are only of auxiliary value in the recognition of renal neoplasms in the restricted sense of the term. As has already been seen in pyo-nephrosis, hydro-nephrosis, etc., the presence of pus or blood in the urine is a valuable clinical factor. In solid growths of the kidney the urine ordinarily gives no evidence of disease until the tumor breaks down and communicates with the pelvis. On the other hand, the presence in the urine of minute particles of the neoplasm has, in rare instances, given a positive clew to the nature and seat of obscure abdominal tumors.

The most important anatomical relation of renal tumors is that to the ascending or the descending colon, as the case may be. The one or other portion of the large intestine can, as a rule, be outlined by palpation or percussion in front, or to the inner side, of the tumor. If the intestine cannot be readily found, the injection of air or of fluid, after the method of Wells and of Simon, will greatly assist the demonstration. When the tumor is quite large the intestine is carried toward the median line, or even across it. There will then be a continuous area of dulness from the inner margin of the tumor across the axillary line to the spine behind. Intestinal resonance is never elicited behind or to the outer side of a renal tumor, unless it develops in a wandering kidney.

Tumors of the kidney are to be differentiated, for the most part, from tumors of the liver, spleen, and kidney.

Neoplasms of the liver, unlike those of the kidney, rarely have any intestine in front of them. The dulness produced by them is directly continuous with that of the liver, beyond the lower border of the ribs. In cases of renal enlargement the fingers can generally be inserted beneath the ribs, and a distinct interval felt between the liver and the kidney. There are, however, exceptions to this rule. In a case of retroperitoneal cysto-sarcoma springing from near the kidney, which the writer saw some years ago, the adhesions to the inferior surface of the liver were so intimate that, even after the abdomen was opened post mortem, the tumor was believed to be of hepatic origin, until it was demonstrated to spring from the retroperitoneal space.[36] Tumors springing from the inferior surface of the liver are especially liable to be mistaken for renal growths. The presence of disturbances of the biliary apparatus will, under such circumstances, greatly facilitate the diagnosis.

Tumors of the spleen are, *par excellence*, movable. Like hepatic tumors, they, as a rule, have no intestine in front of them, and can be traced far underneath the ribs. Splenic enlargements generally retain the normal configuration of the organ, and its sharp internal border can usually be palpated through the abdominal wall when sufficiently relaxed by the recumbent posture.

Ovarian cysts have more frequently given rise to diagnostic errors than any other class of abdominal tumors, in that cysts of the kidney, when they are large, closely resemble ovarian tumors. When the case is observed early, there ought to be no difficulty in diagnosis. Both tumors begin on one side, but the ovarian grows in an upward direction, whereas the reverse is true of renal enlargements. In ovarian disease the intestines lie behind the tumor, and only when adhesions have formed is there any resonance in front of it. Again, a resonant percussion note can be elicited in the loin in ovarian tumors. Vaginal examination reveals the latter projecting into the cul-de-sac, or its attachment to the uterus or bladder.

When a floating kidney is the seat of an enlargement, it is often impossible to make a positive diagnosis. An exploratory incision is indicated if an abdominal tumor, the nature of which is not well defined, threatens life or seriously impairs health.

Treatment.—The surgical management of renal tumors is determined by their clinical manifestations and their physical states. Benign tumors that cause great distress should be removed, if large and solid, by the ventral, if cystic or small, by the lumbar, operation. In cystic diseases, suture to the abdominal wall and incision (cysto-ventrorrhaphy) should always be practised before the extirpation of the tumor is attempted. According to Gross, carcinoma of the kidney should be excluded from the category of cases for which nephrectomy should be done, and his statistics show that the same conclusion should be arrived at regarding the sarcomata of children. In the sarcomata of adults, however, nephrectomy appears eminently justifiable, since it seems to cure twenty-nine per cent. of all cases.

OPERATIONS ON THE KIDNEY.—A perusal of the foregoing pages makes it apparent that for the relief of many surgical affections of the kidney formal operative procedures are indicated. While Hippocrates did not shun the opening of a perirenal abscess and the removal of a stone therefrom, and Laurence Heister, over two hundred years ago, advised cutting into the kidney with the same purpose, it is only within the last decade that a proper subdivision of the operations on the kidney has been made. Until a few years ago nephrotomy was indiscriminately used to designate incisions into a perinephritic abscess, or the removal of a kidney. At present the term is reserved for the formal opening of a renal abscess or of a pyo-nephrosis. When in addition to exposing the kidney the

comparatively healthy renal parenchyma or pelvis is divided, with the explicit object of removing a calculus, the procedure is termed nephro-lithotomy. Finally, to designate the complete extirpation of the kidney, the term nephrectomy has been introduced into the nomenclature of surgical operations.

Nephrotomy.—An oblique incision is made, parallel to the crest of the ilium and midway between it and the last rib. Posteriorly it should begin over the outer margin of the erector spinæ muscle, and be continued forward a distance of from two to four or more inches, according to the age and size of the patient. The incision should divide the integument, the panniculus adiposus, and fascia. The outer edge of the latissimus dorsi and the inner border of the external oblique muscle will then be exposed. These, together with the underlying internal oblique and transversalis fascia, must now be divided on a grooved director, and to the full extent of the external incision. When the outer margin of the quadratus and the posterior layer of the lumbar fascia, which are thus exposed, are next divided, the perirenal fat will at once appear in the bottom of the wound. Before further steps are taken hæmorrhage should be thoroughly checked, and the floor of the wound fully exposed by the use of broad retractors. If the patient rests on the sound side, with a firm pillow placed under the lumbar region, the depth of the wound will be considerably diminished. If now the suppuration has already invaded the perirenal capsule, an incision through it in the direction of the external wound will at once give exit to the pus. When, however, this capsule is much thickened, it is safer to tear it by means of two pairs of forceps. If even then the fluctuating sac cannot be felt with the finger, the hypodermatic syringe may lend valuable service in locating the exact position of the pyo- or hydro-nephrotic fluid. The intervening renal tissue should then be divided with the knife, or in greatly reduced subjects with the thermo-cautery. To prevent possible infiltration of urine, the renal sac may then be stitched to the external wound by four or six sutures. Unless considerable mobility of the sac exists, this is probably superfluous. The operation is not completed until the interior of the sac has been thoroughly explored with the finger or sound, to determine the presence of a calculus. The insertion of a large drainage-tube and the application of an antiseptic dressing complete the operation.

Laparo-nephrotomy.—In exceptional cases of fluctuating tumors of the kidney, in which adhesions have formed anteriorly, or the size of the tumor makes the feasibility of the lumbar operation doubtful, or if the diagnosis is far from certain, the incision is to be made through the anterior abdominal wall. In this case the "cysto-ventrorrhaphy" should always precede the incision of the sac. By a number of sutures the sac-wall must be attached to the abdominal wound before the cyst is opened. Only in this manner can the general peritoneal cavity be protected against infection.

With proper antiseptic precautions, nephrotomy is an operative procedure devoid of danger. The prognosis, therefore, depends entirely on the disease for which it is performed, and upon the condition of the patient at the time of operation.

Nephro-lithotomy.—In October, 1880, Mr. Henry Morris, for the first time in the modern history of renal surgery, cut down upon a comparatively healthy kidney with the distinct idea of removing a calculus before the integrity of the gland should be irremediably damaged. This operation has now been performed twenty-three times, with only two fatal results, which, however, were not directly attributable to the operation itself.

The operation consists in exposing the kidney by an incision and dissection like those for nephrotomy. "When the kidney has been reached," to quote from Mr. Morris, "the index-finger should be passed carefully over the whole of the posterior surface of the organ, including its pelvis, and any inequality of surface or increased hardness, or resistance at any particular spot, should be searched for. If nothing suggestive of the presence of a stone is thus felt, the kidney should be freely exposed to view and a fine needle passed into the renal substance. This should be done in a systematic way, and in several places if the stone be not at once struck, introducing the needle here and there, so as to puncture in succession the several calyces of the kidney, in one or other of which experience tells us the stone usually rests."

When the stone has been detected, the overlying part of the kidney is divided with a narrow bistoury and the stone removed either with the finger or narrow-bladed forceps. Only in exceptional cases is it necessary to crush the stone before it can be removed.

In three cases (Czerny, Kosinski, Morris) in which the stone was not found, extirpation of the otherwise healthy kidney was resorted to, and with good result. This procedure of removing a healthy gland for stone will probably not be justified by the experience of the next decade. The liability of the remaining kidney to lithiasis is great, and the dangers accruing therefrom are enormous. In a case recently recorded by Mr. Clement Lucas, the right kidney was removed for nephro-lithiasis. Four months later the patient was suddenly seized with suppression of urine and vomiting. Mr. Lucas at once cut down on the left kidney and removed an impacted stone from it.[37]

A case presenting some clinical analogy to this was recently reported by F. Lange.[38] Unfortunately, a renal fistula sometimes remains in consequence of this operation. In the case of Mr. Morris it continued five years after the removal of the calculus.

Nephrectomy, first established as a classical operation by Simon, in 1869, has since been performed at least two hundred and fifty times, for the various lesions that have been considered. From the experience of this number the indications for the operation may be said to be:

1. Unilateral and uncomplicated injury to the kidney, that from hæmorrhage or suppuration threatens life; also rupture or other injury to the ureter, in consequence of which a urinary fistula remains.
2. The early stage of tuberculosis; calculous pyelitis.
3. Benign tumors at any age, and the sarcomata of adults.
4. As a secondary operation in hydro- and pyo-nephrosis after nephrotomy has failed, and floating kidney after the failure of nephrorrhaphy.
5. Nephrectomy is positively contra-indicated, according to Gross, first, in sarcoma of children; secondly, in carcinoma at any age, unless perhaps the disease can be diagnosticated at an early stage; and thirdly, in the advanced stages of tubercular disease.

There are three situations in which an incision may be made for the removal of the kidney. They are in the loin, in the median line of the abdomen, and over the linea semilunaris at the outer border of the rectus abdominis.

Lumbar Nephrectomy.—In this operation the incision is like that for nephrotomy, care being taken to keep at least one-half inch below the border of the last rib to avoid wounding the pleura. When the kidney has been exposed, it should be rapidly separated from the adjacent tissues with the finger. If it be determined to leave the capsule *in situ*, this is easily accomplished. If, however, in consequence of chronic inflammatory changes the tissues are greatly thickened, this part of the operation is difficult, and must be carefully conducted lest the peritoneum or the colon be lacerated. No forcible attempt should be made to lift the kidney out of the wound, in order to avoid injury to the thin-walled renal vein, or even to the vena cava. This untoward accident happened in no less experienced hands than those of Lücke and of Billroth. When the kidney has been enucleated, the pedicle can be tied as an entity, or the ureter and vessels may be ligated separately. The latter is always the safer method, since it permits the ureter, which often contains pus or fetid urine, to be drawn into and sutured to the wound. To accomplish the ligation of the vessels a stout carbolized silk should be used, and no instrument answers a better purpose here than the aneurism-needle. When the pedicle is large, it is advisable to encompass its structures in two separate ligatures. After the successful

performance of this step of the operation, the kidney can be removed by a few snips of the scissors, care being taken that enough of the pedicle is left to guard against slipping of the ligature. For this reason it is safer at times to leave portions of the renal tissue until after the removal of the large mass, when the pedicle can be more carefully treated, and seared if necessary with the thermo-cautery. After the wound is thoroughly cleansed a drainage-tube is inserted, and the dressing completed as after nephrotomy.

Lateral Laparo-nephrectomy (Langenbuch's operation), or the extirpation of the kidney by lateral abdominal section, is commenced by making an incision, from four to six inches in length, over the outer border of the rectus abdominis. The integument, subcutaneous fat, and tendinous layers are very carefully divided, the bleeding vessels being temporarily secured with hæmostatic forceps. When the peritoneum is opened, a part of the ascending or descending colon generally appears in the wound. This must be carefully pushed toward the median line, and held there by sterilized potter's sponges or flannel cloths wrung out of some antiseptic solution. By this procedure the outer layer of the meso-colon is exposed, within which there are fewer vessels than on the inner side. This layer must now be divided by a longitudinal incision, when the kidney will at once be exposed. At this stage of the operation the advantage of Langenbuch's operation becomes apparent. If the kidney that is to be removed, or the perirenal tissue, contain pus or other material that might engender septic inflammation in the general peritoneal cavity, the latter can be effectually shut out from the wound by suturing together, catgut being used, the internal margins of both peritoneal wounds—that of the serous layer in front of the kidney to that covering the posterior surface of the abdominal wall. The extirpation of the kidney can then be completed as in lumbar nephrectomy, drainage being effected through the post-peritoneal space. Mr. Knowsley Thornton has quite recently proposed a somewhat similar but less complicated procedure. The incision is like that of Langenbuch; after the peritoneum is reached, the posterior layer of this serous membrane, together with all that it surrounds, is lifted as far as necessary from the anterior surface of the renal tumor. In this manner of operating the vascular supply of the colon is not at all interfered with, and the ligation of the vessels of the pedicle is more readily accomplished than in the lumbar operation.

Laparo-nephrectomy resembles the operation of ovariotomy in every respect until the peritoneum is opened. Coils of intestine generally present themselves in the wound, and when they are pushed aside the posterior layer of the peritoneum is exposed to view. When this has been divided, the renal tumor must be removed and the pedicle treated as in ovariotomy. When the disease for which the operation is made renders infection of the peritoneum probable, it is advisable to puncture the soft parts of the ilio-costal interspace from within, in order to drain the wound from its most dependent part. Whether this step be deemed necessary or not, it is often advisable to close the wound in the posterior layer of the peritoneum with a number of catgut sutures. The insertion of a glass drainage-tube through the anterior wound is called for only when there is danger of oozing of blood or of severe inflammation.

Choice of Operation.—It must remain for the experience of the coming decade to determine which of the methods of removing a kidney shall be adopted in the individual cases that call for nephrectomy. In general terms it may be stated that the lumbar operation presents more favorable statistics than the ventral. Thus Gross collected 233 cases of nephrectomy, of which 104, or 44.63 per cent., died; of 111 lumbar operations, 41, or 36.93 per cent., died; of 120 ventral operations, 61, or 50.83 per cent., died. While it is apparent, therefore, that the fatality after the abdominal operation is greater by 13.90 per cent. than that of the lumbar operation, it is probable, on the other hand, that the former has been resorted to in the graver forms of disease, such as large and malignant neoplasms, or in cases in which the diagnosis was doubtful. In the hands of specialists in abdominal surgery it will probably be shown that laparo-nephrectomy is not much more fatal than the lumbar operation.

Each operation has certain well-defined advantages which give to it a legitimate range of application. Those of the lumbar operation are to be found in the facts that the peritoneum is not opened, and that the wound is remarkably adapted for drainage. It is for the former reason that peritonitis, which causes thirty-four per cent. of the deaths after the ventral operation, causes death in less than three per cent. after the lumbar. "By selecting the lumbar procedure the risks of peritonitis are reduced to a minimum; septic peritonitis is unheard of; as are also primary hæmorrhage and pulmonary embolism, which were the causes of upward of six-tenths of the deaths after the abdominal operation" (Gross). The disadvantages of the lumbar operation are in the restricted field of operation. The removal of the last rib has been recommended and practised to overcome this difficulty, but it is a procedure that can hardly be justified. Again, in large tumors that cannot be reduced by tapping, the lumbar operation is entirely impracticable. The greatest objection, however, that can be urged against the lumbar incision is that the operator can gain no insight into the condition of the opposite gland; indeed, must often remain ignorant as to the existence of a second gland. Hence deaths from uræmia are far more frequent after the lumbar than after the ventral operation. Thus, whereas after the latter only 3.27 per cent. of the deaths were ascribable to anuria, fifteen per cent. of the deaths were due to this cause after the lumbar operation.

The advantages of laparo-nephrectomy lie in the facts that the wound is sufficiently large to easily permit all necessary manipulations, and that an examination of the opposite gland can be made. The latter is a sufficiently important factor to justify so excellent an observer as Thornton in giving the abdominal operation the preference in almost all cases where nephrectomy is indicated. If the second gland cannot be found, or when present is in a diseased condition, the operation is resolved into an exploratory incision, the dangers of which are comparatively trivial. Again, as has already been indicated, tumors which from their size or solidity could not be extirpated from the loin can be removed with comparative ease through a medium abdominal incision. Thus Bruntzel recently successfully removed a fibroma of the renal capsule, weighing thirty-seven pounds, from a woman thirty-three years of age; and Roswell Park has successfully extirpated by laparo-nephrectomy a fibro-cystic kidney, weighing four pounds, from a child only twenty-three months of age.

Joseph Ransohoff.

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KINO (U. S. Ph.; Br. Ph.; *Kino de l'Inde,* Codex Med.). Several substances, from different parts of the earth and different plants, have, at one time or another, appeared under this name, as will be seen below. That which is in the market at present is the product of *Pterocarpus Marsupium* Roxb., Order *Leguminosæ,* a large, handsome Indian tree, whose wood is also valued for timber. Its leaves are alternate, exstipulate, pinnate, with from five to seven oval, emarginate leaflets, its flowers, in lax terminal panicles, are obscurely papilionaceous; stamens usually monadelphous; pod one-seeded, broadly wing-margined, indehiscent. In common with other species of *Pterocarpus,* this tree contains a bright-red, jelly-like juice, which exudes upon incisions being made in the trunk, and hardens upon drying into dark, reddish-brown, brittle tears.

East Indian (Malabar) kino has been imported since the beginning of the present century, and for medical purposes has superseded the African and other varieties which were then used. It always comes in fragments or angular pieces, generally not larger than split peas, and oftener considerably smaller; occasionally these fragments cohere together in crumbly lumps. Kino is of resinous lustre and fracture, very brittle, its pieces smooth and shining opaque, except at their edges, where they are ruby-red and transparent; general color dark, reddish-brown, sometimes almost black; odor, none; taste very astringent and sweetish. The saliva is colored bright-red when kino is chewed. It is partially soluble in cold water, wholly so in boiling water and in alcohol, not in ether.

Kino is a homogeneous uncrystallizable substance, related to the tannic acids of cinchona and krameria, and more closely to catechu. Its deep-red solution becomes violet on addition of a proto-, and dirty green with a persalt of iron. It appears to consist principally of *kino-tannic acid,* a red, transparent substance, soluble in alcohol and water, and capable of decomposing upon long standing in watery solution into insoluble *kino-red; kinoïn* and *chatechin* may be obtained from it in small quantity, and *pyrogallic* acid, by distillation and other means.

Action and Use.—Kino is an active astringent of the logwood and catechu kind, and is employed for exactly the same purposes. For subacute or chronic diarrhœa or dysentery it is equally good with other astringents, and less unpleasant than many of them. As a local application or injection, *tannic acid* is to be preferred. Kino can be given in substance, if desired—dose, one gramme (1 Gm. = gr. xv.)—or in aqueous infusion; as the latter is apt to gelatinize, it should be made freshly. The officinal tincture (*Tinctura Kino,* U. S. Ph.; strength $\frac{1}{10}$, with fifteen parts of glycerine) keeps better, and is the most generally useful form.

Allied Plants.—Kino wood is a fine colored material for carpenters and cabinet-makers. *Pt. santalinus* Linn. furnishes the Red Saunders or red sandal-wood, formerly officinal, used as a dye. *Pt. indicus* Willd., also yields an Asiatic Kino sometimes in the market. *Pt. erinaceus* Poir (*Pt. senegalensis* Hook) supplied the original African Kino, etc. For the order see Senna.

Allied Drugs.—Kino-like products are obtained also from several other genera. Butea Kino is from *Butea frondosa* Roxb.; Order, *Leguminosæ,* and from other species of *Butea.* It is in larger, and more evidently tear-like pieces than the officinal article; aside from containing a larger amount of inert mucilaginous materials, it is of similar composition. Australian Kino is obtained in the same way from several species of *Eucalyptus.* It is collected both by incisions in the bark and by splitting it out of cavities of the wood. It often comes in masses. Logwood, Dragon's-blood, Catechu, Gambir, and astringents in general, may be compared with Kino. See Nutgalls.

W. P. Bolles.

KIRSCHBERG is a small place in Bavaria which enjoys some reputation on account of the earthy mineral spring there found. The waters are used internally and externally, frequently mixed with brine from the neighboring springs of Reichenhall. When employed internally the water is often mixed with milk or whey. Kirschberg water is recommended in the treatment of nervous and debilitated conditions, in anæmia, scrofula, and female sexual diseases.

T. L. S.

KIS-CZÉG is a small town of about five hundred inhabitants, situated in the Siebenbürgen, in Hungary, where there are numerous springs furnishing a strong bitter-water. The waters of the different sources are nearly identical in composition, containing between eighteen and nineteen parts per thousand of saline constituents, the most important of which are sodium sulphate, about 13 parts; magnesium sulphate, about 3 parts, and sodium chloride, 1.4 part. The water is cold, and is employed for its purgative properties.

T. L. S.

KIS-KAN is a small place in Hungary, in which are several thermal springs, the waters of which contain principally various carbonates and chloride of sodium. There is also considerable free carbonic acid. The waters are employed in the treatment of rheumatism and various chronic intestinal troubles.

T. L. S.

KISLOVODSK is a spa in the Russian Caucasus, which has been growing in popularity in recent years. It lies at an elevation of about two thousand five hundred feet above the sea. There are numerous mineral springs, the most important of which are the Narzan and the Hassauth. The Narzan pours out an immense volume of water, very highly charged with carbonic acid, and beautifully clear and sparkling. Its principal constituents are calcium carbonate, magnesium sulphate, manganese carbonate, chlorides, and a small amount of ferrous carbonate. The Hassauth spring contains a larger amount of iron, though no exact analysis of any of the springs has yet been published. The water is diuretic and tonic in its properties. The spa is not very easy of access, and the cost of living is high. The accommodations for visitors are, however, said to be very good.

T. L. S.

KISSINGEN, one of the most important and best known of the German spas, is a town of about four thousand inhabitants, situated in the valley of the Franconian Saale, in Bavaria, about sixty miles from Frankfort-on-the-Main. It lies at an elevation of about six hundred feet above the sea, and enjoys a rather mild climate, although there is considerable rain. During the season, which extends from May to October, the number of guests at Kissingen is very large, being estimated at from twelve thousand to fifteen thousand.

There are three springs situated within the town itself, on the left bank of the Saale River, and two, the Schönbornsprudel and the Sool- or Salinensprudel, a short distance beyond the limits. Of the three springs within the town, the Rakoczy, the Pandur, and the Maxbrunnen, the former is the one most commonly used, although the latter is often taken, mixed with milk or whey, by the younger and more delicate invalids. The following table, from Eulenburg, shows the composition of these several springs. The figures represent the number of grammes of solid constituents in each litre of water.

	Rakoczy.	Pandur.	Maxbrunnen.	Soolsprudel.	Schönbornsprudel.
Sodium chloride	5.822	5.207	2.316	10.554	11.719
Calcium chloride	0.286	0.241	0.376	0.250	....
Lithium chloride	0.020	0.016	0.007	0.020	0.024
Magnesium chloride	0.303	0.211	0.108	0.330	....
Magnesium sulphate	0.588	0.597	0.200	0.904	1.472
Calcium sulphate	0 389	0.300	0.190	0.856	0.332
Calcium carbonate	1.061	1.014	0.565	1.304	1.855
Ferrous carbonate	0.031	0.027	0.002	0.030	0.019
Calcium phosphate	0.005	0.005	0.005	0.004	0.007
Sodium nitrate	0.009	0.005	0.077	....	....
Sodium bromide	0.008	0.007	trace	0.009	0.011
Silicic acid	0.012	0.004	0.003	0.001	0.013
Organic matters, etc	0.022	0.362	0.064	0.037	0.395
Total solids	8.556	7.996	3.913	14.299	15.847

The temperature of the first three springs in the above table is about 51° F., that of the last two is from 64° to 68° F.

The waters are taken before breakfast, in doses of from two to six glasses, a fifteen-minute walk being taken between each glass. Sometimes a bitter-water, also found at Kissingen, is added to the Rakoczy, or is taken alone. For bathing purposes the water of the Sool- or the Schönbornsprudel is usually strengthened by the addition of the mother-liquor remaining after the extraction of the sodium chloride at the salt-works.

Rakoczy water is not purgative unless taken in large quantity, small doses having rather the effect of diminishing the intestinal secretions. A course of treatment at Kissingen is recommended in dyspepsia, chronic intestinal and gastric catarrh, congestion and enlargement of the liver, catarrh of the gall-bladder and biliary calculus, habitual constipation with hypochondriasis, obesity and fatty heart, and chronic bronchitis. The external use of the waters is often of benefit in joint-affections of a gouty or rheumatic nature, peripheral nervous affections, and diseases of the skin.

The season lasts from the middle of April to the end of September. Excellent accommodations are afforded for visitors, and guests of all classes may find lodgings at prices proportionate to their means. *T. L. S.*

KNEE-JOINT. Whether considered from the anatomical or the surgical point of view, this is the most important joint in the body. It is at the same time the most complicated and the most difficult to understand. Its surfaces are necessarily large to support the weight of the body, and as there is not that close adaptation shown at the elbow and hip, its great strength depends upon the surrounding ligaments, fascia, and muscles, which are so effective that dislocation is rare. Its vast extent of synovial membrane predisposes it to inflammation, and its exposed situation renders it liable to injury. Its structure is more readily understood when it is regarded as an assemblage of three joints originally distinct, viz., a patello-femoral and two femoro-tibial. That this is a correct assumption is rendered probable by slight furrows upon the articular surface of the femur

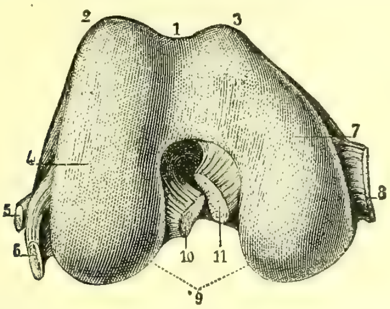

FIG. 1923.—Upper Articular Surface of the Knee-joint. (Sappey.) 1, The patellar groove; 2, outer edge; 3, inner edge, less elevated than the other; 4, outer condyle; 5, external lateral ligament, cut; 6, section of the popliteus muscle obliquely directed downward and inward, and covered by the external lateral ligament; 7, inner condyle; 8, internal lateral ligament, cut; 9, intercondylar notch; 10, section of the anterior crucial ligament inserted upon the posterior part of the inner surface of the external condyle; 11, section of the posterior crucial ligament inserted upon the anterior part of the outer surface of the internal condyle.

(not clearly shown in Fig. 1923) which separate a patellar surface from the two condyles, and the arrangement of the ligaments also amply confirms it; there being besides the capsular, investing the whole joint, certain internal ligaments which are vestiges of the original separate condition. From the middle of the joint, between the two condyles, pass downward and outward two folds of synovial membrane laid upon a thin connective tissue. These are the ligamenta alaria, and they indicate the line of separation into three cavities. Again, there are certain bands accessory to the capsule. Externally these are known as the lateral ligaments (Figs. 1927 and 1928), internally as the crucial ligaments (Figs. 1923 and 1924).

The former pass from the tuberosities of the femur to

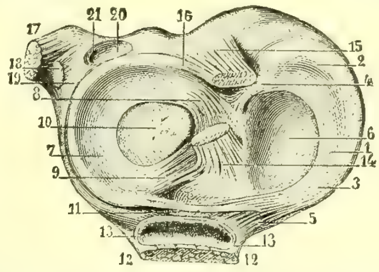

FIG. 1924.—Lower Articular Surface of the Knee-joint. (Sappey.) 1, 2, 3, internal semi-lunar fibro-cartilage; 4, its attachment to the depression behind the spine of the tibia; 5, its anterior attachment; 6, that part of the internal glenoid cavity not covered by fibro-cartilage; 7, external semi-lunar fibro-cartilage; 8, 9, its attachments; 10, part of the external glenoid cavity not covered by fibro-cartilage; 11, transverse ligament; 12, ligamentum patellæ, cut; 13, bursa subpatellaris; 14, tibial insertion of the anterior crucial ligament; 15, of the posterior crucial ligament; 16, band of fibres which unites the external semi-lunar fibro-cartilage to the posterior crucial ligament; 17, tendon of the biceps, cut; 18, external lateral ligament, cut; 19, groove for the tendon of the popliteus; 20, bursa poplitea; 21, orifice occasionally found by which the cavity of the upper tibio-fibular articulation communicates with that of the knee-joint.

the shaft of the tibia, and the head of the fibula on either side; the latter are short bands arising from the femur, on either side of the condylar notch, to insertions in front and behind the spine of the tibia. These accessory bands limit and control the motion of the joint, as do similar structures elsewhere. On complete extension, the whole system is locked by the tension of the lateral and the anterior crucial ligaments, so that no muscular force is required to hold the knee firm in the erect position, the weight of the body falling in front of the joint and fixing it. When the joint is thus fixed and muscular action suspended, a slight blow from behind will throw the whole apparatus out of equilibrium, and occasion a sudden flexion of the limb.

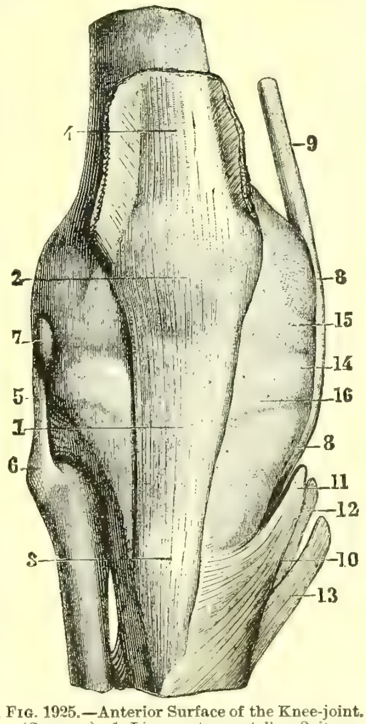

FIG. 1925.—Anterior Surface of the Knee-joint. (Sappey.) 1, Ligamentum patellæ; 2, its expansion over the patella; 3, its insertion upon the tibia; 4, tendon of the quadriceps extensor femoris; 5, external lateral ligament; 6, its insertion upon the head of the fibula; 7, tendon of the popliteus; 8, internal lateral ligament; 9, tendon of the adductor magnus; 10, fascial expansion of the internal hamstring tendons (*patte d'oie*); 11, tendon of the sartorius; 12, tendon of the gracilis; 13, tendon of the semi-tendinosus; 14, internal semi-lunar fibro-cartilage; 15, the upper synovial cavity of the joint; 16, lower synovial cavity, separated from the preceding by the fibro-cartilage.

This tripartite division of the joint corresponds to its condition in many lower animals, in which the three synovial cavities are either totally distinct, or communicate by small openings.

The irregular form of the joint surfaces is due mainly to the action of the muscles. While at the elbow the flexors, but two in number, come down and are inserted

near the plane of movement, at the knee there is a series of flexors stretching over the joint from above, and inserted partly on the outside and partly on the inside of the leg; so that, when acting separately, they tend to twist the tibia upon its longitudinal axis. It will be observed also that while a single muscle, the biceps, is inserted on the outer side, there are four muscles (sartorius, gracilis, semi-tendinosus, and semi-membranosus) (Figs. 1925 and 1926), inserted upon the inner side, the insertion running from the tuberosity of the tibia some distance down the shaft. The consequence of this would naturally be to give more range of motion to the inner condyle, and an examination of the joint-surfaces shows that they are correspondingly shaped to that end.

The inner condyle (Fig. 1923) is bent not only from before backward, but also from side to side like the half of a horseshoe, and roughly corresponds to a cone whose apex is at the insertion of the posterior crucial ligament. The outer condyle is bent only in one direction, but its surface corresponds in a similar way to a cone whose apex is somewhere within the anterior crucial ligament. There is thus seen to be a provision for a double motion of the inner condyle, a back and forth hinge action, and a rotation around the outer, while only the hinge motion has shaped the outer condyle. The peculiar action of these surfaces does not admit of their being fitted into a socket, regular and invariable in form. There are accordingly, developed around the edge of the corresponding portions of the tibial surface, two fibro-cartilages, called the external and internal semilunar (Fig. 1924). These are loosely attached, running at either end into fibrous tissue which is inserted in front and behind the tibial spine, and along their circumference being comparatively loose, merely united with the capsule. Synovial membrane covers both their upper and their lower surfaces, so that they are freely movable. They correspond in a general way to the impression made by the heads of the condyles, but their elasticity is such that, whenever the condyles move and twist, they follow their movements.

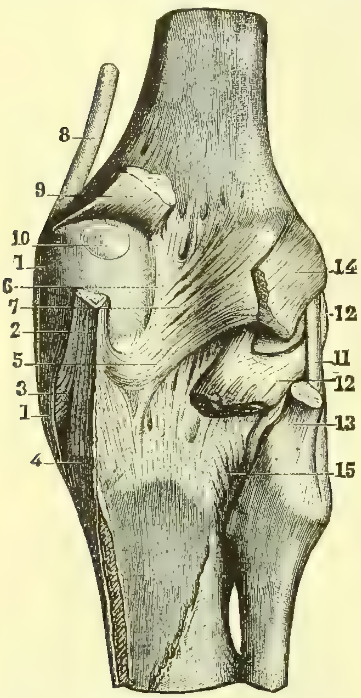

FIG. 1926.—Posterior Surface of the Knee-joint. (Sappey.) 1, 1, Internal lateral ligament; 2, tendon of the semi-membranosus; 3, its anterior or reflected portion; 4, its middle portion attached to the posterior part of the internal tuberosity of the tibia. From this middle portion two expansions extend—one reaches the lower part of the internal tuberosity, the other is continuous with the aponeurosis of the popliteus; 5, posterior portion of the tendon of the semi-membranosus. It forms a posterior ligament directed upward and outward, to be inserted upon the external condyle; 6, 7, fibres of this tendon directed vertically upward; 8, tendon of the adductor magnus; 9, tendon of the internal head of the gastrocnemius; 10, orifice often found in the fibrous capsule over the internal condyle; 11, external lateral ligament; 12, tendon of the popliteus; 13, tendon of the biceps; 14, tendon of the external head of the gastrocnemius; 15, the posterior superior tibio-fibular ligament.

The general capsule of the joint (Figs. 1925 and 1926) is very extensive, reaching above and below beyond the articular surfaces of the femur and tibia, and blending with the tendons of the surrounding muscles and their fascial insertions. It is thinnest just above the patella on either side of the tendon of the quadriceps, and here it is that effusion is most likely to show. The extent of the joint-cavity upward is here so great that the serious mistake has been made of opening a fluctuating tumor here, thereby entering the cavity and endangering the limb. The tendon of the quadriceps passes down in front to the patella (properly considered as a sesamoid bone, developed in its substance), and is continued on, beyond that bone, to the tuberosity of the tibia as the ligamentum patellæ (see Fig. 1925). The whole system answers the purpose of an anterior ligament to the joint.

Of the lateral ligaments (Figs. 1927 and 1928), the external is the shorter, and of the shape of a rounded cord, which may be felt on the outer side of the leg just above the head of the fibula; the inner is longer and flatter,

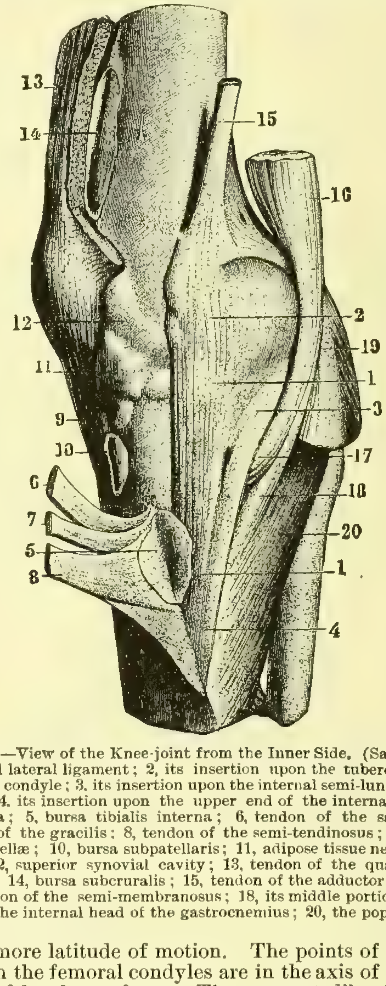

FIG. 1927.—View of the Knee-joint from the Inner Side. (Sappey.) 1, 1, Internal lateral ligament; 2, its insertion upon the tuberosity of the internal condyle; 3, its insertion upon the internal semi-lunar fibro cartilage; 4, its insertion upon the upper end of the internal surface of the tibia; 5, bursa tibialis interna; 6, tendon of the sartorius; 7, tendon of the gracilis; 8, tendon of the semi-tendinosus; 9, ligamentum patellæ; 10, bursa subpatellaris; 11, adipose tissue near its upper part; 12, superior synovial cavity; 13, tendon of the quadriceps extensor; 14, bursa subcruralis; 15, tendon of the adductor longus; 16, 17, tendon of the semi-membranosus; 18, its middle portion; 19, tendon of the internal head of the gastrocnemius; 20, the popliteus.

giving more latitude of motion. The points of their origin from the femoral condyles are in the axis of the cones described by the surfaces. They are not, like the lateral ligaments of the elbow-joint, tense in every position, but allow the twisting motion of the tibia above mentioned. A second or short external lateral ligament is also described, passing from the condyle of the femur in connection with the head of the gastrocnemius, and inserted into the styloid process of the fibula. It is not constant. Behind, the capsule is broad and sheet-like (Fig. 1926), receiving fascial expansions from the tendons of the semi-membranosus and popliteus. The band from the semi-membranosus is sometimes described as the popliteal ligament, and the whole sheet as the posterior ligament of Winslow. It is everywhere of sufficient thickness to resist the irruption of abscesses from the popliteal space into the joint, but pus has been known to burrow from

the synovial cavity outward below the popliteal ligament. This posterior sheet offers the principal obstacle in contracted knee, when associated with fibrous ankylosis. This is probably owing to the fact that it contains but little elastic tissue, and an increase of the white fibrous elements produces, as elsewhere in the body, a certain amount of contraction.

The synovial membrane is very extensive, passing beyond the articular surfaces above, and traceable therefrom downward on either side to the semi-lunar cartilages forming the ligamenta alaria before mentioned. There is here, interposed between the membrane and the ligamentum patellæ, a large pad of fat, from which there passes backward to the intercondylar notch a process of

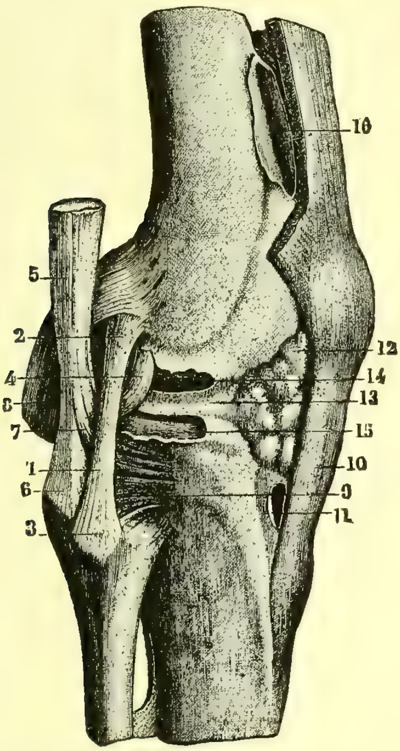

FIG. 1928.—View of the Knee-joint from the Outer Side. (Sappey.) 1, External lateral ligament; 2, its attachment to the external condyle; 3, its attachment to the external part of the head of the fibula; 4, tendon of the popliteus; 5, tendon of the biceps; 6, its attachment to the styloid process of the fibula; 7, the anterior or reflected part of this tendon, passing under the external lateral ligament, to be inserted upon the internal tuberosity of the tibia above the anterior ligament of the superior tibio-fibular articulation; 8, tendon of the external head of the gastrocnemius; 9, anterior ligament of the superior tibio-fibular articulation; 10, ligamentum patellæ; 11, bursa subpatellaris; 12, collection of fat which fills the anterior part of the inter-condylar notch. On each side it passes beyond the ligamentum patellæ; 13, external semilunar fibro-cartilage; 14, the superior synovial cavity, opened to show how it terminates upon the superior edge of the fibro-cartilage; 15, inferior synovial cavity, also opened to show its relation to the same fibro-cartilage; 16, bursa subcruralis.

connective tissue, the ligamentum mucosum (Fig. 1929). After covering the upper side of the semi-lunar cartilages the synovial membrane passes to their under surfaces, and from thence on to the upper surface of the tibia. There are several openings by which the synovial sac communicates with the neighboring bursæ. The principal one is above, where is a large orifice, nearly constant, opening into the bursa subcruralis (Figs. 1927 and 1928). Another, always found, communicates with the bursa under the tendon of the popliteus (Fig. 1924), and from this there is an occasional diverticulum connecting with the superior tibio-fibular articulation. A third communication is with the large bursa under the internal head of the gastrocnemius. Many other bursæ are found near the joint (see article on Bursæ, vol. i.), and some of them may occasionally connect, so that extreme care is always required in operations in this region, lest the opening of one of these sacs should involve the joint-cavity.

The movements of the patella are not only gliding, but slightly rolling or coaptative. The bone is adapted to the shape of the hollow between the condyles by a ridge which divides it into two unequal, lateral portions. Each of these is again divided into facets, so that, taken from above downward, the contact of the bone with the femur is but slight, especially during flexion. It is this circumstance that causes the frequent fracture of the patella by muscular action. It forms a wedge-like body, in contact with the articular surface only by a narrow edge, and the tendinous attachments are so arranged as to pull at right angles to each other directly over this edge. Any sudden jerk in this position has the same effect upon the bone as a sudden shock upon a stick over the edge of a table. It is not strange, therefore, that it is more frequently broken by muscular action than any other bone in the body.

Atmospheric pressure is not without effect on the joint. In conditions of health it holds the patella firmly down and prevents its dislocation. In cases of opening the joint, or where there is effusion, the bone becomes much more movable laterally, and may be spontaneously dislocated.

The movement of the tibia upon the femur is such that, with flexion and extension, a slight degree of rotation always takes place. This is due to the peculiar shape of the condyles above mentioned, and to the pull of the muscles. The joint cannot, therefore, be said to be a perfect hinge, there being a considerable amount of lateral motion. This is most free in the semi-flexed state, and may then amount to forty degrees. It is sometimes called pronation (which turns the toes in), and supination (turning them out), but is not produced by the same mechanism as the motions of the same name in the elbow-joint. The movements of flexion and extension do not exceed an arc of one hundred and sixty degrees.

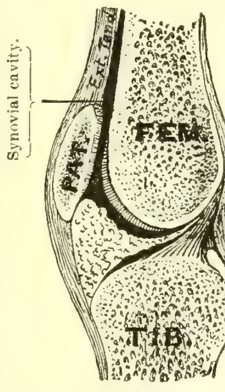

FIG. 1929.—Sagittal Section of the Knee-joint.

The joint is copiously supplied with vessels from the femoral, popliteal, and anterior tibial arteries. The nerves are from both the sacral and the lumbar plexuses, the former through the sciatic, the latter through the anterior crural and obturator. It is interesting to note that interference with these nerves at any part of their course, or centrally, is followed by pain in the knee. The phenomenon known as "hysterical knee-joint," in which there is pain accompanied by no lesion in the joint proper, is usually thus explained. *Frank Baker.*

KNOCK-KNEE. Synonyms: In-knee, Genu Valgum; Fr., *Genou en dedans, Genou cagneux;* Ger., *X-Bein, Backerbein.* A deformity characterized by a want of parallelism of the tibiæ, the internal malleoli being thrown out from the median plane when the inner surfaces of the knees are placed in apposition. One knee or two may be affected, and the deformity may exist in any degree, from a scarcely perceptible deviation from the normal, to a degree rendering the subject actually unable to walk. It may be due to a curve in the tibia or femur in the neighborhood of the articulation, or to an exaggerated disproportion in the size of the lateral segments of the joint-surfaces. The inner condyle of the femur is normally larger than the outer, in order to compensate for the obliquity of the shaft as it passes from the cotyloid cavity to the median line, and it is only when this disproportion in length of the condyles becomes excessive that deformity is produced. The angle which the axis of the femur forms with that of the tibia is normally from 170° to 178°, being

larger in males by reason of the more narrow pelvis and greater relative length of the thigh-bone.

There are two principal forms of knock-knee which differ from each other in their etiology and clinical features, as well as in the indications which they offer for treatment. The first form occurs for the most part in young children between the ages of two and five years, and is dependent upon rachitic softening of the bones entering into the formation of the joint. It never begins after the seventh or eight year, although of course many cases of genu valgum seen in the adult may be simply the unrelieved rachitic deformity of early childhood. A form has been described as occurring about the age of puberty, which some writers have supposed to be due to a bony softening analogous to rickets and which they have called rachitis of adolescence. It may be permitted to doubt the existence of such a disease, and the deformity arising at this age should be properly classed under the second head, that of static knock-knee. In rachitic knock-knee there is usually little or no actual change in the articular surfaces, the deformity being due to softening and consequent bending of the femur or tibia, or both, in the immediate neighborhood of the joint. There is an apparent lengthening of the internal condyle, but it is due to the curve in the femur by which its articular surface is made to look outward instead of downward, and so the inner condyle is lowered and seemingly lengthened. The age of the patient at the time when the deformity was first noticed, and the detection of a curve in the bones, will serve as aids in distinguishing this form from that which follows.

The second, or static form, may indeed be met with in children of any age, but is best studied in adolescents where the influence of rickets may be entirely left out of consideration. It is characterized by an asymmetry in the articular ends of the bones, their shafts being normally straight. It occurs for the most part in the constitutionally delicate, or in those who have been debilitated by disease, and who are obliged to stand many hours a day or to carry heavy weights. The ligaments of the knees, in common with the other structures, are weak and yielding, and are incapable of maintaining the joint in its normal condition. Owing to the obliquity of the femur there is a constant tendency of the weight of the body to increase the lateral angle at the knee. In health this tendency is counteracted by the crucial, and in a measure also by the internal lateral ligament, aided by the muscles whose tendons pass over the joint and act in a certain degree as stays; but once the ligaments lose their tone they yield a little, and the joint relations are modified; the external condyle and the corresponding facet of the tibia are made to receive an increased pressure, while the parts lying on the inner side of the joint are relieved of the weight of the body. The consequence of this abnormal relation is that there is a slight atrophy of the outer half and a corresponding hypertrophy of the inner half of the articular surfaces. The angle is now less obtuse, hence the lateral force is exerted at greater advantage, the ligaments yield still more, and the deformity goes on increasing. The tendency of this form of knock-knee is always to increase as long as the causal conditions are in force.

In the rachitic variety, if the ligaments are unaffected, which unfortunately is seldom the case, a spontaneous rectification of the deformity may possibly take place, similar to that more frequently observed in bow-legs. In either variety the deformity may be unilateral, or, in the rachitic form, there may be genu valgum on one side, with genu varum on the other.

Flat-foot is very frequently associated with genu valgum, usually as a result, though in certain cases it is the first of the associated deformities to appear. Pain may be slight or entirely absent, or it may be so severe as to prohibit all attempts at locomotion. When present, it is usually referred to the feet, and is due to the flattening of the arch and to the consequent disturbance of the relations of the tarsal bones; but it is sometimes experienced in the knees themselves from a sub-acute inflammation of these articulations. The mistake has even been made of directing treatment solely to the tarsal deformity, the surgeon having been misled by the subjective symptoms of the patient and thus overlooking the knock-knees concealed by the dress.

There is scarcely any deformity which is, as a rule, more easily and certainly corrected by purely mechanical means than is the rachitic form of knock-knee, provided the treatment be begun early and be faithfully persevered in.

But if the child be over five or six years of age, or if he cannot be constantly under the control of the surgeon, and if the parents are not faithful and conscientious in carrying out the directions, the attempt to cure the deformity by braces had better be abandoned, for it will be found to be simply a waste of time and trouble.

A spontaneous cure of knock-knee is the exception, even in the rachitic form, and the tendency is almost always to increase unless the weakened ligaments and muscles are supplemented by mechanical support. In the early stages of either variety simple steel uprights, such as are usually employed in bow-legs, will generally suffice. Attached to the shoe below, they pass up, one on either side of the leg, terminating above in a broad band encircling the thigh, and are provided with simple joints at the knee and ankle. A broad pad should be attached to the inner upright opposite the condyle of the femur, or straps may be passed from the outer upright around the limb, above and below the knee.

In old, neglected cases in which the deformity has become considerable, this simple procedure is usually ineffective, and more radical measures are called for. Numerous operations have been proposed and practised for the relief of these cases, nearly all of which are attended with more or less danger to life or to the integrity of the joint. The treatment of genu valgum by immediate and forcible reduction of the deformity, known as *redressement forcé*, is a procedure that is not to be recommended; it has caused death, and the after-treatment extends over nearly as long a period of time as is required for the perfectly safe and often equally effective treatment by gradual reduction. This last-named method is based upon the principle of the toleration by the tissues of a momentary exaggerated pressure which, if continued, would be fatal to their integrity. The simplest mode of application of this pressure, though not the most effectual in aggravated cases, is one proposed by Little, of London. The child being laid upon his back, an assistant holds the knees firmly in apposition, a small pad of cork or soft rubber being placed between the opposing condyles; the surgeon then grasps the ankles and endeavors to approximate the internal malleoli, using considerable force for a few seconds, and then relaxing all pressure for a time. This manœuvre may be repeated several times at short intervals, and should be practised two or three times daily. In the intervals the patient may be allowed to walk about a little, wearing the apparatus above described to support the knees.

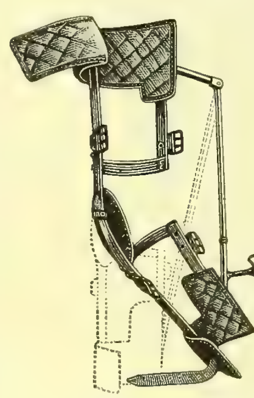
FIG. 1930.—Shaffer's Apparatus for Knock-knee.

Shaffer, of New York, has devised an instrument to accomplish the same object (Fig. 1930). It consists of an inner bar of steel, passing from a little above the malleolus nearly to the perineum, provided with a lateral hinge-joint opposite the knee, from which it is separated by a large pad. An outer bar extends from a little above the malleolus to a point one and a half inch below the knee, and another from just below the level of the perineum to a corresponding point above the knee; the lateral bars are held together by bands encircling the thigh and leg respectively. To an off-set from the outer bar of the thigh-portion is attached an extension-rod which is inserted into the lower end of the outer leg-piece. The in-

strument is attached firmly to the limb and prevented from rotating by straps above and below the knee, fastened by the buckles seen in the figure. If, now, the extension-bar is lengthened, the leg is made to approximate its fellow, the inner half of the joint being subjected to severe pressure while the outer half is relieved. This method, which is the reverse of the process by which the deformity is produced in non-rachitic cases, is somewhat tedious, requiring several months of constant attention, but is perfectly safe, and. when properly applied, is effectual in the correction of the deformity, even in adolescents and adults. The objection to the method, and it is a serious one, is that it is tedious, requiring the confinement of the patient to the bed or lounge, or at least demanding abstention from walking, for many months. Few patients can afford the time necessary for such prolonged treatment, and with so nearly perfect a means of cure as we now possess in osteotomy there is no necessity for resorting to the slower method. In certain cases, however, in which the parents will not consent to an operation, or when for any other reason it cannot be performed, either Little's or Shaffer's method should be resorted to.

There are three principal methods of reducing knock-knee by operation. The first plan, originated by Ogston, of Aberdeen, and bearing his name, consists in the separation of the internal condyle by the saw ; the leg is then straightened, and the condyle slips up beside the femur. This operation was modified by Reeves, who effected the separation of the projecting condyle by the chisel, avoiding injury to the articular cartilage. The second method consists in the removal of a wedge-shaped piece from the inner side of the femur, above the epiphysial line. This is preferable to Ogston's operation, as it does not involve the opening of the joint with its attendant dangers, but it possesses no advantages over Macewen's method, and is, theoretically at least, a less safe procedure. The third operation, and the one which experience has shown to be the safest and to give the best results, is that known as Macewen's. A small incision is made on the inner side of the thigh, just above the knee, and the femur is then divided close to the joint by a chisel. A similar section of the tibia is preferred by Billroth. (For a detailed description of these operations, and of the method of their performance, see the article on Osteotomy.) Macewen's operation is indicated in neglected cases of rachitic knock-knee, in which the misshapen bones have become eburnated and cannot any longer be straightened by mechanical means, and in cases of genu valgum staticum, in which the deformity has progressed beyond the initial stage. It is, of course, also to be practised in knock-knee resulting from a badly set fracture of the thigh or leg.

To sum up briefly the indications for treatment : Knock-knee in its early stages, whether it be rachitic or static, can be cured by mechanical supports, aided by manipulation by the surgeon or parents, after the plan of Little mentioned above. In some advanced cases of the rachitic deformity, provided that the bones are still soft and also that the intelligent co-operation of the parents can be relied upon, a cure can still be obtained by mechanical means alone. In advanced cases of static knock-knee, and also in the rachitic deformity after eburnation of the bones has taken place, no time should be wasted with braces, but osteotomy should be resorted to at once. When, however, an operation is for any reason impracticable, and the patient can afford the time and will obey the surgeon's directions, a cure can be obtained in the course of one or two years by the use of Shaffer's apparatus for the gradual reduction of the deformity.

Thomas L. Stedman.

Climate of Knoxville, Tenn.—Latitude 35° 56′, *Longitude* 83° 58′.—*Period of Observations, January* 1, 1871, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 939 *feet.*

	A			AA	B		C	D	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature.
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January....	33.5	43.7	37.2	38.1	49.5	32.1	47.4	30.5	74.0	51.0	25.5	−14.0	15	29
February...	36.6	48.5	41.4	42.1	48.5	34.8	52.8	35.1	79.0	62.0	29.0	6.0	23	19
March	40.9	55.3	47.2	47.8	54.3	40.9	60.2	39.7	83.0	70.0	32.5	6.0	24	26
April	50.7	65.7	55.8	57.4	60.5	52.7	68.5	47.9	88.0	76.0	38.0	24.0	17	21
May........	60.1	75.6	63.9	66.5	70.5	63.0	78.5	56.4	94.0	84.4	50.0	37.0	17	24
June	68.3	81.3	70.8	73.4	76.4	69.7	83.6	64.4	96.0	90.0	61.0	47.0	20	23
July........	71.7	84.2	74.1	76.6	80.1	72.3	87.9	68.1	100.0	89.2	66.5	53.0	24	27
August.....	69.1	83.3	72.1	74.8	78.3	70.4	86.0	66.3	100.0	88.0	66.0	50.0	24	21
September..	61.5	77.6	65.5	68.2	74.1	65.4	80.4	60.0	97.1	85.0	56.0	40.0	26	18
October	50.4	67.9	55.6	57.9	63.9	51.9	72.5	51.9	90.5	76.0	41.3	25.0	19	23
November..	40.4	52.9	44.6	45.9	49.2	40.0	57.6	37.9	80.5	63.0	27.0	11.5	20	18
December..	34.1	44.7	38.0	38.9	47.3	29.2	49.2	32.0	75.0	57.0	23.3	−5.0	22	24
Spring	......	......	......	57.2	60.5	54.8	......	......	......	......	......	......	......	......
Summer....	......	......	......	74.9	76.3	72.7	......	......	......	......	......	......	......	......
Autumn....	......	......	......	57.3	62.0	54.3	......	......	......	......	......	......	......	......
Winter	......	......	......	39.7	47.4	35.7	......	......	......	......	......	......	......	......
Year	......	......	......	57.3	58.8	55.1	......	......	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind, in miles, per hour.
						Inches.	From	Miles.
January...	88.0	75.4	10.2	6.1	16.3	5.89	S.W.	5.9
February..	73.0	68.6	9.5	7.3	16.8	4.90	S.W.	6.8
March.....	77.0	63.2	11.4	9.1	20.5	5.46	S.W.	7.4
April	64.0	60.7	10.6	9.8	20.4	5.88	S.W.	7.1
May.......	57.0	64.7	13.4	11.4	24.8	3.33	S.W.	5.7
June.......	49.0	72.3	14.7	8.5	23.2	4.39	S.W.	5.4
July.......	47.0	72.6	14.5	10.3	24.8	4.28	S.W.	4.7
August....	50.0	74.3	14.8	9.9	24.7	4.22	N.E.	4.3
September.	57.1	72.6	9.5	14.1	23.6	3.09	N.E.	4.4
October....	65.5	71.4	9.0	14.8	23.8	3.01	N.E.	4.5
November.	69.0	71.5	10.7	8.5	19.2	4.39	N.E.	5.4
December..	80.0	75.0	10.4	8.5	18.9	4.35	N.E.	5.8
Spring.....	88.0	62.8	35.4	30.3	65.7	14.67	S.W.	6.7
Summer...	53.0	73.1	44.0	28.7	72.7	12.89	S.W.	4.8
Autumn...	85.6	71.8	29.2	37.4	66.6	10.49	N.E.	4.8
Winter	93.0	73.0	30.1	21.9	52.0	15.14	S.W.	6.2
Year	114.0	70.2	138.7	118.3	257.0	53.19	S.W.	5.6

KNOXVILLE. The accompanying chart, representing the climate of the city of Knoxville, Tenn., is here introduced for convenience of reference. A detailed ex-

planation of this, and of the other similar charts published in this HANDBOOK, together with suggestions respecting the best method of using these charts, will be found in the article entitled Climate. *H. R.*

KNUTWYL is situated in a valley in Canton Luzerne, Switzerland, lying at an elevation of nearly 1,500 feet above the sea. It is visited because of its mineral spring, the water of which contains about $\frac{3}{10}$ part per 1,000 of saline constituents, chiefly magnesium carbonate, with a trace of iron. There is a fine *Curhaus*, and good accommodations are provided for visitors. Knutwyl is frequented chiefly by persons suffering from anæmia and debilitating affections and from gastro-intestinal troubles. The waters enjoy a good reputation also in the treatment of female sexual disorders. The water is cold and is given internally as well as used in the form of baths.

T. L. S.

KOOSSO (*Brayera*, U. S. Ph.; *Cusso*, Br. Ph.; *Flores Koso*, Ph. G.; *Cousso*, Codex Med.; *Kousso*, etc.). The inflorescence, preferably, of pistillate flowers of *Brayera anthelmintica* Kunth (*Hagenaria abyssinica* Willd.). Order, *Rosaceæ.*

This is a large and handsome, very leafy tree, with downy twigs and very silky buds and young leaves. The leaves are odd- and interruptedly pinnate, from twenty to thirty centimetres long, and consist of from five to thir-

FIG. 1931.—Koosso Plant; Flowering Branch One-third Natural Size. (Baillon.)

teen leaflets, and two very broad adnate stipules. Leaflets lanceolate, acuminate, rounded and unequal at the base, finely serrate, downy along the veins beneath, but elsewhere fairly smooth when mature. The flowers are in unisexual, lateral, freely branched, hairy panicles twenty-five or thirty centimetres (about a foot) long, with scale-like bracts at the bases of the branches and very numerous flowers. Each flower has also two rounded, membranous bracts at its base of greenish- or reddish-brown color. Flowers regular, unisexual, polygamous, or diœcious. The stammate about eight millimetres across, with two whorls of calyx-lobes, five in each, the inner broader and longer than the outer, greenish yellow; petals five, minute, alternating with the inner sepals; stamens numerous, carpels two, abortive. The pistillate flowers have a top-shaped calyx-tube terminating in a constricted neck, also with ten segments, of which the *outer* become very much larger than the *inner* as the fruit matures. Petals small, stamens rudimentary, carpels two, arising from the base of the calyx-tube.

This tree is a native of Abyssinia, where it grows abundantly wild, and is also cultivated about villages and road-sides for ornament. Its medical use was also introduced about 1850, from that country, where every third person is said to have tapeworm, and where it has been used for a century or more. The detailed description of the flowers and panicles given above covers most of its description as a drug. The whole inflorescence is taken

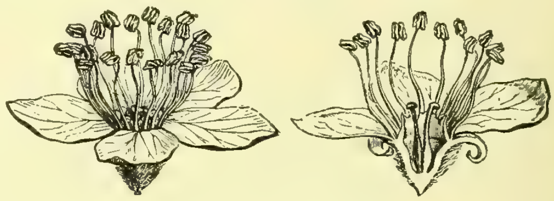

FIG. 1932.—Koosso; Staminate Flowers Enlarged. (Baillon.)

at about the time of flowering and simply dried and packed. Sometimes it comes in bales or large cakes, but more generally it is tied in rolls somewhat smaller than the arm and about as long. The pistillate panicles are generally collected and preferred; they are easily distinguished by their large epicalices and their reddish-brown color, and known as "red Koosso." The odor is slight, fragrant, and tea-like; taste bitter and disagreeable.

COMPOSITION. — By distillation with water Koosso yields a small amount of *essential oil*, to which its fragrance is owing. It also contains nearly one-fourth its weight of *tannic acid* and considerable *wax, resin*, and other common vegetable products. Its peculiar active principle, however, is a yellow crystalline substance, *kosin* (of Merck). It is tasteless, insoluble in water, nearly so in alcohol, readily soluble in chloroform and ether, as well as in alkalies, from which latter it may be precipitated by acids. Kosin is permanent in the air, and is unquestionably the principal tænicide agent of Koosso.

USE.—Koosso has long been a popular anthelmintic in its native land, and since its introduction here has ranked among the best with us. Its action appears to be directly toxic to the worm, and, until the introduction of pelletierine from pomegranate bark, was not only the most sure to bring the bulk of it away dead, but the most certain also to disengage and remove the "head." In order to obtain the best result from this, as well as from

FIG. 1933.—Koosso; Pistillate Flower and Section Slightly Enlarged. (Baillon.)

any other anthelmintic, the intestinal canal should be well emptied of its contents by a moderate laxative—say twenty-four hours before administering the Koosso—then, for at least twelve hours previously, no food whatever, excepting a glass or two of milk, should be taken. The Koosso may then be given, when the patient should be kept quiet for one or two hours after, in order to overcome the nausea or vomiting that may result. Two or three hours after the tænicide has been taken milk or beef-tea may be allowed, and five or six hours later a solid meal. If the drug be given in substance or infusion it usually acts as its own cathartic, but if it fails to do so in six or eight hours, a saline should

be given. Koosso is especially to be recommended for the different varieties of tapeworm; for the round and seat worms there are better medicines. The dejections should be carefully examined for the body of the parasite; from two to five, or more, metres of its larger joints are always found; they mean nothing as to cure, since any brisk cathartic might bring them away, and unless its attachment or "head" is killed, it will certainly grow again. If this is found, the cure is effected, excepting in those cases, exceedingly rare in this country, where two contemporaries exist in the same bowel. As a general rule, if ten or twenty centimetres of the long, thread-like "neck," not more than a millimetre in diameter and without distinct joints, are seen, the "head" is destroyed and has probably escaped observation; such cases are generally cured. But it is not safe unless the "head" has been actually seen to make a positive assurance to that effect until eight or ten weeks have elapsed without any segments appearing in the fæces.

ADMINISTRATION.—A common and efficient method is to give an infusion (*Infusum Brayeræ*, U. S. Ph., strength $\frac{6}{100}$) made without straining from the powdered drug, the patient being expected to stir up and swallow the dregs with the tea; a tumblerful of this may be taken and repeated in an hour. The fluid extract (*Extractum Koosso Fluidum*) is another and less disagreeable preparation, but more infrequently used; dose from fifteen to thirty cubic centimetres (15 to 30 c.c. = ℥ ss. ad ℥ j.). Kosin may be given in doses of from one to two grammes with the same preparatory treatment.

ALLIED PLANTS.—Brayera stands by itself quite distinct in habit and appearance from its near botanical affinities; for the order see ROSES.

ALLIED DRUGS.—The anthelmintics in general, of which Pomegranate, Male-fern, Pumpkin-seed, and Turpentine, are the most efficient tænicides.

W. P. Bolles.

KORYTNICA is a health-resort, situated in a romantic valley in the Carpathian Mountains in Hungary, a short distance from the railroad station of Rosenberg. The elevation is variously given at from 2,380 to 2,540 feet above the sea. The atmospheric temperature is low, and there are rather pronounced changes between the day and night. There is also considerable humidity. There are five medicinal springs, three only of which are much used. The following is the composition of these three expressed in grammes per litre:

	Albrecht-quelle.	Sophien-quelle.	Franz-Josef-quelle.
Sodium chloride	0.006	0.005	0.005
Sodium sulphate	0.057	0.025	0.039
Calcium sulphate	1.063	1.082	1.126
Magnesium sulphate	0.873	0.783	0.770
Calcium carbonate	0.862	0.805	0.891
Ferrous carbonate	0.064	0.061	0.071
Siliceous earth	0.028	0.057	0.049
Total solids	2.953	2.818	2.951
Carbonic acid	1.749 cc.	1.750 cc.	1.608 cc.

The waters are used both internally and in baths, and accessory methods of treatment, pine-needle baths, goat's milk cure, etc., are employed. The bathing facilities are good, and the expense of living is moderate. Korytnica is frequented by from 900 to 1,000 guests each season, and is visited chiefly by sufferers from debility, chlorosis, scrofula, diseases of the digestive organs, catarrhal cystitis, and female sexual disorders. *T. L. S.*

KRANKENHEIL is a spa situated a short distance from Tölz, in Bavaria, at an elevation of about 2,000 feet above the sea. The air is fresh, pure, and invigorating, but rather cool and moist. There are three mineral springs, the waters of which are used for bathing, and are also taken internally. Both for drinking and bathing purposes, they are often strengthened by the addition of a brine. Besides immersion, the waters are applied externally in the form of spray and in compresses. The baths are usually taken at a high temperature. Krankenheil is recommended to sufferers from scrofulous affections, diseases of the skin, tertiary syphilis, and uterine disorders. The water is largely exported. The following is the analysis of the springs, computed in parts per 1,000:

	Bernhards-quelle.	Johann-Georgen-quelle.	Anna-quelle.
Sodium chloride	0.234	0.298	0.031
Sodium bicarbonate	0.323	0.334	0.194
Magnesium bicarbonate	0.029	0.029	0.239
Calcium bicarbonate	0.091	0.101	0.249
Ferrous bicarbonate / Manganous bicarbonate	traces	traces	.....
Sodium sulphate	0.012	0.605	0.293
Potassium sulphate	0.012	0.009	0.021
Sodium iodide	0.0015	0.0015	0.0011
Total solids	0.7025	0.7775	1.0281

T. L. S.

KREUTH is a well-known and popular health-resort in the Bavarian Alps, lying at an elevation of 2,900 feet above the sea. It is very pleasantly situated, and the air is fresh and pure. There is a cold sulphur spring at Kreuth, called "Zum heiligen Kreuz," the water of which contains 1.06 Gm. of calcium sulphate, 1.38 of magnesium sulphate, 0.91 of calcium carbonate, and 6.6 c.c. of sulphuretted hydrogen in each litre. For bathing purposes the water is strengthened by brine brought from Rosenheim. Much use is made, also, of pine-needle baths, whey, and vegetable bitters. The spa is frequented by persons suffering from bronchial affections, from scrofula, congestive troubles of the abdominal organs, and nervous irritability. The accommodations for visitors are good, and the prices are reasonable.

T. L. S.

KREUZNACH is a town in Prussia, about forty miles southeast of Coblentz, lying in the valley of the Nahe, one of the tributaries of the Rhine. It is very pleasantly situated, and enjoys a mild and equable, though rather damp, climate. Its elevation is only 330 feet above the sea. There are four springs, only one of which, the Elisenquelle, is used for drinking. For bathing purposes the waters of the other springs are used, and their strength is increased by the addition of the strong brine. The following is the analysis of the two chief springs, the amounts being computed in grammes per litre:

	Elisenquelle.	Oranienquelle.
Sodium chloride	9.49	14.15
Calcium chloride	1.72	2.96
Potassium chloride	0.12	0.05
Magnesium chloride	0.03	....
Lithium chloride	0.0098	....
Magnesium bromide	0.0399	0.231
Magnesium iodide	0.00039	0.0014
Calcium carbonate	......	0.03
Barytum carbonate	0.038	....
Magnesium carbonate	0.175	0.01
Ferrous carbonate	0.025	0.045
Silicic acid	0.04	0.012
Total solids	11.68809	17.4894

Kreuznach is much frequented by sufferers from scrofula in all its manifestations, from chronic joint disease, affections of the skin, suppurative diseases of the ear, and uterine affections. Inhalations of spray are often employed in addition to the baths and the internal use of the waters. The accommodations for visitors are excellent, and the number of guests during the season is very large. *T. L. S.*

KYPHOSIS. Synonyms: Excurvation of the Spine; Fr., *Cyphose, Dos voûté;* Ger., *Buckel, Rückwölbung der Wirbelsäule.* A deformity characterized by a posterior curvature of a portion or the whole of the vertebral column. In this article will be considered only the functional or non-inflammatory forms of posterior curvature, kyphosis symptomatic of spinal caries being treated of in the article on that subject. There are five varieties of this deformity: 1, Infantile, or rachitic; 2, adolescent; 3, professional; 4, paralytic; and 5, senile.

In infants the curvature occurs, as a rule, as one of a number of the symptoms of rickets, and is due to the relaxation

of the muscles and ligaments and to the softening and irregular ossification of the bones of the spine incident to this disease. In very young infants the entire spine is curved, the point of greatest yielding being from the tenth dorsal to the first lumbar vertebra. When occurring in older children, after the normal curves of the spine have been formed, the deformity usually manifests itself as an exaggeration of these physiological curvatures. Rachitic kyphosis is, however, a rare condition after the third year. The curve is most marked when the child sits or stands, and is greatly diminished by recumbency. The diagnosis of this form is facilitated by the existence of rachitic changes in the cranium and other parts of the skeleton. The prognosis is favorable, the deformity yielding readily to treatment; and, like many of the other deformities of rickets, often undergoing spontaneous correction as the general disease subsides, even when its therapeutical management is neglected. But the local treatment of the distorted spine should never be slighted because of the chance of a self-correction, for this does not always take place, and we are unable to foresee in any particular case what the termination will be. Children with rachitic curvature of the spine should maintain the recumbent position for a considerable portion of the twenty-four hours, and should never be allowed to sit up or move about without some support to the weakened back. The support should be made as light as possible, yet strong enough to prevent the spine from bending. The simplest form consists in two light steel uprights, passing up one on either side of the vertebral column, attached below to a pelvic band, and terminating above in two buckles, to which padded straps passing over the shoulders and under the axillæ are fastened. The general rachitic condition, of which the deformity under consideration is but a symptom, is to be treated by the appropriate remedies.

The adolescent form of spinal excurvation occurs in boys and girls, and is the condition generally known as round shoulders. The subjects of this deformity are usually not very robust, are of a rather indolent disposition, not fond of out-door sports, but devoted rather to books and sedentary amusements. The deformity is due to a relaxed condition of the spinal muscles and ligaments. While the patient sits the entire spine is curved, but as he rises to his feet the necessity of maintaining an equilibrium causes a lordosis of the lumbar spine, so that the deformity becomes merely an exaggeration of the normal curves. The spine is perfectly flexible, at least in the early stages, and the patients themselves are able to stand erect, but the effort to do so is irksome and is seldom persisted in. The scapulæ do not lie flat against the ribs, but their lower angles project away from the thoracic wall (scapulæ alatæ). These patients are also quite commonly flat-chested. The exciting cause of round shoulders is often to be found in the school-room, where the child sits stooping over a low desk, or stands to recite with the arms folded on the chest. Sitting for several hours on a piano-stool with no rest for the back is often a cause of round shoulders in children whose muscles and ligaments are weak and without tone. Near-sightedness is another occasional cause of this deformity. Girls are more often affected than boys, by reason of the more sedentary lives which they are generally compelled to lead.

A cure of adolescent kyphosis, when of slight degree, may be obtained by exercises alone, without mechanical support, but it will nevertheless be found advantageous to aid the patient in maintaining an erect posture by suitable apparatus. The brace should be made of tempered steel, so that, while the back is held straight, active voluntary flexion of the spine is not materially interfered with. It is formed of two elastic uprights, made straight above but curved anteriorly below, to fit into the hollow of the lumbar region, and attached to a pelvic band. The band is fastened securely about the pelvis by means of an anterior strap and buckles, and then the uprights are held against the back by means of straps passing from their free extremities around each shoulder to buckles attached to the brace at a point corresponding to the lower angle of the scapula. By this means a constant elastic force is exerted to hold the back straight in whatever position, whether of sitting or standing, the patient may be. The treatment by exercises is very useful in this form of kyphosis, and, indeed, should never be omitted, since the fault lies chiefly in a want of tonicity in the muscular and ligamentous tissues. It is unnecessary to describe any of these in detail, as a number of them will readily suggest themselves to the surgeon if he consider the muscles which are relaxed. Some of the Indian-club exercises are well adapted to fulfil the indications. Walking, for an hour or so a day, with a light weight on the head, is often beneficial. A life in the open air is to be recommended, and in some cases it will be necessary to remove the child from school for a year.

The next two varieties require but a few words. Professional kyphosis occurs in engravers, watch-makers, copyists, and all those whose occupation compels them to sit stooping over their work for many hours consecutively every day. Here, as in the previously described condition, there is usually a reduced general condition of health, due in great measure to the confinement within doors. The therapeutical measures should be directed to improving the health and developing the dorsal muscles. The patients can seldom be induced to wear any apparatus, as it interferes, more or less, with their work by preventing them from stooping. The paralytic form is rarely met with. When the paralysis exists on but one side, the resulting deformity is a scoliosis; when on both sides, a kyphosis. The spine should be supported by the elastic uprights described above. The affected muscles are to be treated locally by electricity, massage, and similar measures.

Senile kyphosis occurs often as a sequela of a disregarded or neglected professional stoop. The position having been maintained for a great length of time, there occur changes in the bones and ligaments which render any correction of the deformity impossible. The intervertebral cartilages become thinned anteriorly, and finally disappear, and similar atrophic changes take place in the bodies of the vertebræ, whereby they become wedge-shaped; sometimes there may even be anchylosis between several of the vertebral bodies. The curve may also be produced in the aged from senile weakening of the muscles and ligaments, together with a softening of the bones. Still another and much more serious form is met with, which is due to chronic rheumatic arthritis of the spine (arthritis deformans). The resulting deformity in this case is often extreme; the entire spine is curved, and the trunk is, in consequence, thrown so far forward that an equilibrium can be maintained only with the aid of a cane. There is frequently anchylosis of a large portion of the spine from ossification of the anterior ligament. Sometimes osseous new growths arise from the bodies or articular processes of the vertebræ; in the latter case the foramina for exit of the spinal nerves may be so encroached upon as to give rise to very severe peripheral neuralgias, and there may also be paralysis from the same cause. Free expansion of the lungs is prevented by reason of the dorsal curve, and the interference with respiration may even be so great as to seriously threaten life. But little can be accomplished in the way of treatment. When the deformity is seen to be constantly increasing, an attempt should be made to arrest its further progress by the application of a firm support. This may be constructed of annealed steel, similar to, though of course much heavier than, that described above as applicable to rachitic curvatures of the spine. A plaster-of-Paris jacket answers the purpose admirably in some cases; but it should be remembered that the vitality of the skin, as well as of the other tissues, is greatly reduced in the aged, and constant care is necessary to prevent excoriations forming on those parts subjected to pressure from the corset. In arthritis deformans a trial should be made of colchicum, iodide of potassium, and the like. When this disease involves the cervical vertebræ, compresses, wet with a solution of carbolic acid and applied to the neck every evening, as recommended by Hueter, may be of service.

It is of the utmost importance, in regard to both prognosis and treatment, to differentiate these various forms of kyphosis from that symptomatic of vertebral caries, Pott's disease of the spine. In the above-described conditions, with the exception of the senile form, there is always some motion between the different vertebral segments—even if extension is restricted, an increase of flexion is possible—but in Pott's disease the affected portion of the spine is absolutely rigid. The character of the deformity is usually different. In the forms of kyphosis under consideration there is a general rounded excurvation of a large portion or the whole of the spine, while in that due to caries there is usually an angular prominence of a limited part, though a round, even excurvation, involving a large extent, is by no means uncommon. In rachitic kyphosis evidences of the disease are discoverable in other portions of the skeleton; but it should not be forgotten that spinal caries may occur in apparently rickety subjects. Peripheral pains, paralysis, exaggerated patellar tendon-reflex, contraction of the psoas and iliacus internus muscles, cold abscess—one or all, when present, are signs confirmatory of vertebral caries. For a fuller presentation of the differential symptoms, the reader is referred to the article on Pott's Disease.

Thomas L. Stedman.

LABASSÈRE is a small village in the Pyrenees, lying in a picturesque valley, at an elevation of nearly 1,700 feet above the sea. There is a spring here of a strongly alkaline sulphur water, which is seldom drank on the spot, but is carried to the neighboring spa of Bagnères de Bigorre. The following is the composition of the water, estimated in grammes per litre, according to the analysis of M. Poggiale:

Sodium sulphide	0.0400
Iron, copper, and manganese sulphides	trace
Sodium carbonate	0.0233
Sodium, potassium, and calcium sulphates	trace
Sodium chloride	0.2124
Potassium chloride	0.0019
Calcium silicate	0.0477
Aluminium silicate	0.0004
Magnesium silicate	0.0080
Iodine	trace
Organic matters	0.1630
Total solids	0.4967

The water is clear and colorless, and has a strong sulphurous odor. It is largely exported, and does not become deteriorated in the process of bottling and transportation.

It is used in the treatment of plethora, and is of value for individuals of an irritable, nervous disposition with a tendency to abdominal congestion. *T. L. S.*

LABOR, MANAGEMENT OF. I. NORMAL CASES.—The management of labor comprises two elements: First, the careful observation of every successive stage of the process of parturition, which presupposes a familiarity with the mechanism by which nature, left to herself, effects delivery; and secondly, the application of artificial assistance at the proper time, either to accomplish results for which nature alone is insufficient or to obviate the disastrous effects of intercurrent accidents. In the cases first to be considered—those in which nature is adequate to every step in the process—the former element in the management will predominate, and the attitude of the practitioner is chiefly one of expectancy; an expectancy which, however, should always be armed with a definite knowledge of nature's methods (see Labor, Mechanism of); while, as we pass on through the possible abnormalities and complications of the parturient process, the second or active element enters largely into the management.

The average mortality of labor, as met with in general practice, is stated by Dr. Matthews Duncan at one in one hundred and twenty. That is, one in one hundred and twenty women delivered at term dies within a month of childbirth. Under good obstetric management, however, women in comfortable circumstances in life should, it is believed, show a lower percentage of mortality than that.

To begin with a simple case. The mother is of sufficient age to have reached her full sexual development, and not so old as to have the parts involved in parturition in too rigid and unyielding a state; she has the pelvis and the genital passages of sufficient capacity, and has good muscular strength. The child presents by the vertex—*i.e.*, this portion of the body lies toward the os uteri, and will be the first to impinge upon the examining finger. The presentation of the vertex necessitates that the head shall be well flexed upon the chest. The occiput is directed toward the left acetabulum (first position, O. L. A.). Though in the management of a simple case of this kind the practitioner will need little in the way of apparatus, yet, for the reason that he never can tell in advance what will be the character of a given labor, he should always go prepared with the following articles: An English red gum-elastic catheter, of size 6 to 8; needles with a long curve, and needle-holder; either silk, carbolized catgut, or silver wire for sutures; a Davidson syringe with long nozzle, for uterine injections; a hypodermic syringe with Magendie's solution, and a solution of ergotine or of an extract of ergot suitable for subcutaneous injection; a pair of obstetric forceps; a stethoscope; a small bottle, each, of fl. ex. of ergot, the perchloride of iron, tincture of opium, and of a solution of chloral; carbolic acid or a solution of mercuric bichloride; chloroform or sulphuric ether. At the house of the patient, ice, hot water, brandy, scissors, and tape should be provided.

Labor is usually divided into three stages, the first extending from the beginning of the process till the os uteri is fully dilated; the second, or expulsive stage, from the completion of the first stage to the birth of the fœtus; and the third, from the birth of the child to the expulsion of the secundines. The relative and absolute length of these stages vary much with the age of the woman, the number of the labor, and individual idiosyncrasy. But in general it may be said that the three stages average respectively, in primiparæ, ten to twelve hours, two to three hours, and twenty minutes; and in multiparæ, six to eight hours, one to two hours, and fifteen minutes. Elderly primiparæ have longer labors than younger ones. The possible range is so great in different cases, and variations in the rate of progress are so liable to occur at any moment, that it is always unwise in the practitioner to attempt anything like a prophecy as to when the labor will be completed.

On reaching the patient, the attendant should see that the bed is properly arranged. It should be, if possible, in a light and airy room, not immediately adjacent to a water-closet. The bed should be accessible from both sides. The mattress should be protected by a rubber sheet placed under the lower sheet; above the latter should be a draw-sheet folded to several thicknesses and about two feet in width. The attendant should carefully wash his hands, using a nail-brush, before making any examination of the patient. It is well to further disinfect the hands by a solution of carbolic acid (1 to 50) or bichloride of mercury (1 to 1,000). During the first stage of labor the patient need not be undressed, but should wear a wrapper that can be easily removed. When she takes to bed, at the beginning of the expulsive stage, or before the escape of the waters, the night-dress should be gathered up above the waist, in order to preserve it from the discharges, and a sheet folded in the middle and secured by a piece of tape or bandage tied about the waist. This can readily be removed with the blood and discharges after the labor. As soon as possible after arriving, the attendant should make an examination, at first of the abdomen (the patient lying upon her back), both by inspection and palpation, and then digitally *per vaginam* (see Diagnosis of Position, under Mechanism of Labor).

If he arrive soon after the onset of pains, he will find that the os externum is just beginning to dilate, but will not as yet admit the finger. The inner os is also beginning to yield, or the canal of the cervix may already have been taken up into the uterine cavity, through the unperceived uterine contractions of the few days preceding the

onset of "pains," which clinically marks the beginning of labor.

If a diagnosis of normal presentation can be made out at the first examination, and if the pains are effective, the accoucheur has evidence that all is beginning well, and may postpone further examination. If the bowels or bladder have not been emptied for some time, this may now be done, by the use of cold-water injections in the one case, and by the catheter, if necessary, in the other. This should always be done if the pains of the first stage are troublesome, but do not appear to accomplish much toward the dilatation of the os. The pains, if "true" ones, are sharp, cutting in character, recur periodically, with gradually increasing frequency, and under them the inner os yields and the outer gets thinner and gradually opens, till the projecting membranes are felt swelling down upon the examining finger at each recurring pain. The examination should generally be begun in the intervals between the pains, but it is usually desirable to continue it during the pains.

A copious glairy secretion, having a lubricating function, has gradually been pouring out into the vagina and vulva. The dilatation of the os is effected most easily and naturally by the bag of waters in front of the child's head, which acts as an elastic wedge. Hence, as a rule, this bag should not be broken artificially until its mission, the dilatation of the os, be complete. When, however, there is an excessive amount of the amniotic fluid, so that the uterus is overdistended and its contractile power therefore weakened, it is necessary to rupture the membranes artificially, which may be readily done with the point of a straightened hair-pin, carried into the vagina along the index-finger, or between it and the middle one, and held against the bulging membranes during a pain. As a rule, the membranes give way before the beginning of the second stage, and under the force of the pain which has ruptured them the head is driven down till it impinges against the cervix on all sides, and acts as a ball-valve to prevent the escape both of the umbilical cord and of the bulk of the amniotic fluid, which dribbles away during the greater part of the expulsive stage. We may add here, by anticipation, that during the second stage the fœtus is born through the aperture made in the ruptured membranes, which aperture can be readily seen in the secundines later. But when the membranes are especially tough, the point of rupture is sometimes not situated at the most dependent part of the envelopes, and the head of the child is born still covered by the membranes, under which circumstances the child is said to be born "with a caul," a condition held by old women to betoken good luck. The posture of the woman during the first stage of labor should be either sitting or standing, as the presenting part thus most readily accomplishes the dilatation.

The young practitioner sometimes feels considerable uncertainty in regard to whether he should remain by his patient or leave her during the first stage. It is not customary for the accoucheur to remain in continuous attendance throughout the whole labor, unless specially requested to do so and paid accordingly. But after watching the rate of progress for a time, having satisfied himself that the position is normal, that the woman, if a multipara, has not habitually had precipitate labors, he may go away for a time, always taking the precaution to leave word where he may be found if wanted, and at what hour he will return. It should be needless to add that this appointment to return should be kept with unfailing accuracy. This matter of leaving the patient is one of some importance, for, on the one hand, a man may

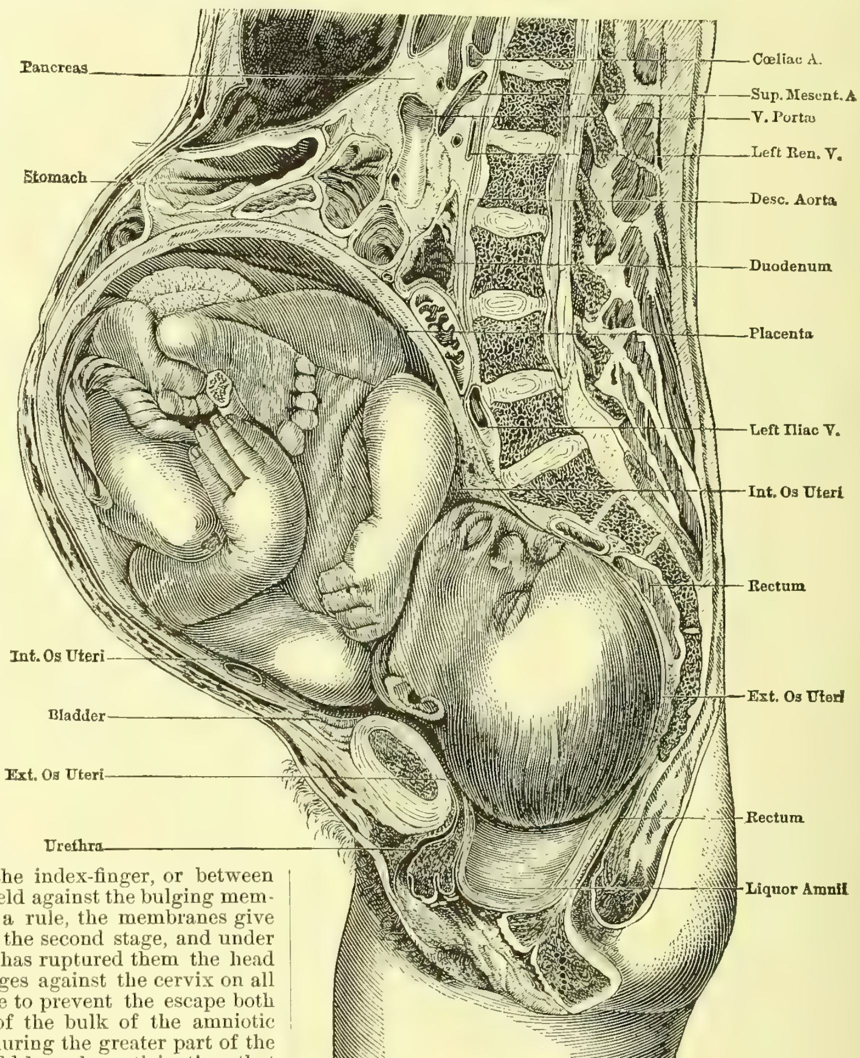

FIG. 1934.—Section of a Frozen Body at the Termination of the First Stage of Labor. The bag of membranes is still unbroken, the cervix is fully dilated, and the head (in the second position) is in the pelvic cavity. (From Playfair, after Braune.)

convey the impression, especially to women who have had many children, of inexperience if he "sits around" through a normal first stage of eight hours; besides that, he wastes valuable time, and may even add to the nervousness of his patient; while, in avoiding this mistake, he may fall into the opposite one, of leaving his patient so long that the child is born in his absence. The latter evil is, of course, much the worse of the two.

During the second stage the accoucheur should not, as

a rule, leave his patient. When the dilatation is complete, so that uterus, cervix, and vagina form one continuous canal, the patient should go to bed. Whether she lie upon the back or upon the left side is a matter of not much importance. It may generally be left to the convenience of the woman and the custom of the obstetrician; practically, most women will turn back and forth during their labor.

Toward the close of the second stage the left lateral decubitus is preferable, as it permits better watch and care of the perineum than a dorsal posture.

The thighs should be flexed and the body bent forward in a semi-prone posture. As the propulsive stage begins, the character of the pains changes from sharp and cutting to dull and grinding, and with this change the cries of the woman, from being sharp and querulous, become prolonged, deep, and grunting in quality, corresponding with a holding of the breath, a fixation of the diaphragm, and a contraction of the abdominal muscles.

Digital examinations should be made more frequently in the second stage than in the first. The descent and rotation of the head should be carefully observed, to see if they are going on according to the natural method. (See Mechanism of Labor.) A too rapid progress of the child is undesirable, from the danger of uterine relaxation and post-partum hæmorrhage. On the other hand, a retention of the head too long in contact with the soft maternal structures may cause the latter to slough. In general, so long as progress can be discovered, no interference is called for. Additional assistance may be given by manual pressure over the fundus, which incites uterine contraction. The woman should be exhorted and assisted to aid herself by "bearing down," taking hold either of the hand of the attendant or some support, like a jack-towel attached to the foot of the bed, by which she can steady herself.

Of course, this bearing down should be limited to the time of a pain. Moral encouragement is important at this time, as the woman often becomes fatigued and dispirited. The assurance of the desirability and effectiveness of vigorous pains is usually productive of much comfort. A change of position from back to side, or *vice versa*, will sometimes enhance feeble pains. If the belly is lax and the womb falls forward, it should be swathed back. Finally, these means failing, and no progress having been made for an hour or more, the use of the forceps will generally be called for. Care should be taken, during this stage, that the bladder does not become overdistended; if micturition have not occurred freely during the first stage, percussion over the pubes should not be neglected, as the obtunding of the sensibilities may prevent the woman from perceiving the ordinary calls of the bladder till a large vesical tumor is formed, productive of pain, suspending the uterine contractions, and even causing danger of rupture of the bladder. If the catheter is required, the short female instrument should not be used. Instances have occurred where an attempt to employ it has led, by a sudden writhe of the patient, to the disappearance of the instrument into the bladder. The elongation of the urethra by the drawing up of the bladder necessitates the use of a longer instrument. The silver male catheter conforms pretty well to the curve of the urethra, but still better is the English male gum-elastic instrument. It should be introduced only in the intervals of the pains, and if the intercurrence of a pain stops the flow, the catheter should be kept in place till the pain is again over. As a rule, it is best to employ actual inspection in introducing the catheter, as the meatus is somewhat displaced and swollen, rather than run the risk of bruising the parts by working in the dark.

The Use of Anæsthetics.—The question of using anæsthetics to assuage the pain of a normal labor is one on which great differences of opinion and of usage prevail among the profession. A few authorities of eminence, notably Professor Barker, favor the habitual use of anæsthetics simply as a relief to the pains of labor. They hold that it is the part of humanity to afford this mitigation, as a rule, to every parturient woman, and report none but the most agreeable and favorable results to have followed their practice. Another class, while not making the employment of anæsthetics their routine practice, do not hesitate to use them whenever the patients call for such relief, considering, however, that this course slightly increases the length of the labor and may suspend the activity of the pains—a risk which they are willing to assume if the patient demands the relief. Others, still more conservative, accede to the call for an anæsthetic only when the pains are very severe and exhausting—in other words, refuse it in normal labors. These persons hold that any flagging in the force of the pains, whether accompanied by exhaustion or not, is a contra-indication to the use of ether. Finally, a fourth class are so impressed with the perils of uterine inertia and post-partum hæmorrhage as the result of anæsthetics in labor that they refuse them, except in the case of operative interference, and prefer even then, if it be possible, to dispense with their use.

The most tenable position on this ground is the following: Ether administered to the degree of full surgical anæsthesia checks, and may suspend, uterine action. Given to a degree that affords any relief to the patient's suffering, it may, and sometimes does, check the force and frequency of the pains. There is reason for believing that, by reason of this effect upon the uterine contractions, post-partum hæmorrhage may sometimes be favored through its use. Yet, when one is forewarned and on the watch for the first evidences of weakened uterine action, he may with reasonable safety invoke the relief of anæsthesia whenever the pains are more than commonly severe and prolonged. Nay, more, when there are signs of exhaustion, ether is positively called for, that the patient's energies may be husbanded for the ordeal still before her, and because exhaustion is itself a fruitful cause of uterine relaxation, and so of post-partum hæmorrhage. In these cases, then, as well as in those of dystocia and precipitate labor, which will be considered later, ether is to be given. A little prolongation of labor, if that result follow, will be less prejudicial to the patient's interests than the exhaustion of suffering. Moreover, instances are not uncommon in which the short interval of rest afforded by an anæsthetic has enabled a patient to complete by her own efforts a labor which would otherwise have required artificial assistance.

The principal drugs that are employed for relieving the pain of labor are opium, chloral, chloroform, and ether. Opium has an intrinsic tendency to lessen the force of uterine contractions; but, on the other hand, when severe pain, as that of colic, is present, which in itself is a hindrance to uterine contraction, a full opiate, by controlling these pains, will start up the activity of the uterus. Opium is most valuable in the first stage of labor, and is often given with chloral. When there has been much suffering, and no commensurate progress, a subcutaneous injection of morphia will often secure a comfortable nap, which will be succeeded by more efficient pains.

Chloral has a beneficial application in the first stage of many normal labors, and when this stage is prolonged, or when there is a rigid and painfully dilating os, it should be given freely, in gramme doses, which may be repeated two or three times at intervals of half an hour, until brief sleep or relief to the exhaustion of suffering is obtained. If the stomach is irritable, it may be given per rectum.

Ether and chloroform are most useful during the second stage of labor, though they may be used during the first if opium and chloral fail to give relief. As between these two anæsthetics, the relative claims are in the main the same as in surgical practice. Those who, with the majority in this country, concede the superior safety of ether have no good reason for preferring chloroform in obstetric practice. Though it should be said that the record of chloroform is much better when administered to lying-in women than in general surgical practice. The fact that there has been no fatality reported from the use of it, with its greater portability and agreeableness, has made it a favorite with some who otherwise prefer ether. The method of employment of

each anæsthetic is to give it only during the pains. It is well to let the patient hold the sponge or handkerchief herself, so that if she should begin to lose herself the anæsthetic would be dropped. The cardinal point is to stop short of inducing unconsciousness. The active co-operation of the patient in her labor must not be allowed to be interfered with. When the head reaches the perineum, and during its emergence, when the pain reaches its climax and while it is desirable that active expulsive efforts should cease for the sake of the integrity of the perineum, the anæsthetic may be pushed to the point of momentary unconsciousness. After the birth of the child the anæsthetic should be at once discontinued, except when there is necessity for removing a retained placenta. If much ether has been given, the accoucheur will do well to watch the uterus carefully till its contraction is secure. There is also more than ordinary need for the administration of ergot.

Bromide of ethyl has recently received high praise as an anæsthetic in simple confinements, it being claimed that it relieves pain, and at the same time shortens labor, besides giving a less chance for post-partum hæmorrhage than when the drug is dispensed with.

During the whole of the expulsive period the head of the child accomplishes a series of progressions, alternated with retrocessions corresponding to the intervals between the pains. Thus each successive portion of the genital canal becomes prepared by a preliminary dilatation to receive the head within its calibre. This natural oscillation becomes of special importance as the head reaches the perineum, inasmuch as that structure is particularly liable to give way before the distending action of the head, unless it has been made lax and pliable by being stretched up several times before the final emergence of the head. It is in securing this end that the most successful management of the perineum in labor consists. Much that was formerly taught in regard to "supporting the perineum" was fallacious. The hand of the attendant held against that body cannot add to its resisting power at the moment when the head emerges (which is the time, if any, of rupture). The integrity of the perineum depends upon its capacity of dilatation to an extent equal to the size of the emerging head. It is not a question of strength so much as of elasticity or of distensibility. It is manifest, then, that intelligent assistance at this juncture will be directed either to diminishing the call upon the perineum for dilatation or to increasing its ability to respond to the call that is made. Neither of these desiderata can be attained by any amount of force applied, in the way of "support," outside the perineum. What, then, is the manœuvre for saving the perineum? First, to reduce the size of the distending head. This may be done by securing as complete flexion as possible. Combined with a general repression of the whole head, to be presently alluded to, there should be especial pressure made upon the anterior portion of the head, so as to keep it well behind the occiput. Next, the whole head should be kept firmly pushed up to the pubic arch, so as to take it as much away as possible from the commissure. This may be done in part by posture. The observations of Schroeder seem to show a much greater immunity from rupture in the lateral position. Whether or not this is due to the removal of the influence of gravity in adding to the pressure of the head upon the commissure does not seem certain. Those who believe it is, advocate the turning of the patient over so that the body bends forward. Indeed, it is claimed that women who are delivered unexpectedly, while in a sitting posture, rarely experience a perineal laceration. Actual pressure of the head toward the pubes should be made from the time it begins to emerge at the vulva, and an appreciable space can usually be gained in that way.

But still more important than the measures already described are those directed to increasing the distensibility of the perineum. Nature's method of accomplishing this is by the pouring out of an abundant lubricating discharge, under which the head, alternately advancing and retreating, stretches the perineum a little way, then retires, returns and stretches it further, and again desists, till in the course of half an hour or more every successive part of it has been softened up to its utmost degree of suppleness and distensibility. In somewhat the same way a saddler develops the pliability of a piece of dead integument; much more effective is such a process upon a living tissue. The delay, sometimes so vexatious to the patient's friends, when the head is upon the perineal floor, and with each successive pain seems about to emerge, only to sink back in the interval and apparently lose what it has gained, is nature's safeguard against a lacerated perineum. If, then, the head is large and the pains strong, it should be our endeavor to imitate this process by pushing back the head and preventing its emergence as long as possible. The voluntary efforts of the patient should be discontinued. She should not bear down, and should be encouraged to cry out in order to lessen the fixation of the diaphragm. If the labor still progresses rapidly, an anæsthetic may be required to check the pains. If the secretion above referred to is not abundant, so as to combine moisture with the dilating force, hot fomentations may be employed. Inasmuch as perineal rupture, when it occurs, is almost always in the median raphé, an attempt may be made to direct the chief pressure of the head from this weakest point of the perineum to the sides, where its resisting power is greater. This may be done by bearing with the thumb against that portion of the head contiguous to the raphé, which widens the cranium and removes some of the pressure to the sides.

It will be seen that the manœuvres above described really consist, as has been said, of management of the head rather than of the perineum. They comprise the most useful means within our reach; but something may perhaps be done to the perineum itself. Dr. Goodell hooks one or two fingers into the rectum and pulls the perineum forward in the interval of the pains. This is rational and undoubtedly effective, but possesses the disadvantage of being usually very distasteful to the patient and of sometimes causing paralysis of the sphincter. Nearly the same thing can be accomplished by putting the thumb on one side of the perineal body and the fingers on the other, and gradually approximating them, at the same time pressing them forward toward the vulva. Thus the perineum is pulled out as much as possible from its lateral attachments, and the anterior extremity of the raphé, the point most liable to a tear, receives the chief benefit of the relaxation gained.

In the practical management of the perineum in labor, then, the woman lying on the left side, the accoucheur, facing the foot of the bed, places one or two fingers of the right hand on the occiput and the thumb toward the posterior commissure. The thumb may, at will, be introduced into the rectum, either to obtain more complete control over the head or to aid in its extraction between the pains. The head is kept back during the pains, and well up to the pubic arch. This may be effected by passing the left hand between the patient's thighs and clasping its fingers with those of the right upon the advancing head. Strong flexion is secured. Finally, when the head can no longer be kept back, the woman is told to bear down in the interval of the pains. This may expel the head. If not, it is sometimes desirable to introduce the thumb or a finger into the rectum, and, hooking it into the child's mouth, to draw the head out between the pains. The same end, according to Ritgen, may be attained by lifting the head upward and forward by means of pressure with the finger-tips behind the anus and close to the coccyx. If the forceps have been used, the extraction of the head can readily be made in the interval of the pains. But, in the experience of the writer, if the measures previously described have been taken and the head kept back till the perineum is well softened up, it is not usually necessary to take active means to secure the extrusion of the head between the pains; but it may be allowed to slip out at the end of a pain. In cases where a rupture seems inevitable, it is occasionally advisable that two lateral incisions be made through the vaginal mucous membrane and the constrictor muscles, but not through the integument of the perineum. The point of election

is on each side, 1½ ctm. anterior to the commissure ; the direction of the incision outward and backward, and its length not more than 2 or 2½ ctm. It should be made with a bistoury (introduced flat if the head is at the point of expulsion). The proper time is during a pain, while the resisting structures are on the stretch. Inasmuch, however, as proper care will often allow a head to pass without injury to a perineum which seemed inevitably doomed, this operation (episiotomy, so called) is probably seldom indicated, and then only when the head is known to be phenomenally large.

After the head has been born, it should be supported in the attendant's hand and the neck examined to see if the cord is about it. If so, the maternal end should be pulled down sufficiently to relieve any strain, and the loop passed over the head if possible. If the cord is pulsating, the accoucheur may wait for the next pain to expel the body. If the cord is constricting the neck and cannot be slackened, it may be tied once and cut between the ligature and the placenta. Care must be taken lest the perineum be ruptured by the posterior shoulder. Indeed, it is a not infrequent occurrence for the attendant, having assiduously watched the perineum during the passage of the head, to allow it to become ruptured by the shoulder, or even by the placenta. The neck should be pressed well up to the pubic arch. The left hand of the attendant should, during this time, be kept over the fundus uteri, both to assist in the expulsion of the child and to prevent relaxation and hæmorrhage.

As soon as the shoulders are born the rest of the body follows, and the second stage of the labor is at an end. The child, as a rule, immediately cries and begins to breathe, and in from five to ten minutes the cord ceases to pulsate. As soon as this occurs, and, as a rule, not until then, two ligatures are to be applied at about 3 and 6 or 7 ctm. respectively from the umbilicus, and the cord divided by scissors between them. The best material for the ligatures is wide tape or clean lamp-wicking. During the whole of the third stage of labor a hand should be kept with moderate pressure against the fundus. For this reason it is desirable that the woman lie on the back after the child is born ; besides that, the lateral decubitus, as in Sims' position, has a tendency to draw air into the uterus. If the child has not begun to breathe spontaneously, active measures must be taken at once to establish that function, by clearing the mouth from blood and slime, and by the application of external cold, as by fanning or slapping the chest lightly with a wet towel. For the further treatment in cases of suspended animation, the reader is referred below, under the subject of asphyxia neonatorum. As soon as the child has fairly begun to breathe, he should be wrapped in a warmed blanket and put aside, to be oiled, washed, and dressed when the labor is complete.

Usually, if slight pressure is maintained on the fundus, in the course of fifteen minutes or thereabouts one or more pains will be felt, and the placenta will be expelled either into the bed or into the vagina. The cord should be held taut, but not drawn upon. The latter course is liable to lead to irregular or spasmodic contraction of the uterus, which may produce hæmorrhage, retention of part of the secundines, or even to inversion of the organ. Besides this, the cord is likely to part near the placenta, in which case we lose a valuable guide if internal introduction of the hand for detachment or removal becomes necessary. If the attachment of the placenta be wholly or partially lateral, it is usually expelled edgewise. But if implanted centrally at the fundus, especially when the separation begins at the middle of the placenta, it may be born inverted, with the fœtal surface first and the membranes reflected back over the maternal surface. Such a condition does not, therefore, necessarily argue that traction has been practised upon the cord, though the chances of its occurrence are increased under those circumstances if such traction has been made.

The detachment of the placenta is affected by the uterine contraction, and begins during the expulsion of the child. It is not, however, till the uterine bulk is diminished by the removal of the whole or a large part of the child's body that the placenta is detached. Then that portion of the uterine wall which was covered by placenta, and which during pregnancy occupied some seventy square inches, is suddenly reduced to eight square inches, and the placenta, not being able to undergo any material reduction, is slid off from the contracting subjacent surface.

The placenta may fail to appear, not because it has not been detached, but because while free it is not extruded. If there have been pains accompanied by a further diminution of the uterine bulk, the placenta will be found lying in the vagina, and can be carefully hooked out with the finger. If it be free in the uterine cavity, its presence as a foreign body will soon insure its expulsion, though the temporary distention caused by it may produce some hæmorrhage. In such cases the finger following up the cord detects a cone of placental tissue filling the os. The finger may be engaged in this, and while the other hand follows down the fundus the placenta may be withdrawn.

If after waiting twenty minutes the placenta does not come away, and the absence of pains gives reason for supposing that it has not been detached, moderate compression of the fundus may be made, which will perhaps start up a contraction. If it does not, Credé's method of expressing the placenta should be employed. This consists in making friction over the fundus till contractions begin, then seizing the fundus in the palm and closing the hands (one or both) upon it as one squeezes the bulb of a syringe, at the same time pressing down in the direction of the uterine axis. This manœuvre usually drives the placenta out into the vagina, or even into the bed. The placenta is drawn forth from the vulva and twisted a number of times upon its axis, so that the membranes which remain behind it are wound into a cord and thereby are less likely to break and leave portions of themselves behind when the placenta is withdrawn. Some recent authorities have objected to the Credé procedure as likely to cause uterine inversion. It has doubtless been often practised too soon after the birth of the child, and therefore unnecessarily. Through carelessness the operator may press the uterus too far down into the pelvis, or by uneven compression he may make an indentation which may conduce to inversion. But applied at the proper time, and in the proper manner, this manœuvre is doubtless of value, in that it obviates the necessity of introducing the hand into the uterus.

If, now, the uterus is to be felt as a firm, hard ball above the pubes, it will probably remain contracted with sufficient force to obviate hæmorrhage. But as an additional safeguard against both bleeding and the absorption of septic matter through the uterine veins it is customary to insure more perfect contraction by the administration of a teaspoonful of fluid extract of ergot. Usage varies between giving it at the moment of the birth of the child and after the birth of the placenta. If there is special reason to fear hæmorrhage, it is better to give the ergot when the head is born, that there may be time for it to act when the placenta comes. But, inasmuch as there is apparently a possibility that the tonic contraction induced by ergot may shut up the uterus, and interfere with the birth of the placenta, it is better in ordinary cases to wait till the uterus is empty before giving the ergot. It is well to have a hypodermic syringe within easy reach, that ergotine, to the amount of a third of a gramme, may be given subcutaneously if the bleeding is free. Frictions over the fundus will ordinarily serve to secure and maintain proper uterine contraction.

A certain amount of blood, equal to what is at the moment of separation contained in the uterine sinuses and in the cavernous structures of the placenta, is lost physiologically in labor. If the uterus promptly and permanently contracts, there is no further hæmorrhage. The treatment to be pursued in case this limit is exceeded will be given below, under the subject of post-partum hæmorrhage. But the means which may in a moment become requisite for meeting such an emergency—ice, hot water, vinegar, electricity, and a styptic, such as

Monsel's solution, ferric alum, or the liquor ferri perchloridi—should not be far away in any case of labor.

An inspection should now be carefully made to see if the soft parts of the mother have suffered serious laceration. In the absence of inordinate hæmorrhage it may be assumed that no important laceration of the cervix has occurred. The introduction of the finger into the genital canal is to be avoided if possible. If, however, a rupture of the cervix of any considerable amount is pointed to by a continued oozing while the fundus uteri remains firmly contracted, and such rupture is detected by digital examination, it should be sewed up at once. Visual inspection of the perineum should always be made. In primiparæ a superficial rupture at the fourchette is the rule, and calls for no interference. A laceration to the extent of half an inch or thereabouts does not call for sutures, though it is the custom of many to touch such a raw surface with strong carbolic acid as a safeguard against septic infection. All ruptures more extensive than this should be sewed up at once. The method will be given subsequently.

The practitioner should, as a rule, remain with his patient an hour after the expulsion of the placenta, to see that the womb remains permanently contracted and that the danger of post-partum hæmorrhage is at a minimum.

II. MANAGEMENT OF LABOR IN CASES OF MALPRESENTATION.—*Face Presentation.*—While it was once thought that this presentation was an insurmountable obstacle to natural labor, it is now known that spontaneous expulsion occurs in nearly the same proportion of cases as in vertex presentations. Still the labor, both in the dilating and the expulsive stage, is protracted, which increases its danger for the mother; besides that, she is subjected to greater risk of laceration. The fœtal mortality is ten per cent. even when rotation occurs as it should, and including the failures in rotation it is thirteen per cent.

For the mechanism of labor and the diagnosis in this as in other malpresentations, the reader is referred to the article on the Mechanism of Labor. The management of a case must recognize the tendency of nature to complete her work. If the diagnosis of face presentation be made early, before the head has engaged, and the chin is posterior, two courses are open to the attendant—one, to attempt to convert the presentation into that of the occiput. Though somewhat difficult on account of the height of the child from the vulva, this has in a good number of cases been successfully done. The os being dilated enough to admit two fingers, and the bladder and rectum having been emptied, the fingers are introduced through the os and upon the vertex, which is pulled down, while the external hand helps in the manipulation through the groin by pressing the hollow of the occiput downward at the same time. Schatz recommends a simpler method, which consists in external manipulation alone. One hand presses the child's chest upward and backward, while the other forces the breech over in the opposite direction. Thus the child is raised up and doubled over, and the complete flexion of the trunk lets the head fall into its normal position. Each of these manœuvres, of course, must be performed in the intervals of the pains. If successful, they convert what was the most unfavorable face position into the most favorable position of the vertex. The corrected position must be maintained, by rupturing the membranes and pressure on the fundus, until the vertex engages. Forceps may be at once applied. So simple an operation as that of Schatz, if it can be made to succeed, would seem, in view of the gloomy prospect for the face-presenting child, to be indicated in every such case. If not feasible, the former mode of converting the presentation should be tried, at least if the chin is posterior. The next resort, version, formerly much in favor in all face cases, is too serious in its prognosis to the child to warrant us in resorting to it even if the chin is posterior. It takes the case out of nature's hands for the sake of a contingency—non-rotation—which is improbable. After the head has engaged, an attempt to convert the presentation to that of the vertex is rarely successful, though its accomplishment, with the aid of the vectis, has been reported. Version, also, at the time when the failure of the chin to rotate has become an established fact, can no longer be performed.

Forward rotation can be aided by securing full extension of the head, as that position, by bringing the chin lowest, favors its forward rotation. A finger hooked into the child's mouth may also be used to make some traction toward the arch during the pains.

The malposition, however, persisting, and labor having come to a standstill, interference must be made with the forceps. The application of this instrument should be so made as to make the extension of the head as complete as possible, and the attempt should then be cautiously made to favor rotation. If, however, the body does not readily respond, the attempt must not be persisted in; otherwise there will be danger to the atloido-axoid articulation. Failing to bring the chin forward, it must be carried over the perineum and coccyx in the effort to accomplish the mechanism which nature very rarely carries out (see Labor, Mechanism of, under Face Presentation). As a last resort we have craniotomy, which fortunately is seldom required.

If the forward rotation takes place naturally, we may still have to interfere when the natural process is taking too much time, or is beyond the mother's power of endurance. In the application of the forceps, which is then not difficult, the mechanism of natural expulsion must be clearly in mind.

Brow Presentation.—This is produced in cases with pelvic deformity, particularly, it is said, of the kyphotic type. The prognosis, on account of the delay in the labor, is somewhat worse for both mother and child than in normal cases. This malpresentation may be considered to be either an imperfectly flexed presentation of the vertex or an imperfectly extended one of the face. The first effort is, naturally, to convert it to the former presentation. For this purpose it is justifiable to introduce the hand and pull down the occiput. Should this fail, the face presentation may be favored in like manner. With the latter aim it has been proposed to introduce the fingers into the mouth and pull down in the superior maxilla. The forceps may be applied so as to favor the desired flexion, and the extraction performed as usual. If the favorable diameters for passing through the pelvis cannot be secured by either flexion or extension of the head, and if the time for version has passed, there is no alternative but craniotomy.

Breech Presentation.—This anomaly is due to laxity of the uterus and abdominal walls, permitting lateral obliquity; to excessive amount of liquor amnii, permitting free revolution; to multiple pregnancy, contraction of the pelvis, and to a peculiar formation of the lower uterine segment, which is likely to be conjoined with a low implantation of the placenta. It is also frequent in premature labors, the fœtus not having yet assumed its normal attitude.

Its occurrence does not materially affect the mother's welfare, except in so far as the treatment may conduce to a laceration of the cervix. The prognosis to the child, however, is grave, the average mortality being one in eight and a half, while some authors give the fatality as high as one in three, and for primiparæ, as even reaching to sixty per cent.

In view of the gravity of the case, prophylaxis becomes very important. The attitude of the fœtus is usually simply inverted from the normal. Hence, if it can be turned end for end, we shall have a vertex presentation. This is not difficult to do by external manipulation three or four weeks before labor, and can often (though with more difficulty) be accomplished as late as just before the onset of labor. Hence the desirability of the attendant seeing his patient shortly before her expected confinement. A correction of this malpresentation too early, on the other hand, will not be permanent.

Should this simple operation fail by reason of having been deferred till the fœtus is too large, nothing can be done, except that, if then a contraction of the pelvis be discovered, podalic version is indicated at the very outset of labor, before the membranes have ruptured.

In the majority of breech cases the duty of the attendant

is chiefly to resist a common impulse to accelerate nature's work, which attempt has the usual effect of extending the arms above the head, besides pressing the neck down to the cervix before sufficient dilatation of the latter has occurred to admit of its passage; so that there is either troublesome delay at a very critical time for the fœtus, or else the cervix is torn. Hence the rule to make the traction as slight as possible, and if the cervix is not well dilated, to dilate it by Barnes' bags or similar means before beginning to extract the breech. The first indications that the fœtus is in need of progressing more rapidly toward the outer world is the discharge of meconium, which is a reflex act dependent upon beginning asphyxia, usually from compression of the placental or umbilical vessels. Reflex movements of the legs have a similar significance, although neither of these signs should drive the attendant into undue haste. Auscultation should be repeatedly practised, for more perfect evidence of any failure of the circulation.

Supposing the breech to have been expelled naturally, the legs, one or both, fall outward. They are to be wrapped in a warmed napkin, both to protect the skin from injury and to prevent the cold air from starting up respiration through reflex action. The disengaged hand is now introduced into the vagina sufficiently to feel the cord and see if it is properly pulsating. A loop of it should be pulled down and placed on that side of the pelvis where it will have most room. If this cannot be done, or if the pulsation is feeble, there is need of haste. Traction is to be made in the direction of the pelvic axis, while the fundus is pressed down so as to be kept in close apposition to the head, with a view of thus diminishing the chances of the arms ascending above the head. The posterior elbow should be released by introducing the hand in front of the fœtus, seizing the forearm, and bringing it down across the chest and abdomen. The other hand is now to be released in the same way.

FIG. 1935.—Chailly-Honoré.

If through unduly rapid traction or other cause, the arms have become extended above the head, there may be great difficulty in getting them down. The fœtus should be carried strongly forward toward the pubes. Thus the posterior shoulder is pulled as far downward as possible. The hand is introduced and two fingers worked up the upper arm to, and over, the elbow. Thus flexion is made, while the forearm is pulled downward across the face. Now, placing this extracted arm with the rest of the trunk and limbs under the cover of the napkin, and resting the body along his arm, the operator rotates the body of the child so as to bring the disengaged arm to the rear. The rotation must be made in such a direction that the undelivered arm, which from lateral pressure of the pelvis is kept from following perfectly the rotation, will fall across the front, and not the back of the child. For instance, the back being to the mother's left and the right arm delivered, the left shoulder must pass around by the mother's left side, and not by her right. Instead of effecting the rotation by direct action on the thorax, the same result may sometimes be as well attained by seizing the posterior arm and drawing it around to the pubes.

In some cases the anterior arm can be dislodged without rotation, if the pelvis is tolerably roomy, by carrying the fœtus well to the rear. If this is possible, it is desirable, because the rotation above described may injure, or even kill, the fœtus if the head does not follow the body, by producing too strong rotation at the atloido-axoid articulation. The latter admits of only ninety degrees of motion with safety. Still this risk must be often taken, because the hollow of the sacrum is the only side of the pelvis which admits the hand to flex and bring down the arm. Fracture of the humerus can generally be avoided by taking pains not to seize the upper arm in this manœuvre. But if the accident does occur through the necessity of removing the child from danger of asphyxia, it need not cause great apprehension. Well-padded little splints should be applied, and the arm bandaged to the side. Union occurs very quickly.

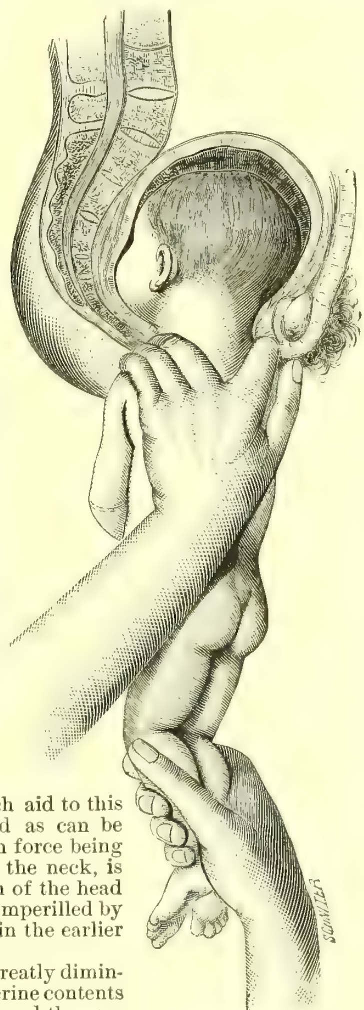

FIG. 1936.—(Lusk.)

The posterior shoulder is now drawn out over the commissure, the body being carried forward, and then the anterior shoulder in turn, while the body is carried backward, and the child is born all but the head. The completeness with which the latter fills the pelvis is sure to exert disastrous pressure on the cord. From this point on, therefore, artificial assistance is usually needed to save the life of the child. All manipulations, however, must recognize the importance of flexion of the head and of the anterior rotation of the occiput, as well as the curve of the pelvis. Such aid to this rotation of the head as can be given, without much force being applied in twisting the neck, is useful. The flexion of the head is most likely to be imperilled by too active traction in the earlier stages of delivery.

Inasmuch as the greatly diminished bulk of the uterine contents at this time has lessened the contractile power of the uterus, the weakened *vis a tergo* requires to be reinforced by manual pressure. This can be made through the fundus directly upon the head, and without danger of disturbing the normal relations of the latter to the genital canal.

The child's body is now supported, belly downward, along the operator's left arm, the fingers of the left hand pass under the perineum, and press on the cheek bones to pull the head into a state of flexion, or, passing into the mouth, they may hook over the lower jaw, while the fingers of the right hand, forked upon the shoulders, exert traction, and one finger occasionally, if necessary, assists in maintaining flexion by pressing upon the occiput (Fig. 1935). The power in this case is to be exerted on the shoulders, the finger hooked over the jaw being used only to maintain the flexion.

The "Prague method" is sometimes very useful in extracting the head, especially when it has not yet passed the brim. The fingers of the left hand are forked over

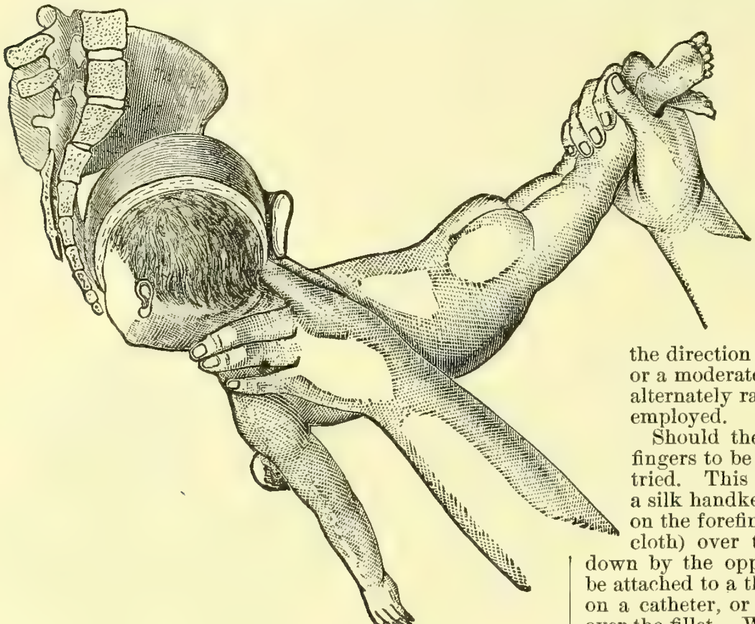

FIG. 1937.—(Lusk.)

the nucha, and get a purchase on the supra-clavicular depression on either side. The right hand grasps the feet, and the two hands exert traction together. This traction is to be carefully made in the axis of that portion of the pelvic canal which corresponds to the equator of the head for the time being. If the head have not engaged, of course the direction for traction is that of the axis of the brim. After the head enters the pelvic canal, the left hand is used as a fulcrum, and the body of the child is rapidly carried upward, with its back toward the mother's abdomen, thus favoring the flexion of the head while the extraction is made (Figs. 1936 and 1937). Should symptoms of asphyxia become imminent before the head is removed, we can sometimes reach the mouth with a catheter, so as to permit the child to breathe while the face is in the hollow of the sacrum.

If this manœuvre be not successful, forceps may be applied to the after-coming head, an assistant meantime holding up the child's body above the pubes. (For the method of application, see Forceps.) In the management of every breech case, forceps should be kept at hand, ready for use if required.

Should the occiput not rotate forward, the difficulty of extracting the head is somewhat increased. But it must be remembered that the traction still is to be in the pelvic axis, and the occiput should be pressed up, if necessary, to secure complete flexion, while the body is drawn backward until the occiput fixes itself at the posterior commissure (Fig. 1938). The body is then carried backward, while the chin, nose, forehead, and bregma successively emerge under the arch. In the rare cases where the chin, not being close to the chest, becomes arrested above the symphysis, the head engages by its occiput in the strait, and thus traverses the whole curve of the sacrum until it disengages by a movement of further extension over the perineum. Meantime the child's body is carried up over the pubes, its abdomen facing that of the mother.

We have hitherto considered these cases of the breech where obstetric aid is demanded only, or chiefly, in the interest of the child. Nature would probably expel the fœtus in time if left to herself, but the fœtus would be dead. This period of danger from interference with the umbilical circulation does not begin till the breech has been expelled, and it is this period that we have hitherto discussed. There may, however, be cases difficult for the mother, when the breech is impacted or fails to emerge from the lower strait, and when assistance is demanded for this end. The best instrument for delivering the breech, when it can be used, is the *finger*. When the breech is well down, and no resort to more serious operation is considered probable, no anæsthetic is required. The woman is placed on the back, across the bed, the hips raised. One index-finger is introduced under the pubes and hooked over the anterior groin toward the back. The opposite index is introduced, and an attempt is made to make its tip meet that of its fellow; or the second index may be hooked over the posterior groin, if that be easier. Traction in the direction of the axis is made with both fingers, or a moderate swaying movement antero-posteriorly, alternately raising and lowering the pelvis, may be employed.

Should the groin be too high up to allow of the fingers to be hooked over it, the fillet is next to be tried. This consists of a wide and soft fabric (like a silk handkerchief) which can sometimes be carried on the forefinger (which is inserted in a knot of the cloth) over the anterior groin, and met and pulled down by the opposite finger; or the handkerchief may be attached to a thread, which is carried over the groin on a catheter, or Bellocque's sound, and used to draw over the fillet. When the latter is in place it can be used, care being taken that it lies smoothly in the fold of the groin, to make traction.

If the breech fails to descend, and neither the finger nor fillet can be made to draw it down, the operator's duty is to decompose the wedge which is formed by the

FIG. 1938.—Extraction of After-coming Head, Occiput remaining Posterior. (Dictionnaire de Médecine.)

breech, by bringing down one extremity. There is great difference in the facility with which this can be done, according as the legs are flexed on the thighs, the ordinary attitude, or are extended upward along the child's

body. In the former case the feet are close by the breech and readily accessible to the hand of the operator, not far from the os uteri, if expulsion have not begun. In the other case the feet are at the fundus. In the first or simpler cases, after determining the position of the sacrum,

Fig. 1939.—Seizing a Foot to Decompose the Wedge of an Impacted Breech. (Barnes.)

the fingers of the hand whose palm comes opposite the child's abdomen are introduced in front of the fissure between the thighs, and near the breech they readily come upon the feet. The anterior foot is seized by the instep and brought down, the half-breech serving to prepare the way for the transit of the trunk better than would be the case if both feet were extracted (Figs. 1939 and 1940).

If, however, the legs are extended on the thighs, the hand must be introduced to a great depth; surgical anæsthesia is necessary. The hand is passed by the breech, palm toward the child's abdomen. The anterior foot is reached, if possible, and seized by the instep, thus flexing the leg on the thigh (Fig. 1941). The hold is maintained upon the foot till it is extracted. Any attempt to draw down the leg by working on the thigh or knee, will either fail or result in injury, probably fracture of the femur. The considerable difficulty involved in this operation makes it proper to resort to it only if the fingers and fillet have failed, although when the leg is flexed the extraction of the foot is to be given precedence over any other method of getting out the breech.

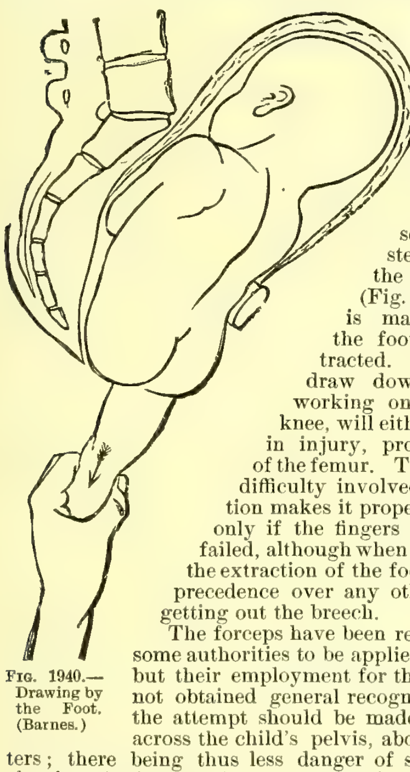

Fig. 1940.—Drawing by the Foot. (Barnes.)

The forceps have been recommended by some authorities to be applied to the breech, but their employment for this purpose has not obtained general recognition. If used, the attempt should be made to apply them across the child's pelvis, above the trochanters; there being thus less danger of slipping than if clasping the fœtus in its antero-posterior diameter. The only circumstances under which the forceps would be likely to be indicated are when the breech is too far down to admit the hand past it to find the foot, and when yet it is too high up to permit the fillet.

Another instrument of questionable advantage is the blunt hook, formerly in common use. Contusions of the groin leading to sloughs, as well as fractures of the

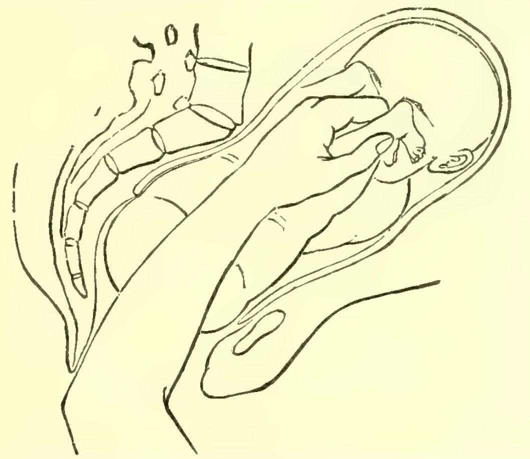

Fig. 1941.—Seizing a Foot when the Legs are extended along the Trunk. (Barnes.)

femur, have so often followed its employment that it has largely and properly lost favor. If the failure of other means of relief seems to the attendant to require the blunt hook, it should be introduced under the arch, in a direction parallel to the child's spine, turned over the thigh, and the handle twisted in such a manner as to bring the point of the hook away from the femur and well toward the child's abdomen. Traction with one hand is made while the index of the other hand is kept apposed to the tip of the hook until a finger can be substituted for the hook. A cover of rubber has been sug-

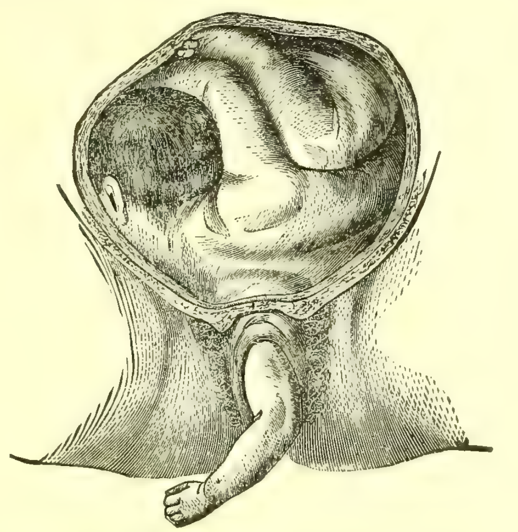

Fig. 1942.—Presentation of the Left Shoulder, D. R. A. Head in right iliac fossa; dorsum anterior; prolapse of arm. (Dictionnaire de Médecine.)

gested for this instrument, as a means of protecting the soft parts from the damage which they are apt to receive from it.

Knee presentations can readily be converted into footling, and the latter admit of ready extraction; of course, under the same conditions and precautions that have been described above.

Transverse or Shoulder Presentation.—The more de-

tailed description of this anomaly will be found under the Mechanism of Labor. In treatment, however, we are never to count upon nature's ability to carry out the mechanism there described. The sooner the malpresentation is remedied the better. If the patient be seen before labor, which is always wise, the lack of correspondence in direction of the axis of the uterus and that of the mother's body is quite obvious and should lead us to correction of the misplacement. Though the causes, which in the main are those of other malpresentations, may reproduce the attitude.

The prognosis is not necessarily bad if the treatment be early and judicious. But otherwise the maternal mortality is considerable, and the fœtal still greater ; while in long-neglected cases it is wellnigh impossible to save the child's life and the mother's is greatly imperilled.

The treatment of this condition consists in *version*, to which topic the reader is referred. Suffice it to say here that the varieties of version to be successively tried are usually external manipulation—either cephalic or podalic—bimanual (combined external and internal), and finally, the others failing, introduction of the whole hand.

When an arm has remained prolapsed for hours and the uterus has contracted tetanically about it, the waters having entirely drained away, version may be impossible. Then, if our examination reveal no tendency toward spontaneous evolution, we have to choose only between Cæsarean section and embryotomy. As the child is probably dead we have to consider only the mother.

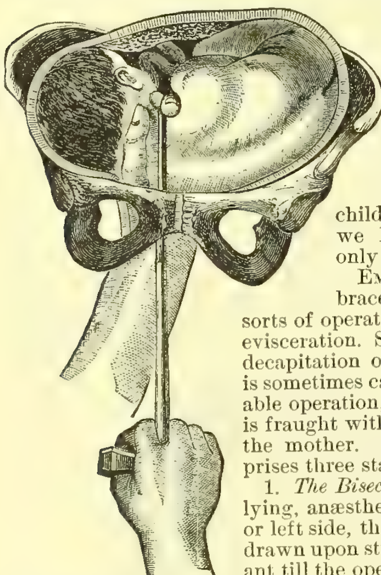

FIG. 1943.—Application of Braun's Decollator. (After Lusk.)

EMBRYOTOMY embraces two different sorts of operation—bisection and evisceration. Section at the neck, decapitation or decollation as it is sometimes called, is the preferable operation, though even this is fraught with grave dangers to the mother. Decapitation comprises three stages :

1. *The Bisection.*—The patient lying, anæsthetized, on the back or left side, the prolapsed arm is drawn upon strongly by an assistant till the operator's fingers can reach the neck. Various instruments—the écraseur, curved saw, and curved scissors—have been used. The best is Braun's decollator, an angular hook, or Ramsbotham's knife. The former fractures the cervical vertebræ, the latter has a cutting edge. Some operators prefer to use both instruments, the first to break the spine, and then the second to cut through the soft parts. An instrument combining in itself both characters has been devised, a knife-edge being released after the bone has been fractured. Braun's instrument is introduced by the right hand along the child's back (whether that be toward the mother's back or front), the left fingers being used to guide the hook, and finally, if possible, to meet it in the neck of the child and aid in protecting the maternal structures (see Fig. 1943). The handle is turned so as to bring the tip of the hook toward the child's spine rather than toward its head. If the Braun instrument is used, it is wrenched and at the same time drawn upon till the spine gives way. Then the Ramsbotham hook, being introduced, is carried by a sawing motion through whatever tissues remain undivided. It is advised to insert this instrument with the point of the hook posteriorly.

2. *Extraction of the Trunk.*—This is effected by traction on the prolapsed arm, the severed head being pushed to one side as the body advances (see Fig. 1944).

3. *Delivery of the Head.*—This may be the most difficult step in the operation. The danger to the mother is from laceration by the sharp fragments of bone at the point of bisection. Hence, whatever means of extraction be practised, the operator must use his hand to cover, so far as possible, the jagged wound. The assistant holding the head well down toward the pelvis, an attempt is made first to extract with forceps. If this fails the cranioclast must be used. Though the writer has never known of the introduction of a blade through the foramen magnum, there would seem no reason why this should not be done, the other blade passing outside the skull. If necessary an artificial perforation of the head may be made and the cranioclast applied in the more usual way. (For description see below under Contracted Pelvis.) The cephalotribe is applicable in cases in which the foregoing means have failed, especially in much contracted pelves. On the other hand, an exceptionally small head may be delivered manually, or by bone forceps, or by both combined.

If the neck cannot be reached in these cases of neglected trunk presentation, evisceration is to be practised. This may be performed either upon the thoracic or abdominal cavity. Its object is to favor delivery by a process akin to spontaneous evolution. The puncture is to be made with sharp scissors, either between the ribs or on the abdominal wall, traction then being made on the trunk by a crotchet or cranioclast. Sometimes actual bisection of the trunk is called for. These latter operations are, as might be supposed, exceedingly trying to the operator and hazardous to the patient. The utmost skill and patience are required to avoid inflicting serious injury to the maternal parts.

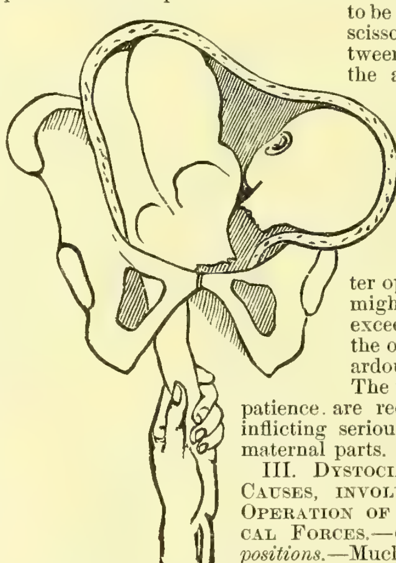

FIG. 1944.—Extraction of the Trunk after Decapitation. (Barnes.)

III. DYSTOCIA FROM OTHER CAUSES, INVOLVING IMPAIRED OPERATION OF THE MECHANICAL FORCES.—*Occipito-posterior positions.*—Much depends upon an early recognition of the abnormality (see Labor, Mechanism of, for the diagnosis). Fortunately, in the great majority of these cases forward rotation eventually takes place, even though it be not until the head is upon the perineum. But before the head has thus descended the patient may become seriously exhausted. The key-note of the treatment is to secure that perfect flexion the want of which has interfered with the rotation. In the early stages of labor this may be done by interposing resistance, during pains, to the anterior part of the head, which, in the great majority of the cases, is toward the mother's left ilio-pectineal eminence. It is just here that careless application of forceps sometimes does great harm, in that it tends to carry the chin away from the neck and thus make the flexion less perfect than before. The operator's hand may be introduced into the vagina to promote flexion and to help in forward rotation. The latter may be helped by pressure on the trunk externally. If the forceps should be required, as they frequently may be, on account of the protraction of the labor, they must be used primarily to secure flexion of the head, rather than directly as extractors. Some authorities have recommended applying the forceps *reversed, i.e.*, with the concavity backward, in order to pull down the occiput. Then they are taken off and reversed, and rotation favored as the traction is made.

Attempts directed primarily to remedying the position before the head has entered the cavity are generally futile, because the malposition is at once reproduced unless flexion can be maintained.

Uterine inertia is a common and troublesome complication of labor. To a certain extent it is involved in the phenomenon of rigid cervix, which is considered under the head of the Resistance of the Maternal Structures. It is, however, in the expulsive stage that true inertia is most common. The causes of this feeble action are exhausted nervous and muscular power, and the diminution of the size of the uterus due to its partial emptying, which gives it much less contractile force than when it had the full bulk of the fœtus to work upon. Manometric experiments have demonstrated a great diminution in the pressure exerted by the retracted uterus. The atonic condition is contributed to by exhaustion, constitutional weakness, frequent childbirth, excessive youth or age in the patient, uterine malposition, pendulous abdomen, intestinal accumulations, distention of the bladder, excess of liquor amnii, and mental trouble. Long residence in tropical climates is also assigned as a cause.

Sometimes, when the pains seem to have ceased entirely, more careful investigation reveals the fact that the uterus instead of being inert is really tonically contracted. As this sort of action is powerless to effect delivery, its effect, so far as advancing the labor, is as if there were atony.

The symptoms, apart from the lack of progress toward the completion of labor, are those of exhaustion. The patient is peevish and restless, the pulse quick and sometimes feeble, the skin and likewise the vagina hot and dry; nausea and vomiting appear, and finally, if no relief is afforded, delirium and death.

The treatment is twofold, the first aim being to rouse nature, if possible, to do her work by the increase or replacement of too feeble pains, and that failing, to do the work for her by extracting the child by force *a fronte.* Some of the agencies to be alluded to in case of rigid cervix have an application here, particularly the hot douche and the securing to the patient of a short rest by chloral, morphine, or ether. The rectum and bladder, if distended should be emptied. If the membranes are unruptured, and the dilatation is well advanced, an advantage may be gained by rupturing the chorion, especially if the degree of its expansion suggests that the waters are excessive in amount. Ergot, which has in the past been so freely administered in these cases, and it is to be feared is still given, at least by midwives, is a dangerous instrumentality. In selected cases, the head being well down, not excessive in size, and the canal roomy, and the fact being clear that only a few good pains are necessary to effect delivery, the use of ergot may be defended. But under these conditions forceps are so easily applied that the risk from that operation is less than the danger of tonic contraction, retained placenta, etc., from ergot.

The raising of a pendulous abdomen, so as to bring the axis of the uterus into nearer accord with that of the pelvic brim, is an important measure in such cases; a firm binder is to be applied to maintain the correction. Frictions applied at the fundus uteri, whenever the feeble attempts at uterine action occur, have the effect sometimes of strengthening the pains. A change of position is often effective. The habitual attitude of primitive peoples in labor may, perhaps, be an indication that the recumbent position is not the most favorable to uterine activity. At all events, a semi-reclining posture is sometimes useful when the pains have died away during recumbency. It has been recently recommended that two chairs be placed side by side, with the hind legs touching and the front ones a little separated. The woman sits between them, with the thighs moderately separated. As the abdominal muscles begin to act the patient is transferred to bed.

If weakness is the cause of the atony stimulating nourishment should be given—brandy, beef-tea, and coffee with milk, being among the most useful articles for this purpose.

Electricity has been found useful in calling forth uterine action, particularly in nervous women who feel pain acutely, in those who have sympathetic disturbances, such as hiccough and vomiting, and in those requiring stimulation. The current should be the induced one, the strength mild, the electrodes large, and covering the motor points, which are found approximately by bisecting the lines drawn from the umbilicus to the middle of Poupart's ligament. It is claimed that while the suffering is mitigated the pains are increased in effectiveness.

Finally, if nature cannot be roused to do her work, it only remains to remove the child, for which the application of forceps is, in most cases, the proper operation.

Precipitate labor is an abnormality, the reverse of the one just considered, though it is much less common. The sources of danger are first from the incessant and tempestuous character of the pains, exhausting to the mother's strength and dangerous to the fœtus from the unintermitting compression; but second, and most seriously, through the hurried completion of the labor, without that gradual preparation of the soft parts which is so essential to the maintenance of their integrity. Finally, the child may be forced out so rapidly, the woman being unprepared, that he falls into a water-closet or upon the floor.

A lack of proportion between the size of the child and of the passage and an excess of nervous activity are the immediate causes of this accident.

The treatment consists in restraining the woman from voluntary expulsive efforts; this may require the abolition of consciousness through ether. Morphine is much less effective.

Uterine Displacements.—The common forms of uterine displacements which complicate pregnancy have usually righted themselves, been reduced by the physician, or led to abortion before the onset of labor (see Pregnancy, Disorders of). Cases do occur, however, where anteversion is present at term. Of course, if the uterine axis is distorted, it should be brought back and retained by an abdominal binder. Posterior displacement, if persisting to term, may divide the uterine cavity into two parts—an anterior one, containing the most of the fœtus and lying above the pelvic brim, and a posterior one, containing, say, the fœtal head. The cervix is displaced upward, behind the pubes, and uterine contractions fruitlessly expend themselves against the posterior vaginal wall, where the head lies in a degree incarcerated. The usual method of reposition is required, the woman being in the knee-chest position and the head being pushed above the promontory, while the cervical portion is brought down. Usually extraction by the foot is the best mode of terminating the case.

Uterine malformations, while rare occurrences, usually result in tedious labor. In the double uterus there is, of course, lateral deviation of the pregnant horn, and the placenta may not be spontaneously thrown off if attached to the septum, which shares the imperfectly developed condition of the non-pregnant horn. Craniotomy has been found necessary in some of these cases, as well as division of a vaginal septum, if it obstructs the labor.

Hour-glass Contraction.—A further anomaly of contraction, of graver import than either deficiency or excess of uterine action, though fortunately rare, is that known as falciform, or hour-glass contraction. Owing to irregular distribution of nervous action a circular zone of the uterus contracts strongly, while the part above it does not. The seat of this contraction corresponds to the so-called ring of Bandl and is probably at the true internal os, although the situation of the contraction is sometimes half-way to the fundus, the lower segment being greatly stretched and thinned. This forms a great obstacle to labor, thwarts the operation of forceps, and prevents the introduction of the hand for turning. The necessary operative interference involves great danger of causing rupture. Full etherization gives the best chance of relaxing the spasm, and with great gentleness and patience the fingers must be introduced for manual dilatation of the constriction.

During the third stage of labor a somewhat analogous condition sometimes occurs. The seat of the constriction may not be the same, but it produces a similar shutting

off of a portion of the uterine cavity, which is occupied by a portion or the whole of the placenta. Here there is not the urgent need of quickly overcoming the obstacle, for the sake of the uterine contents, that exists when the fœtus is being subjected to the incarceration. When the constriction is very close, the placenta, either still remaining adherent to the fundus, or having become detached, remains in the upper compartment, the constriction completely encircling it, and permitting only the passage of the cord. Under these circumstances the placenta is said to be encysted. A less complete enclosure of the placenta—the uterine muscle simply forming a raised collar about its edges—is spoken of as an *encasement*. The seat of the placental attachment is usually the inactive part of the uterine muscle. Hence there is a liability to hæmorrhage. If this does not occur, we may wait a reasonable time for the spasm to pass off, giving a dose of morphine subcutaneously. Nitrite of amyl has proved useful in accelerating this relaxation. Three or four drops should be inhaled from a handkerchief. Ergot, it is hardly necessary to say, is contraindicated. If despite this treatment the hæmorrhage becomes abundant, the hand must be used as described above to dilate the constriction, the cord serving as a guide, although, as there is now less imminent danger of producing rupture, an anæsthetic is not so necessary. It is not usually necessary to make full dilatation; one or two fingers should be passed in, and an edge of the placenta drawn into the constriction. This, with combined friction over the fundus, will gradually dilate the sphincter, and the most of the placenta can be slowly drawn through. If the placenta is adherent in the upper segment, more complete dilatation under ether is necessary preliminary to its digital removal.

Retained Placenta.—This term is commonly applied to all cases in which the secundines are not born within a reasonable time, say half an hour, after the child. Used thus loosely it covers many conditions, even that in which the placenta is lying loose in the vagina or the cervix. If fairly in the uterus it may, though rarely, be retained there by an annular constriction, as already described. Usually, however, only a little further time is required to complete its spontaneous detachment and expulsion, at least out into the vagina. Undue size of the placenta, or a traction upon the cord which has pulled it into the cervix, so that no air can get by it, and it is held by atmospheric pressure, are among the causes of simple retention. On the other hand, it may, though very rarely, be actually adherent. This is the result of old inflammations of the endometrium, as well as of degenerations of the placenta itself. Sometimes there are fibrous adhesions of great strength, so that separation, even post-mortem with a scalpel, is difficult. The adhesions may exist all over the placenta or only in limited spots. The chorion may, in a like manner, adhere to the decidua at scattered points. The same individual may suffer in successive pregnancies from retention of the placenta. In a premature labor, as those physiological processes which normally lead to the detachment of the secundines have not been fully completed, the placenta is liable to fail of immediate expulsion. In the treatment, having tried the Credé method, described above under normal labor, we may, before introducing the hand, if there is no hæmorrhage, follow Cazeaux's suggestion of injecting cold water into the umbilical vein, at the point where the cord has been divided, with sufficient force to diffuse it throughout the placental mass. It distends the latter, giving the womb a greater bulk to work on, and by the impression of cold stimulates uterine contraction.

Whenever the placenta is detached only in part, or when, even if wholly free, it is retained by what Barnes calls an "inverted polarity," within the uterus, thereby preventing the contraction of the organ which is necessary in order to shut up the uterine sinuses, there is apt to be hæmorrhage. This calls for the immediate removal of the after-birth.

The operation for the manual removal of the placenta is the same, whether the hæmorrhage be due simply to retention or to adhesion, though in the latter case, of course, it is the more difficult. The woman being placed on the side or the back, the operator introduces the left hand into the uterus, at the same time steadying the fundus with the right. After recognizing the placental structure by the big vessels on its frontal surface and the entering cord, the finger-tips are carried from below up the posterior wall till they meet the placental edge, and are inserted under it. Then, by a sawing motion, the tips and edges of the fingers acting like a paper-cutter, the hand is carried up, separating the whole width of the placenta, as it goes, to the fundus (see Fig. 1945). When the detachment is complete the placenta lies in the operator's hand and is withdrawn, the outside hand following down the contracting fundus at the same time.

The obstacles to the perfect success of this operation are abnormalities of the placenta, among them *placenta succenturiata* (in which a subsidiary placenta exists, more or less completely separated from the main one), and placenta duplex or multilocular, when there are two or more completely separate parts. And secondly, such closeness of adherence as makes it impossible to detach the whole organ without also tearing away portions of the uterine wall. Serious results have been reported as caused by maladroit efforts in this direction. Dr. Braxton Hicks has lately pointed out another condition likely to cause difficulty. Sometimes, though not always, after the

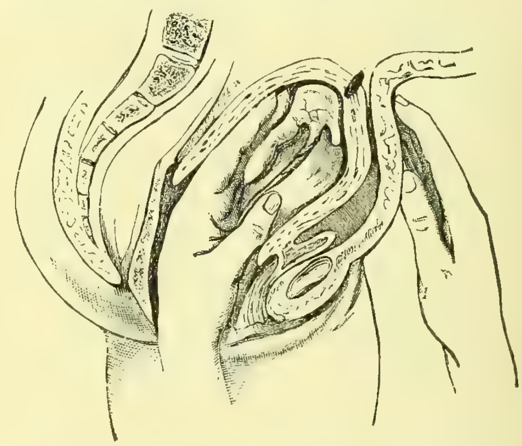

FIG. 1945.—Manual Removal of Adherent Placenta. (Barnes.)

fœtus has been expelled the mucous membrane of the uterus, instead of contracting equally with the muscular tissue, forms folds or waves, movable on the subjacent structure. If there are inflammatory nodules which produce occasional adhesions, the similarity to rough placental structure is increased. Dr. Hicks has noticed this phenomenon, especially in cases when there really was an adherent placenta. The difficulty of finding the margin of the true placenta among these folds of mucous membrane is obvious.

When all that is certainly placental tissue has been removed with the fingers, anything as to which the operator is in doubt should be left, for even if it be placenta it will in all probability be extruded by natural process without causing harm. If, however, shreds and fragments that remain keep up a hæmorrhage, they must be removed by curette in the manner to be described under Post-partum Hæmorrhage.

Rupture of the Uterus.—While this accident may occur during pregnancy, and even in the non-gravid uterus, its chief importance is in connection with labor. Regarding its frequency, statistics are so variable as to be of little value. There is reason to believe that its occurrence is somewhat more frequent than its recognition, and considerably more common than most of the figures given indicate, owing to the reluctance of practitioners to report cases for which they may hold themselves to be responsible.

The rupture most commonly begins in the lower seg-

ment of the uterus, where the walls are thinner than elsewhere, and from thence extends upward upon the fundus (see Fig. 1946). It is rarer in primiparæ than in multiparæ. The thickened fundus in the latter brings to bear a greater force on the thinned walls of the lower segment (the "obstetrical cervix") than can be exerted in the less developed organ of the primipara. The common mechanism of the accident is this: The head does not properly descend. Hence the fundus cannot approach the pelvis, but remains a fixed point, and the uterine action draws the lower portion upward. Thus the ring of Bandl rises and the lower segment is stretched and thinned until it gives way. The rupture may be spontaneous in a thoroughly healthy uterus, due, as Barnes says, to a "strong contraction upon incompressible contents that cannot escape." Or there may be impairment of the uterine muscle, through great distention, as from twins, degeneration of the tissues, cancerous disease, or fibroid tumors. The strain laid upon the uterus may be abnormally intensified, as from contracted pelvis, malpresentations, hydrocephalus in the fœtus, the injudicious administration of ergot. In these cases often the amniotic fluid has drained off, taking away the equally diffused hydrostatic pressure. Rupture may result from the attempt to dilate an hour-glass constriction, or to perform difficult version, or other of the more serious obstetric operations.

The rupture may be partial, not involving the whole thickness of the wall. It may involve only the mucous surface and fibro-muscular coat, or, on the other hand, the peritoneal coat may be alone or chiefly torn. A "rubbing through" of the uterus is described, due to attrition against the bony structures, as the promontory of the sacrum, the symphysis, or the ileo-pectineal line. Such a tear, if insufficient to permit the escape of the fœtus, may give rise to sloughing and secondary perforation. The laceration which separates a portion of the cervix will be alluded to below, under the subjects of contusion of the anterior lip and lacerations of the genital canal; such laceration begins usually on the left side. A complete annular tear may separate the uterus from the vagina. Lacerations of the vaginal portion may or may not extend through the peritoneum.

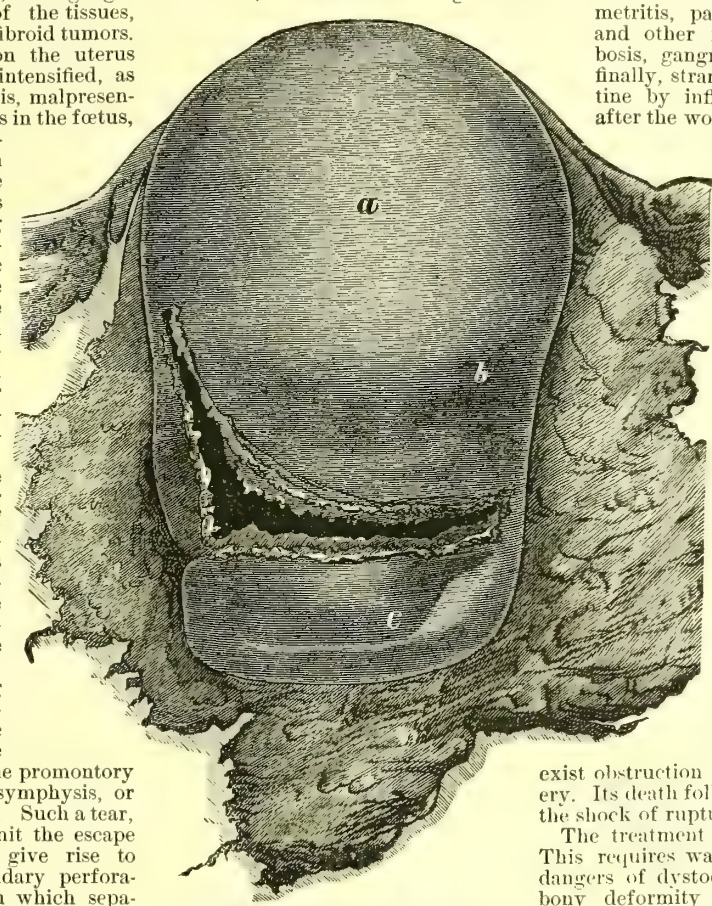

FIG. 1946.—Rupture, beginning in Lower Uterine Segment. (Lusk.)

The symptoms of uterine rupture are sharp pain (which may, however, not be distinguishable from the pains of the labor), sudden collapse, faintness, feeble pulse, vomiting, some external hæmorrhage, but not enough to account for the shock, which is due to the internal bleeding. The intestine may protrude at the vulva. There is sudden cessation of uterine contraction; recession of the fœtal head, disappearance in great degree of the globe of the uterus, and appearance of an abnormal body in the abdomen outside the uterus. This is when the fœtus has at once escaped from the uterine cavity. Some patients have described a sensation of a warm fluid pouring through the abdominal cavity. A snapping sound, occasioned by the rent, has also been heard in some cases. Finally, the introduction of the hand into the uterus reveals the presence of a fissure through which the hand can pass directly into the abominal cavity.

If the rent has been less extensive or more gradual, the symptoms of shock, of course, come on more slowly. It is in these cases that the diagnosis is sometimes not made, though, under these circumstances the tear, being lateral, is apt eventually to involve large vessels and so cause symptoms of hæmorrhage.

Generally, if the rupture is complete, the child escapes into the peritoneal cavity, the placenta remaining attached to its site. In some cases due to simple obstruction, however, the fœtus remains in the uterus.

The prognosis to the mother is very grave. The successive gauntlets she has to run being shock, hæmorrhage, metritis, parametritis, peritonitis, and other inflammations; thrombosis, gangrene, septicæmia, and, finally, strangulation of the intestine by inflammatory bands left after the wound has healed, supposing that fortunate result to have occurred.

Recovery has, however, followed negative treatment, even when the rupture was extensive. Dubois reports a case where the fœtus escaped into the patient's right hypochondrium. She recovered, and became again pregnant, when the same accident happened again, and the fœtus escaped into the left hypochondrium. Subsequently one fœtus was removed by an abscess, and the other by laparotomy. Under appropriate treatment the prognosis is much better than under expectancy. For the child the prognosis is also very grave if expulsion into the abdominal cavity have occurred, or if there exist obstruction to its immediate delivery. Its death follows very quickly upon the shock of rupture.

The treatment includes prophylaxis. This requires watchfulness against the dangers of dystocia. If the presence of bony deformity is known, premature labor should be induced at the proper time. All uterine obliquities are to be corrected, as far as possible, so as to keep the axis of the womb coincident with that of the pelvic brim. If thinning of the lower segment is observed, the head not having engaged, means must be taken to relieve the strain by cautious version. If it has engaged, forceps or craniotomy is indicated. As a preliminary to craniotomy Bandl advises the application of forceps to hold the head downward during the perforation.

If rupture has occurred, the immediate symptoms of the mother may require the usual treatment for shock, including a hypodermatic injection of ether. If the child remains wholly or chiefly in the uterus, immediate delivery *per vias naturales* is called for; the head alone having escaped from the uterus, it can usually be drawn back through the rent and delivered as by version. The removal of the placenta requires care that no intestine which may have fallen into the uterus be drawn out with

it. If the fœtus remain with head presenting, craniotomy is applicable. Should the entire ovum be extracted laparotomy will still, in all probability, be required in the interest of the mother, for there must be a considerable hæmorrhage going on in the abdomen. If, however, the rupture seems to have been only partial, and the symptoms of hæmorrhage are not marked, and especially if proper facilities for the graver operation are not at hand, the attendant is justified in waiting after clearing away all clots within reach. Some authorities even advise an expectant treatment when there is a perceptible opening into the abdominal cavity, providing there is no serious hæmorrhage. If this policy be adopted, a drainage-tube should be passed through the tear and maintained in place by suture during the healing process, and after the first two days irrigation should be practised to wash out the pus that forms in the circumscribed portion of the peritoneal cavity. The danger of general peritonitis and septicæmia in such cases, however, is doubtless greater than that from laparotomy, and statistics give a much more favorable showing to this lattter mode of treatment than to any other, as high as seventy-five per cent. of recoveries having been claimed for it, as against eleven per cent. for expectant methods.

There is more room for doubt as to the relative merits of simple laparotomy and Porro's operation, though the prevalence of opinion seems to favor the former (see Hysterotomy). The section should be made in the middle line, and may require to be extended from above the umbilicus to two or three inches from the pubes. The child and placenta, if in the abdominal cavity, are to be removed, bleeding vessels secured, and all clots carefully cleaned away. If a part of the ovum only has escaped, extraction is to be made through whichever cavity involves the least extension of the rent. The peritoneum and uterus having been cleansed and washed with disinfectant solution, the lips of the wound are carefully brought together with carbolized silk sutures, and the abdominal wound closed. In view of the statistics of ovariotomy it is probable that the large fatality following even this treatment is due to the shock of the accident, and that the operation of laparotomy itself does not contribute to the fatal result, but offers the best chance for recovery from the alarming condition into which the rupture has brought the patient.

If the rupture is very extensive, and it is found difficult to check the hæmorrhage fully, hysterectomy is perhaps advisable, although the results are even more discouraging than those of the operation performed under other circumstances.

IV. Dystocia from Increased Resistance of the Maternal Structures.—*Anomalies of the Bony Pelvis.*—The bony walls of the canal through which the child has to pass may be encroached upon through malformations, either congenital or acquired. The diseases most likely to distort the pelvis are rickets and osteomalacia. A dwarf or hunchback is extremely unlikely to have a pelvis of normal capacity, as is also a woman with undue curvature of any of the long bones, or with the "rosary" of rickets upon the costal cartilages; though, on the other hand, a large and seemingly well-formed woman is not certain to have a correspondingly roomy pelvis. Breadth of hips and of sacrum argue well for the obstetric perfection of the pelvis. A history of previous normal labors is confirmatory of this satisfactory condition. Schroeder says, however, that even in considerable pelvic contraction the first labors are liable to be easier than the subsequent ones.

The only certain knowledge of the capacity of the pelvis is to be gained from measurements. Three external diameters are of importance, that between the anterior superior spines, that between the iliac crests, and the external conjugate, or diameter of Baudelocque, viz., that from the depression just beneath the spine of the fifth lumbar vertebra to the upper margin of the pelvic symphysis. For the first two of these measurements the patient should lie supine on a table or hard bed; for the last, she must lie on the side. Various calipers or pelvimetres have been provided for ascertaining these measurements. That of Baudelocque consists of two curved arms terminating in knobs, and movable at a joint with a graduated arc, whereby the distance of the knobs from one another can be easily read (Fig. 1947). The most important normal measurements, which will be seen on comparison to be somewhat greater than those of the skeleton (see Labor, Mechanism of, for measurements of the pelvis), are as follows: Between the anterior superior spines just outside the origin of the two sartorius muscles, 26 ctm. = $10\frac{1}{4}$ inches; between the iliac crests, 28 ctm. = 11 inches; external conjugate, $20\frac{1}{4}$ ctm. = 7.9 inches.

The chief significance of the first two of these measurements is in their mutual relation rather than in their absolute value. If the first dimension equals or exceeds the second, the pelvis is probably rickety. The third measure gives an approximate estimate of the true conjugate; at least, if it fall below 16.75 ctm. (7 inches) there is reason to suspect narrowing of the brim.

The true conjugate can, however, be accurately determined only by internal measurement. This is effected as follows: The index and middle fingers of the left hand are introduced into the vagina, the remaining digits being closely flexed into the palm. The most advanced point of the hand, which is, of course, the tip of the middle finger, is directed upward and backward above the hollow of the sacrum, the wrist for this purpose being carried well backward, and the perineum being gradually but strongly raised. The most prominent point of the spine, which is usually the promontory, is sought for; but in some cases of deformity the junction of the first and second sacral vertebræ projects more than the true promontory, while in the spondylolisthetic pelvis the lower lumbar vertebræ are most prominent. In such cases the greatest projection, even if it be not the true promontory, is selected for measurement, as the object is to have the shortest antero-posterior diameter. The ulnar side of the tip of the middle finger impinging on the promontory, the radial side of the index is brought close under the pubes and the point at which the edge of the inferior pubic ligament meets the finger (or metacarpus) is marked with the nail of the right index. Then the hands are withdrawn, and while the fingers are still occupying the same relative position the distance is measured. If the bladder and rectum be emptied before the operation, there is usually little difficulty in reaching the promontory, at least if there is any narrowing of the brim.

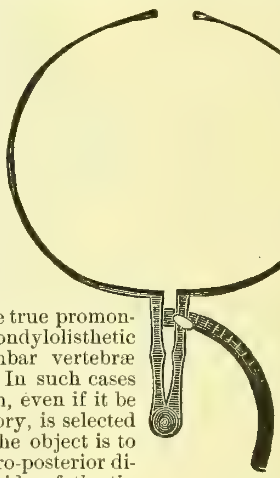

Fig. 1947.

The measure of the diagonal conjugate should, in a healthy pelvis, be 13 ctm. (5.1 inches). From this measure we may compute the conjugata vera—the distance from the promontory to the upper edge of the symphysis. The latter is evidently the third side of a triangle, of which the diagonal conjugate is one and the height of the symphysis the other. The latter can be determined by digital measurement. The angles of the triangle, and hence the value of the required third side, depend on the inclination of the symphysis to the horizon. If normal, the triangle is nearly a right one (Fig. 1948); if its upper extremity is tilted unduly downward, the triangle becomes more nearly isosceles, so that the true conjugate is not much shorter than the diagonal (Fig. 1949); while if the symphysis be tilted upward, its angle with the true conjugate becomes more obtuse, and a greater amount must be subtracted from the diagonal to give the true conjugate (Fig. 1950). In general, in a normal or equally contracted pelvis the true conjugate is $1\frac{3}{4}$ ctm. (.68 inch) less than the diagonal; in a flat, non-rickety pelvis we

Labor.

should subtract rather more than this, and in a rickety pelvis 2 ctm. or more.

The distances between the tubera ischii, which are of importance in some cases where there is narrowing toward the outlet, as in kyphotic pelvis, are easily obtained by compasses, the woman being placed in the lithotomy position. No subtraction need be made for the soft parts. This measure should be 11 ctm. (4 inches).

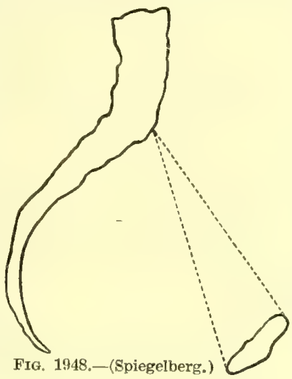
FIG. 1948.—(Spiegelberg.)

The other measurements of the pelvic cavity and outlet are of more theoretical than practical importance, and are not easy to be accurately determined. With experience, however, the accoucheur can form a general estimate as to whether the pelvic cavity is deficient or not.

The principal causes of bony deformity may be classed as follows: 1. Congenital, or developmental, as in the uniformly contracted pelvis. 2. Diseases of the nervous system; notably rickets, a disease of childhood, and osteomalacia, a disease of adult life, commonest in the female and especially in the puerperal state. 3. New growths. In the United States rickets is so much less common than in the Old World that one fruitful source of pelvic deformities is largely removed from our native-born population.

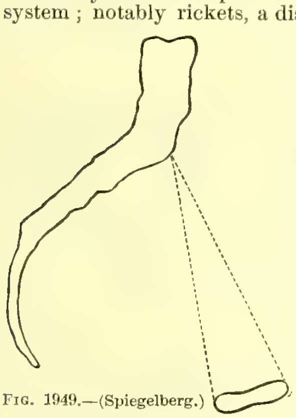
FIG. 1949.—(Spiegelberg.)

The limits of this article do not admit of a complete description of the various forms of pelvic deformity, but the chief varieties will be enumerated.

1. The generally uniformly contracted pelvis (æquabiliter justo minor) retains nearly the normal relation between its diameters; but, as the name indicates, its size in every respect, as shown in all the chief measurements, is somewhat diminished. It is not specially common, but is found in persons of small stature and in women in whom the juvenile pelvis has persisted in adult life. Thus the sacrum is narrower, straighter, and less depressed in the pelvis than normally in adult life. The diminution of the various diameters sometimes averages 3 ctm. (1⅛ inch), and the encroachment on the normal calibre is most serious at the brim. Very rarely this deformity may be due to rickets, in which case there are the customary expansions of the superior iliac spines.

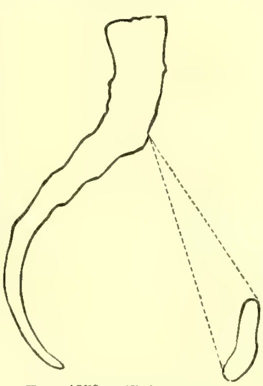
FIG. 1950.—(Spiegelberg.)

2. The flat pelvis represents by far the most frequent deformity. It is characterized by a diminution of the antero-posterior diameter, the brim, as in the preceding class, being the part most affected. According as the transverse diameter is, on the one hand, of normal or increased length, or, on the other, is diminished, the pelvis is spoken of as (*a*) the simple flat, or (*b*) the generally contracted flat pelvis.

(*a*) The simple flat pelvis may be rachitic or non-rachitic in origin. When rachitic, its inclination is abnormally great. The sacrum has descended farther than usual into the pelvis, being forced downward and forward from the synchondrosis with the ilia, so that, instead of being concave transversely, the sacrum is straight, or even convex. The general shape of the brim sometimes becomes like the figure of 8, only one loop of the figure being available for the transit of the fœtus. Supero-inferiorly the curve of the sacrum is increased. As in all rachitic pelves the diameter between the anterior superior spines is increased relatively to that between the crests. The pubic arch is widened, the symphysis makes a greater angle with the conjugate, and the tubera ischii are farther apart. There is rotation of the sacrum upon its transverse axis (see Fig. 1951).

The non-rachitic variety of flat pelvis is much the most common in this country, as indeed it is even in countries where rachitis is far more frequent than here. It is produced by an excessive operation of those agencies which cause the development of the infantile into the woman's pelvis, thus being etiologically the reverse of the justo-minor pelvis. The sacrum has descended into the pelvis as in the rachitic cases, but there has been no rotation around the transverse axis. The approximation of the promontory to the symphysis has caused an elongation of the transverse diameter; but inasmuch as the whole pelvic structure is likely to be somewhat smaller than normal, the absolute transverse diameter of the brim may be no greater, or may even be somewhat less, than it is in normal pelves. This deformity has been ascribed to too early active exercise by little girls, carrying of excessive weights, etc. While relatively a frequent condition, its existence does not betray itself to casual observation as do most other kinds of deformity. Measurement only will reveal its existence. The degree of obstruction caused by it is rarely so great as with the rachitic deformities, and often nature is able to effect delivery by giving the head the inclination to the plane of the brim known as Naegele's obliquity (see Labor, Mechanism of). In all cases where, with good pains, the head fails to engage, the existence of a simple flattening of the pelvis may be suspected.

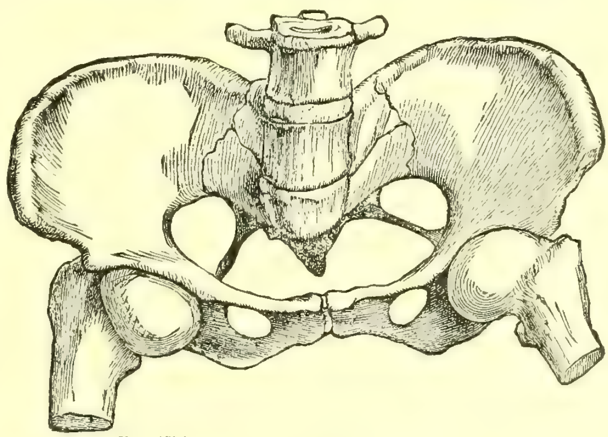
FIG. 1951.—Simple Flat Pelvis. (Barnes.)

(*b*) The generally contracted flat pelvis, or, as it is sometimes called, the generally unequally contracted pelvis, differs from the foregoing only in that the transverse diameter, instead of being within physiological limits, is contracted like the conjugate. Like the simple flat pelvis, it may be of rachitic origin or not.

The deformities already considered, which constitute the most frequent ones, all involve an obstruction greater at the brim than elsewhere. In those now to be named the outlet suffers, as a rule, equally with or more than the brim.

3. In the spondylolisthetic pelvis the last lumbar vertebra has separated from its articulation with the sacrum, and the inferior surface of the former rests on the ante-

rior surface of the latter. The whole spine sinks into the pelvis, and the three or four lower lumbar vertebræ form an arch which takes the place of the true promontory, but from which the sacral masses do not expand laterally as in rachitic flattening. The point of bifurcation of the aorta is sometimes carried so far down as to be within

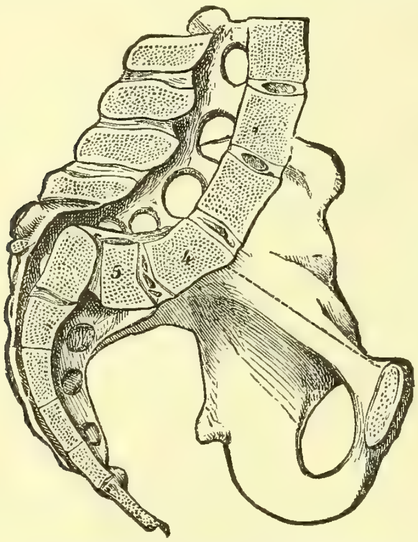

FIG. 1952.—Spondylolisthetic Pelvis. (After Kilian.)

reach of the examining finger. The diameters of the outlet are also contracted (see Fig. 1952).

4. The kyphotic pelvis, the kyphosis being in the lumbar or sacro-lumbar region, and usually due to caries, has a narrow but long sacrum, and the promontory is carried up out of reach. All the diameters at the brim are enlarged except the transverse, while in the cavity and at the outlet all are diminished, the anterior posterior least so. The pubic arch is narrow. If the kyphosis be high enough up, so that there is compensa-

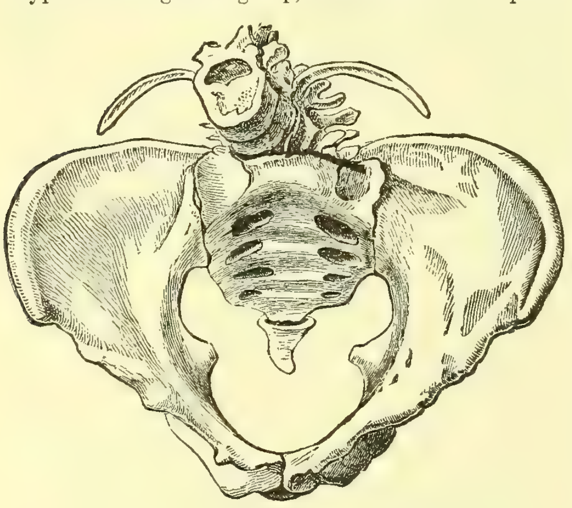

FIG. 1953.—Kyphotic Pelvis. (After Hugenberger.)

tory lordosis below, the antero-posterior diameters are contracted (see Fig. 1953).

5. The funnel-shaped pelvis is normal at the brim, but its walls converge below till the outlet somewhat resembles that of the kyphotic, with the tubera ischii approximated so as to narrow the pubic arch. This pelvis is frequently asymmetrical.

6. The anchylosed, obliquely contracted pelvis, known as the "Naegele pelvis," and (7) the anchylosed, transversely contracted pelvis are rare, and the names sufficiently describe their general shape. The latter of these is otherwise called the double synostotic, or Roberts' pelvis. The anchylosis affects both sacro-iliac synchondroses. Various external measurements on the two sides, as from one tuber ischii or trochanter to the opposite posterior superior iliac spine, reveal the lack of symmetry.

8. The osteomalacic deformity is characterized by marked curvature of the sacrum, the promontory being approximated both to the symphysis and to the coccyx. The brim is somewhat triangular in shape, and beak-like toward the symphysis. The antero-posterior diameter in the cavity is not usually shortened, but the outlet is lessened in both the sagittal and coronal planes. The descending rami of the pubes are nearly parallel, the tuberosities of the ischia having approximated each other (see Fig. 1954).

9. Bony deformities may result from the callus of fractures or from osteo-sarcomata, or other new growths.

The *prognosis* to mother and child in cases of contracted pelvis depends in general upon the degree of contraction, though the moderate degrees of contraction are less dangerous for the mother than for the child. The minimum length of true conjugate diameter which is considered safe for a living child at term is 9.4 ctm. (3¾ inches), though living children have been delivered arti-

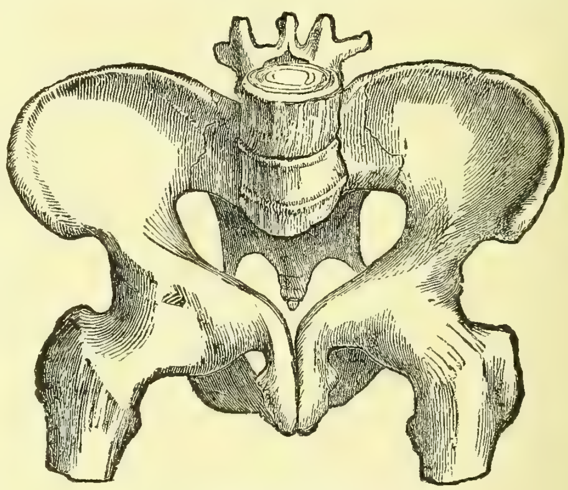

FIG. 1954.—Osteomalacic Pelvis. (Barnes.)

ficially through conjugates as small as 6.5 ctm. (2½ inches). For the average operator there is little hope of saving the child under 7.5 ctm. (3 inches). In the spondylolisthetic and other deformities which affect the pelvic canal below its brim the prognosis is worse than where the contraction is limited to the short space of the inlet.

The dangers to the mother are those of bruising to the soft structures, uterus, cervico-vaginal tissues, bladder, etc., with consequent sloughs and fistulæ, the risk of gangrene depending more upon the length than upon the severity of the pressure; rupture of the uterus and, rarely, of the pelvic joints; the accidents of prolonged labor and the risks attendant on the operative procedures which may be necessary for her relief.

The child's dangers are those of pressure, especially upon the head. The overlapping of the sutures, which is one of nature's provisions for lessening the size of the head, may be so extreme as to cause rupture of the sinuses, and there may be sloughs of the scalp. Fissures, incurvations, spoon-shaped depressions of the cranial bones occur, the latter being especially fatal (fifty per cent. of the cases), and even when not fatal sometimes leaving permanent deformity. Cephalæmatomata are found at the bottom of these depressions, and elsewhere. Moderate effusions of blood on the surface of the brain are much less dangerous than those at the base. Solutions of continu-

ity at the base of the skull, as by the tearing off of the condyles, from the occiput, occur when the head comes last rather than when the vertex presents.

Asphyxia of the child may result from the compression of the placenta or from its premature detachment, as well as from prolapsed funis, a comparatively common accident in cases of pelvic contraction. All the dangers to the child as well as to the mother are likely to be greater in the succeeding labors than in the first, for the reason that the uterus has become less capable of functional activity than it was at first.

TREATMENT OF DYSTOCIA FROM CONTRACTED PELVIS.—The prophylaxis merits more attention than it has hitherto received. Prompt treatment of the first appearance of rickets in children, accompanied with rest in bed, and precautions against too early walking in female infants or the carrying of heavy weights, are reasonable precautions.

Unfortunately it is difficult to predict the amount of obstruction likely to be caused to labor in any given case as however accurate one may be in the pelvic measurement, the size of the fœtal head always remains an unknown quantity. In the slighter cases of contraction, *i.e.*, when the conjugate is 9.5 ctm. or upward, expectant treatment is sufficient. We have only to watch nature's possibly difficult process, which is as follows : The contraction at the brim hinders the head from engaging before labor begins, and the agencies which usually produce flexion fail to act. The head finally engages, with the forehead low, the sagittal suture transverse. The shorter and more compressible bitemporal diameter is better adapted to pass the contracted conjugate than is the biparietal, and though the former is never quite substituted for the latter, the presence of the large fontanelle opposite the promontory indicates that the diameter of the head that passes that point is nearer to the bitemporal than to the biparietal. The portion of the head posterior to the frontal suture completely fills the one lateral half of the brim, while the other half is only partially filled by the forehead.

When the head has fairly passed the brim the usual conditions produce flexion, and ultimately rotation. In the generally uniformly contracted pelvis the natural agents of flexion act from the first, and more strongly than usual, on account of the increased resistance.

If the difficulty of engagement is considerable the extension may go to the degree of causing a face presentation, which persists throughout the labor, rotation of the chin usually occurring rather late. If the pelvis present it is the feet rather than the breech that first find their way through the brim. Transverse positions are more common than normally, and the back is toward the mother's spine in an inordinate number of instances. The lack of adaptation of the presenting part, whatever it may be, to the narrowed brim, makes prolapse of the funis unduly common.

The dilating stage is liable to considerable delay, because the height of the fœtus does not admit of its proper pressure being brought to bear on the os as an aid. If the belly is pendulous the os is so far back that the anterior lip is very slow to be obliterated. On the other hand too rapid dilatation, while the uterus is still high, may, by rapidly slipping the os over the head before it has entered the pelvis, greatly stretch and even tear the vaginal junction. An unusual activity of the uterine contractions is necessary to make the head engage, and although their severity may threaten rupture, which accident is by no means unheard of under these circumstances, still these violent contractions are to be welcomed, as giving the best and only chance for nature to finish her work. The mother is to be encouraged to bear down, and thus call the accessory muscles into play at an earlier stage than usual, that is, to force the head into the cavity rather than, as usual, through it after it has already entered. In the simple flat pelvis it is the former step that costs. That having been taken the rest gives little difficulty. Two anomalies of uterine contraction are likely to be met at this point ; the one, feebleness due to exhaustion of the uterine muscle in the present or a previous labor. This requires an artificial *vis a fronte* to supplement the inadequate *vis a tergo*. The other difficulty is a tetanus of the uterus caused by a fusing together of very frequent pains. It is most commonly seen when a malpresentation, as that of the shoulder, has made impossible the task that otherwise was simply one of difficulty. This requires anæsthesia as a preliminary to operative interference.

The "Naegele obliquity" (see Labor, Mechanism of) is a potent aid in helping the head through a flattened brim. The posterior parietal bone is inclined toward the corresponding shoulder, and the sagittal suture, which passes parallel to the transverse diameter of the brim, is nearer to the promontory than to the symphysis, consequently the anterior parietal boss passes into the pelvic cavity before its fellow. The advantage gained by a substitution of a subparieto-supraparietal diameter for the biparietal is enhanced by the fact, already alluded to, of the occiput gliding to one side so as to bring even this diameter somewhat outside the point of greatest narrowing.

When a patient with deformed pelvis is under observation throughout pregnancy, it is the opinion of the vast majority of obstetricians, despite the unfavorable attitude of one or two German authorities, that the labor should be anticipated. If the conjugate be less than 6.5 ctm. ($2\frac{1}{2}$ inches), the possibility of a living child being born is *nil*, and hence abortion should be induced as soon as pregnancy is diagnosticated. Some would extend the limit calling for abortion to 6.85 ctm. ($2\frac{3}{4}$ inches). The time for abortion having elapsed, however, in these small pelves, it is better to let the woman go on to term, as perforation will be inevitable, and it is unnecessary to expose her to the added risks of induced labor. If the diameter is between 6.5 and 9 ctm. premature labor is demanded in the interest of both mother and child, the proper time for its induction being indicated by the following table (from Playfair after Kiwisch) :

If the conjugate	is	6.5 ctm. ($2\frac{1}{2}$	inches)	induce	labor at	30th	week.
"	"	6.7 ctm. ($2\frac{2}{3}$	"	"	"	31st	"
"	"	7 ctm. ($2\frac{3}{4}$	"	"	"	32d	"
"	"	7.5 ctm. (3 to $3\frac{1}{12}$	"	"	"	33d	"
"	"	8 ctm. ($3\frac{1}{4}$	"	"	"	34th	"
"	"	8.5 ctm. ($3\frac{1}{3}$ to $3\frac{1}{2}$	"	"	"	35th	"
"	"	9 ctm. ($3\frac{3}{4}$	"	"	"	36th	"

He who, in accordance with this table, induces labor at the thirtieth week will probably be disappointed in saving the child, but perhaps the chance is worth striving for.

The patient having gone on to term the probability is that, given a conjugate of 9.5 ctm., she will accomplish her labor without need of assistance. If, however, there is delay, and the welfare of mother or child begins to be compromised, the conjugate diameter being three inches or over, and the head not engaged, *version* is indicated (see Version, Forceps). The advantages of this operation over high forceps are these : A soft part of the fœtus being substituted for a hard one there is less bruising of the maternal tissues ; an after-coming head can be extracted through a narrower brim than the same head will pass fore-coming ; a high-forceps operation is graver for the mother than turning, because the blades must be applied over the forehead and occiput, a faulty position in that the blades are too much spread, and, moreover, any compression produced will be at the expense of increasing the biparietal dimension of the head, already too great to pass the contracted conjugate.

If turning has succeeded, traction can be made without any compression of the head which will lengthen the opposite diameter of the head, and the base of the cranium serves as a more natural dilator of the passage than the larger vertex. A living child has thus, at term, been extracted through a diameter of only two and three-fourths inches. Moreover, if perforation is finally found necessary it can be performed upon the after-coming head with no greater risk to the mother than upon the vertex. Version is, of course, the operation to be used in the not uncommon trunk presentations which accompany contracted pelvis.

The high-forceps operation is by some recommended as the routine treatment for cases of moderate contrac-

tion, though, for the reasons given, the writer prefers version. If, however, the head has passed the brim the time for version has passed, and forceps is the proper operation. If for any other reason version has failed the forceps should be tried before having recourse to any more serious measures.

The degree of contraction which is fatal to the birth of a living child, and yet admits of the extraction of a mu-

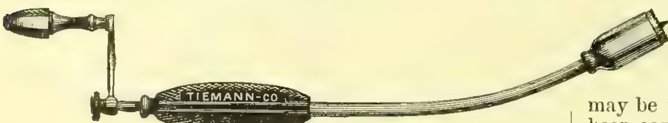

FIG. 1955.—Braun's Trephine Perforator.

tilated one *per vias naturales*, is put at 6.8 ctm. (2⅝ inches) for the upper limit, and the lower margin varies between 5.5 ctm. (2.1 inches), the German estimate, and 4 ctm. (1.5 inch), the English. Flat pelves, having conjugates within this range, and justo-minor pelves, with conjugates even reaching 3¼ inches, require either, on the one hand, Cæsarean section or one of its modifications, or on the other, craniotomy. The theological tenets of the Roman Catholic Church are opposed totally to craniotomy in the living child. But, waiving these considerations, we may say that for such cases craniotomy gives a better promise for the safety of the mother than Cæsarean section, at least as that operation can be performed by the general obstetrician, and the general sentiment of intelligent obstetricians holds the mother's life (when both are imperilled) more precious than the child's. When the contraction is so great as to preclude the possibility of extracting

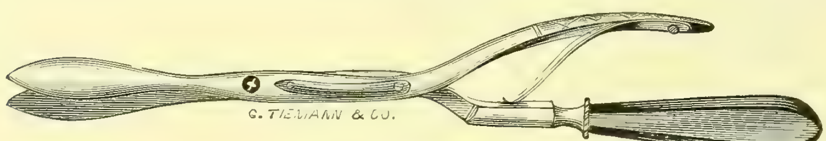

FIG. 1956.—Blot's Perforator.

even a mutilated child, the Cæsarean section, Porro's operation, or laparo-elytrotomy must be performed (see Cæsarean Section).

Craniotomy as an operation will, for convenience' sake, be considered at this place, though it is indicated under other circumstances than pelvic contraction of the degree just specified, namely, when there has been failure to deliver by version or forceps in minor cases of deformity, in atresia, cicatricial or due to cancerous or other tumors, in cases of locked twins, of marked hydrocephalus, or impaction of the fœtus from any other reason, and whenever the fœtus is dead and the conditions require speedy delivery. The operation is thus performed: The patient being anæsthetized and the bladder and rectum emptied, the first step is perforation; for this the point of election in vertex cases is the most accessible part of a parietal bone felt through the cervix, avoiding the immediate neighborhood of a suture or fontanelle. The head being fixed as firmly as possible by an attend-

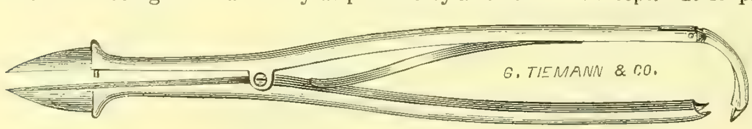

FIG. 1957.—Naegele's Perforator.

ant, perforation is best performed with a trephine made for the purpose. The advantage of this instrument is the cleanness of the opening and its persistent patency, without irregular needles of bone projecting. One hand of the operator holds the shaft of the trephine, the other (corresponding to the side of the mother at which the opening is made) secures apposition of the rim throughout its circumference and protects the maternal structures, while an assistant turns the screw at the handle of the trephine until the bone is bored through. If other perforators are preferred, Smellie's scissors, or Simpson's, Blot's or other modification thereof, may be employed. With the same precautions as to the locality and direction of the puncture the perforator is driven through the skull by a boring motion. Careful examination should be made with the finger to see that the perforation involves nothing but the fœtal head. With the same finger as a guide the scissors are passed into the skull, and the brain-substance is thoroughly churned through to the base of the skull. The most painful spectacle for operator and for friends may be presented if the destruction of the brain has not been complete. Unless there is special haste it is well to wash out the lacerated brain-substance by a syringe introduced through the hole in the skull.

In cases of extreme pelvic contraction this diminution of the head still leaves the base of the skull too large and firm to be drawn through the canal. Hence the *basilyst*, a combined screw and dilator, has been devised, to be carried through the cranial cavity, fixed in the firm bones of the base, and divulsed to break them up. The necessity for the use of this instrument is not frequent.

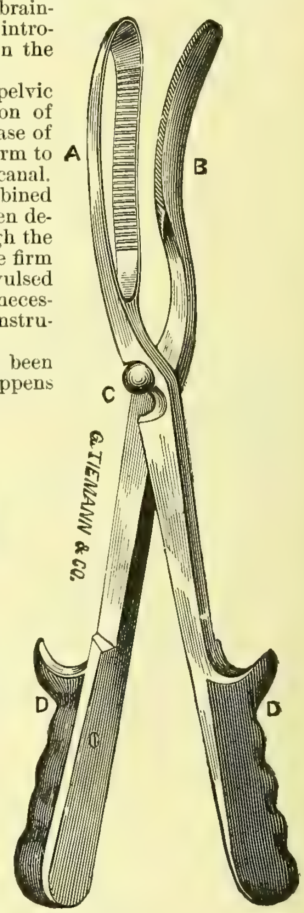

FIG. 1958.—Simpson's Cranioclast.

When the head has been evacuated it sometimes happens that the uterine contractions are then able to force the diminished head through the pelvis, but this result, however happy, is not to be expected nor long waited for. The cranioclast is the best instrument for performing extraction. It has two blades, which are curved in the same direction and closely oppose each other. The smaller male blade is introduced through the opening well into the skull, and the fenestrated female blade outside the skull in the manner of the long forceps. It is placed toward that side which admits of the strongest "grip," and the handles screwed together firmly. Then traction is made in the axis of the brim. Barnes recommends using the female blade between the scalp and skull to lift off portions of the calvarium in order to let the arch fall in more perfectly; then the cranioclast is applied over forehead and face for extraction. If the perforation has been made by any of the scissors-perforators the operator must, during extraction, carefully shield the maternal passages from any spiculæ of bone.

The cranioclast is, contrary to what its name would indicate, an extracting rather than a crushing instrument. The cephalotribe is more essentially a crushing instrument, though it has been arranged to admit of axis

traction by Barnes. It is applied, like forceps, quite outside the skull, and is an exceedingly powerful instrument. But it is found that even cephalotripsy is best preceded by perforation, on account of the tendency, if the head is not evacuated, for the strong compression in one place to make a troublesome lengthening in another.

When the face presents, perforation is less easy than through the skull. The orbit should be used as the place of perforation, if possible ; if not, the roof of the mouth. Of course, here the trephine is not applicable. On the after-coming head the perforation cannot be made vertically, but must be made obliquely. Here, too, therefore, the trephine is inapplicable. The child's feet and body being carried well back, the perforator is entered under the pubic arch, and forced through the occipital bone or at any accessible point behind the ear.

Having thus considered contractions of the bony pelvis, we now pass briefly to new-growths of various kinds in the genital canal which may lead to dystocia by obstruction.

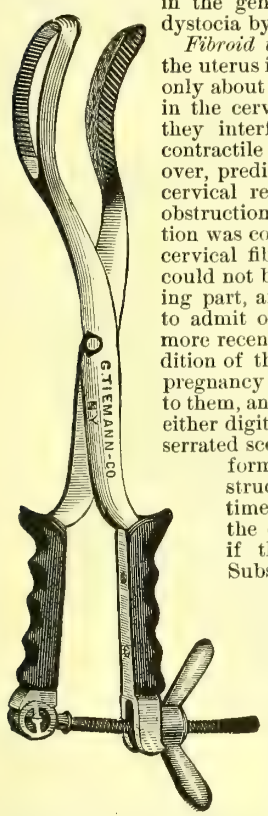

FIG. 1959.—Braun's Cephalotribe.

Fibroid tumors occur in the body of the uterus in the great majority of cases, only about twelve per cent. being found in the cervix. In the former situation they interfere with labor by replacing contractile uterine muscle, and, moreover, predispose to hæmorrhage. In the cervical region they cause danger from obstruction. Formerly the Cæsarean section was considered the only remedy for cervical fibroids of large size, if they could not be pushed above the presenting part, and were not pediculated so as to admit of easy avulsion. But it has more recently been shown that the condition of the os in the later months of pregnancy offers rather favorable access to them, and the operation of enucleation, either digitally or by means of Thomas' serrated scoop, has been successfully performed on some very large obstructing fibroids. The preferable time for the operation is before the expiration of the pregnancy, if the condition is recognized. Subserous myomata situated behind the uterus, and greatly encroaching on the cavity of the pelvis, demand Cæsarean section.

Any obstructing cystic tumors should, of course, be aspirated. Abscesses of the lips of the os tincæ have been recorded, causing great pain and hindering dilatation. If fluctuation is obtained, incision of the abscess is the obvious treatment.

Ovarian tumors were formerly advised to be tapped and otherwise temporized with until the expiration of the pregnancy. But, as tapping has been found to injure the chance of successful operation, and as even this cannot be depended upon to relieve the mother of uncomfortable, not to say dangerous, distention, the weight of recent authority is in favor of ovariotomy, at least if it can be done by the fourth month. After the fifth or sixth month there is more danger of miscarriage and a slower recovery. The removal of both ovaries simultaneously at the fourth month has been found not to prejudice the course of the gestation, or even the lactation.

Cancerous degeneration of the cervix, if not excessive, frequently causes no special difficulty. Sometimes incision of the healthy portion is required. Embryotomy, in any form, is contra-indicated, inasmuch as the disease, already compromising the mother's life, should cause all risks to be put on her rather than upon the child. In case that laparotomy is inevitable, the Porro operation is especially indicated.

Various conditions other than those already mentioned may cause obstruction to the passage of the fœtus. Prominent among them is *rigidity of the cervix.* This term applies properly where there is no structural lesion. It exists in two forms, which may be distinguished as passive and active. The former, which is the less common, is characterized by a resistance of the thick, dense cervical muscle, which merely keeps it from dilating under the pressure of the presenting part. This condition is seen especially in very young and in elderly primiparæ, and in premature labors. It is often accompanied by severe pains in the loins.

The active rigidity, spasmodic contraction, or trismus cervicis, is characterized by a spasm coming suddenly in a cervix that has begun to dilate and closing it up again. Instead of being thick and dense, the edge of the orifice is thin and falciform. The structures are irritable. The condition usually does not last for a great while before it yields, but while it does last the labor is brought to a standstill, though the pains are even more fretting to the woman than if they were effective. Even after the head has passed through the os the contraction may form again about the neck. The spasm may occur in the strong and robust, but is more frequent in the anæmic, irritable, and nervous. The premature draining away of the amniotic fluid (dry labor) is especially calculated to call forth this spasmodic rigidity.

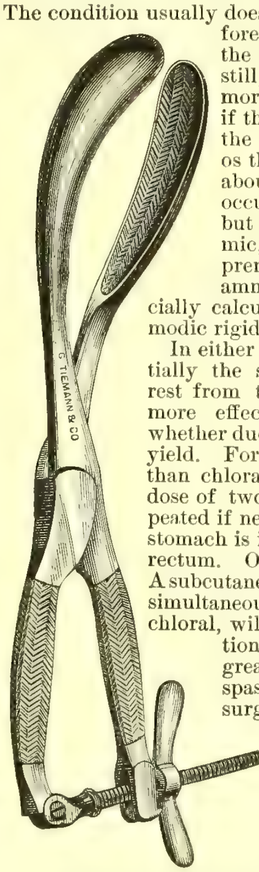

FIG. 1960.—Simpson's Cephalotribe.

In either case the treatment is substantially the same. A short physiological rest from the pains will bring them on more effectively, and the obstruction, whether due to resistance or to spasm, will yield. For this purpose nothing is better than chloral, which may be given in a dose of two grammes (thirty grains), repeated if necessary after an hour. If the stomach is irritable, this may be given per rectum. Opium is also a useful adjunct. A subcutaneous injection of morphia, given simultaneously with a moderate dose of chloral, will distribute the calmative action over two hours or more, to the great benefit of the patient. If the spasm is very persistent, a brief surgical anæsthesia, with ether or chloroform, is useful. Hot vaginal injections, thrown forcibly against the cervix, have an excellent effect in these cases. Tartar emetic and bleeding, which were formerly employed in rigid cervix, have largely given way to the treatment already indicated. Bleeding should be resorted to only in the plethoric, if at all. The indications for incising the cervix must be very rare.

As rigidity of the cervix is often due to escape of the liquor amnii, it has been recommended to push back the head, in the hope that enough fluid may reaccumulate to effect dilatation. An artificial imitation of this mechanism, through the use of Barnes' bags, may be usefully made. Finally, if all the above endeavors fail, digital dilatation is to be performed, in the manner described under "Labor, Premature Induction of," which see. Full surgical anæsthesia should be induced, as well for the relief of pain as for relaxing the spasm of the cervix. The time at which this last measure is to be resorted to depends, of course, upon the woman's condition. If the membranes are still intact, we may wait longer than if they have yielded ; for in the former case there is a better chance that nature can finish her work. But it is always to be remembered that exhaustion can be produced

at this stage of labor as readily as later, and a fatal sequel of artificial dilatation may be due to the operation having been too long deferred rather than to its intrinsic severity.

A word may be added in strongest condemnation of the use of ergot for rigid cervix. Nothing could be more unfortunate than the action of this drug.

Organic rigidity may be due to the density of an extensive cicatrix, in which case an incision may be required. Otherwise the treatment is identical with that just described. Cicatrices sometimes exist in the vagina or vulva sufficiently strong to require division before the head can pass.

Atresia, if complete, has of course become so since impregnation, though its cause probably dated back to a laceration from a previous labor, or to some antecedent inflammation. An apparent atresia of the cervix may be due merely to a malposition of the os, which is a much less rare occurrence than a true atresia. A careful search should therefore be made with the finger, and by use of a speculum, for an os carried very far back and very high, or for an anterior lip covered by a posterior. Sometimes the external orifice is merely agglutinated, in which case a dimple can be found that can easily be dilated by the finger-tip. If, however, actual atresia does exist, as evidenced by long and fruitless attempts of the presenting part to cause any opening, and by failure to discover any rudiments of an orifice, an operation is called for. An incision should be made transversely, not over an inch in length, the layers being divided one by one with a bistoury ; or the cervix may be drawn away from the head with toothed forceps, and divided with straight scissors. Radiating incisions may sometimes be called for. Atresia may affect in like manner the vagina or vulva, and require division. The rare instances of rigid perineum and persistent hymen should be mentioned in this connection. The former requires hot fomentations, followed, if necessary, by small incisions, the latter incision followed by dilatation.

Œdema and contusion of the anterior lip is caused by descent of the head before dilatation is complete. The cervix carries the anterior lip before it, elongates, and bruises it. Sometimes it is actually torn off. The real amount of obstruction caused by such a tumor is, perhaps, not great, but the pain to the mother is intense, and the danger of gangrene is not inconsiderable. Hence efforts should be made in the intervals of the pains to push this lip above the advancing occiput. If this cannot be done, from the condition not having been recognized early enough, it is probably good practice to puncture the tumor so as to diminish its volume, in the hope of thus reducing it.

Rectocele and cystocele, in their extremer degrees, may encroach upon the vaginal canal. The rectum and bladder must be emptied, and the prolapse controlled, either by the hand or by a colpeurynter, until the head has come past the redundant tissue, so that the latter may not be jammed down and torn or sphacelated by the hard vertex. Vaginal hernia, if large, also requires support before and during the transit of the head.

Retention of urine may cause a swelling which interferes with parturition. The diagnosis depends on the seat and character of the tumor, though there may seem to be a history of regular micturition. The introduction of a catheter settles the diagnosis and treatment. But under some circumstances this is no easy matter, the head so compressing the urethra as to prevent the passage of the instrument. A raising of the hips may cause the head to fall back enough to admit of the catheterization, which, of course, must be done in the interval of pains. In extreme cases, aspiration *supra pubem* may be necessitated.

Vesical calculus may become impacted before the advancing head. The diagnosis is easy from the mobility of the stone. Usually it can be readily reduced in the interval of pains, and must be kept from again prolapsing. If reduction were impossible, vaginal or urethro-vaginal lithotomy would be required.

V. Dystocia from Abnormalities of the Fœtus.—*Plural Births.*—The occurrence of multiple fœtuses constitutes an abnormality both in pregnancy and at delivery. The labor occurs prematurely in about a quarter of the cases, which fact is in part, doubtless, the cause of the lessened vitality and inferior size of twin offspring. For the arrangement of multiple fœtuses in their respective membranes, and other matters relating to their development, the reader is referred to the article on Pregnancy, Disorders of. With triplets and quadruplets the tendency to premature labor is greater even than with twins, and the development of the fœtuses is so imperfect that comparatively little disturbance of the progress of labor is apt to result. So that we have to consider practically only twin labors. When the fœtuses are both enclosed in a common chorion, being then usually of the same sex, there is more opportunity for mutual entanglement than when each occupies its own sac.

The prognosis regarding both mother and child is less favorable than in ordinary labors. The mother's interest is compromised by the uterine distention, with its tendency to cause inertia, flooding, etc., by the increased demand on her organism, and by the possibility of malpresentations ; the fœtus' interest, by the last-mentioned fact, by the impaired development attending the division

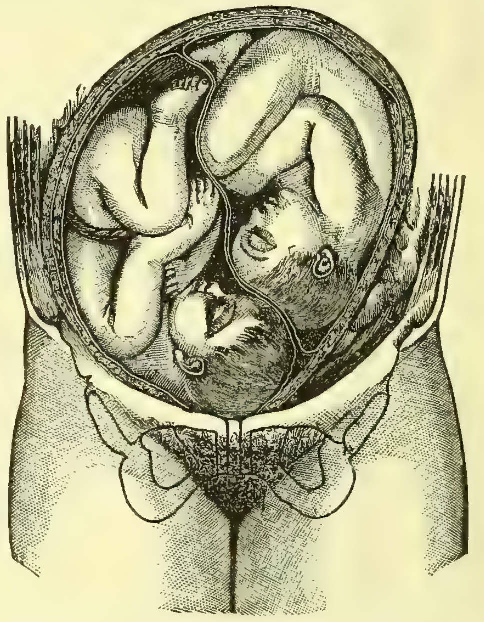

Fig. 1961.—Twin Labor; each Child in separate Sac ; Presentation of both by the Head. (From Tarnier and Chantreuil.)

of a given amount of nourishment between two individuals, and by the prematureness of the labor.

Nevertheless, in the majority of cases of multiple birth the process is carried on without mishap. In nearly half the cases both fœtuses present by the head. In nearly one-third one presents by the head, the other by the breech ; and in nine per cent. both by the breech. In somewhat over one-tenth of the cases the second fœtus lies transversely, the first child presenting generally the head, but more rarely the breech. According to some authorities, as high as sixteen per cent. of the second fœtuses have a transverse position. This malposition is almost always secondary, occurring after the uterus has been relieved of the first child, and when the flaccid organ permits the second child's body to fall transversely into the pelvic brim, instead of maintaining the longitudinal direction that prevails while both fœtuses are *in utero*. It will thus be seen that while head positions predominate in plural births, yet breech and transverse positions are much more frequent than in normal labors.

In ordinary cases (see Fig. 1961) the accoucheur has only to wait. The first child is born naturally. In excep-

tional cases its placenta follows at once. If not, the cord is to be divided in the usual way, special care being taken to tie firmly the placental end, because the two placentæ may communicate, and an oozing from the cut end of the cord would then compromise the second fœtus. It is at this point sometimes that the existence of twins is first detected, though if the case has been under observation throughout the later months of pregnancy the fact of twins should have usually been recognized. Digitally we detect the second head presenting, often with its bag of waters still unruptured. The second birth usually goes on quickly, because of the previous dilatation of the genital passages made by the first child ; but the second child is apt to be the larger of the two, in which case, of course, the canal is not quite completely dilated for it. Moreover, the uterine muscle may suffer from the inertia of over-distention. For these reasons the second child may be delayed after the few moments of physiological rest which should intervene after the first child is born. If a reasonable time pass without the advance of the second head, the membranes should be ruptured, and, if necessary, further assistance given. Special precautions require to be taken against hæmorrhage in the placental stage of the labor and post-partum. Hence the wisdom of following down the uterus by external pressure during and after the birth of the second child.

The second fœtus is, as we have seen above, quite liable to present otherwise than by the head. If by the breech, there is, of course, danger of compression of the cord. If transversely, the malposition must be remedied at once by version, and the foot brought down. It is good practice to introduce the hand into the vagina after the delivery of the first child, if the second vertex is not immediately recognized, for the purpose of detecting at once the position, and remedying it if it be transverse, or securing flexion to the head if that be wanting. It is to be remembered that all malpositions and malpresentations conduce to prolapse of the funis. If this accident occurs, its prompt recognition is of course very desirable.

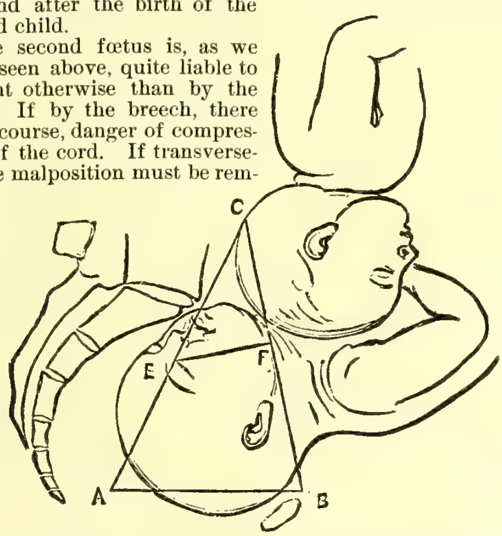

FIG. 1962.—Locking of Twins when both Heads Present. (Barnes.) *A* represents the apex ; *BC*, the base of the wedge which offers itself to the brim ; *EF*, line in which, by craniotomy, the wedge may be broken.

A locking of the two fœtuses into one another may occur in two ways. 1. Both heads presenting, the two occupy the pelvis at once, the second lying in the hollow of the neck or against the thorax of the first (see Fig. 1962). The first head is born, but the second wedges so tightly that the body of the first and the head of the second are equally unable to emerge. Here, if possible, we should apply forceps to the head of the first fœtus, which is extracted while the second is pushed back as much as possible out of the way. The prognosis for both children is very grave, especially the first, whose neck has been subjected to great pressure by the head of his fellow. Sometimes craniotomy is necessitated, though not often. When the two heads are seeking to enter the brim simultaneously, one can usually be pushed aside to allow the other to pass.

A more common method of locking of twins is shown by Fig. 1963. The first child presents by the pelvis, and is born without difficulty as far as the neck. It is then arrested by the head of the second, which locks it by the overlapping either of the chins or of the two occiputs. The body of the first being pushed back a little, and a finger introduced, the diagnosis is usually made without much difficulty. If the heads are exceptionally small, and the pelvis roomy, it is possible for the fœtuses to be born without the lock being decomposed. But this fortunate result is not usually to be expected. The attempt may be made, after pressing back, as far as possible, the body that has been born, to loosen the lock by pushing the heads apart. This should be done under ether.

Before resorting to mutilation we may try to apply forceps to the second head, and draw it past the other body ; but this must generally be very difficult of accomplishment. The first fœtus (the one presenting the breech) is exposed to the greater danger of the two, because its cord must almost infallibly have been compressed, besides that its neck and chest will have been squeezed by the hard cranium of the other. Hence any mutilating operation should fall by preference upon this fœtus. Decapitation, by the method of Ramsbotham or Braun, above described, is to be attempted.

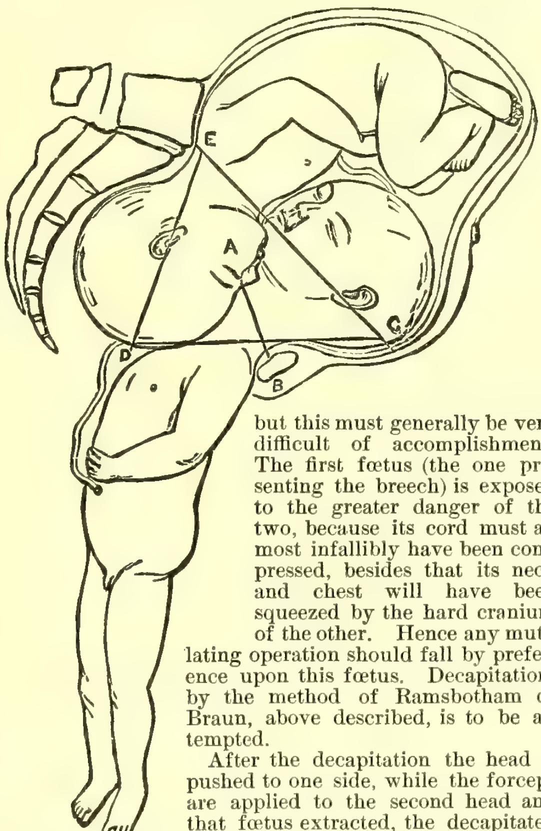

FIG. 1963.—*D*, apex of wedge ; *EC*, Base of wedge which cannot enter brim : *AB*, line of decapitation to decompose wedge. (Barnes.)

After the decapitation the head is pushed to one side, while the forceps are applied to the second head and that fœtus extracted, the decapitated head being removed last. Or, if we have reason to believe that both children are dead, the perforator may be applied to the second head, and its bulk diminished sufficiently to admit of the extraction of the first.

Fœtal monsters properly deserve mention in this connection. Such abnormities are often the result of the fusion of multiple fœtuses. They may be born like twins without difficulty, but in case of dystocia embryotomy would be justifiable at the earliest moment when it could prove of advantage to the mother. The difficulty is to distinguish the real nature of the case from locked twins. Hence the treatment is begun in the same manner as for the latter condition, the attempt being made to cause the heads to engage separately. A pelvic presentation is better adapted to securing this end than a cephalic, and turning, therefore, is desirable if it can be performed. The extracted trunk is then carried as far forward as possible, which tends to bring the posterior head lower than the anterior. If embryotomy becomes necessary, it is to be begun as directed for locked twins,

and must be carried to whatever extent is needed to effect the extraction.

Single monsters may be anencephalous or hemicephalous. In the former case there is no cranial vault to present; hence, frequently some other part, as the nucha, presents, and the mechanism of rotation is imperfect. If the mass which occupies the base of the skull in an anencephalous monster be reached by the attendant's finger, it is liable to be mistaken for a placenta, which tissue it much resembles. It can, however, be ascertained to have no connection with the uterus, and there is not the hæmorrhage of placenta prævia. Version is usually the best method of extraction. The acardiac monster is developed simultaneously with a normal fœtus, and is, as the name indicates, without a heart. It may also be devoid of head, trunk, or limbs, and the diagnosis can only be made after delivery.

Congenital hydrocephalus in sufficient degree to obstruct labor is fortunately rare. It has been found in about one in three thousand cases. In the minor degrees it neither hinders labor nor is necessarily fatal to the child after birth. But if extensive enough to obstruct the labor it would very likely be inconsistent with the survival of the child, so that the latter's interest may yield even earlier than usual to that of the mother. To the latter the prognosis is also grave, unless early aid be given. Lacerations

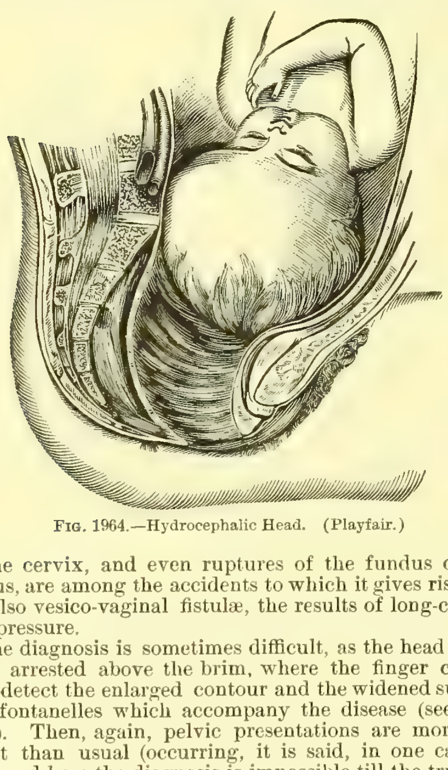

FIG. 1964.—Hydrocephalic Head. (Playfair.)

of the cervix, and even ruptures of the fundus of the uterus, are among the accidents to which it gives rise; as are also vesico-vaginal fistulæ, the results of long-continued pressure.

The diagnosis is sometimes difficult, as the head is apt to be arrested above the brim, where the finger cannot well detect the enlarged contour and the widened sutures and fontanelles which accompany the disease (see Fig. 1964). Then, again, pelvic presentations are more frequent than usual (occurring, it is said, in one case in five), and here the diagnosis is impossible till the trunk is born. A history of previous normal labors is of some value against the diagnosis, as is that of previous hydrocephalic children somewhat in its favor. The introduction of the whole hand is often necessary to complete the diagnosis. A fluctuating sac requires to be differentiated from other cystic tumors, spina bifida, and encephaloid, in which latter condition there is an accumulation of cerebral fluid under the scalp, often communicating with the encephalon.

The treatment consists of tapping the skull between the bones and drawing off the excess of fluid, so that the bones can come together. Version is a good method of completing the delivery. The other fluid collections, just mentioned, may, if obstructive to labor, be treated in the same way. The same remark applies to the rare cases of excessive ascitic or other serous effusions of the child's trunk.

Excessive development of the fœtus causes delay chiefly only as it affects the cranium. The lack of progress calls for forceps or other method of extraction, but it is usually not till after the delivery that the excessive size of the child is certainly learned.

Congenital tumors, as of the spleen, liver, or kidneys, as well as great ascitic distention, may require artificial diminution before the body can be extracted.

A short funis is a not very frequent cause of dystocia. The cord may be short naturally, or may have been shortened accidentally, through having been knotted or coiled about the child's body. The shortest cord on record is 5 ctm. (2 inches). Here, obviously, unless the cord or the placenta yielded, the expulsion of the child would be interfered with. On the other hand, it has been found as long as 175 ctm. (70 inches). Its average length is about 50 ctm. (20 inches). During pregnancy the coiling of the cord about the child's limbs may lead to intra-uterine amputations; but at or near delivery it more often twists about the neck. Fortunately, in such cases it is usually long enough to cause no trouble. But if it be a short one, besides the mechanical obstacle to delivery, it compromises the fœtal safety through pressure on the structures of the neck, and still more through compression of the umbilical vessels themselves, exposing the child to the danger of asphyxia. The circumference of a child's neck varies from 16 to 21 ctm. ($6\frac{1}{2}$ to $8\frac{1}{2}$ inches). Two complete loops about the neck, with the allowance of 16 ctm. ($6\frac{1}{2}$ inches) for the distance from the umbilicus to the neck, would, it is readily seen, nearly take up a cord of average length, to say nothing of the distance from the neck to the placenta, for which there should be cord enough to extend from the vulva to the placenta, a distance varying according to the position of the placental insertion. A certain amount of stretching doubtless takes place in a cord, but it is at the expense of narrowing the umbilical vessels and constricting the neck. The dangers to the mother are of hæmorrhage from the avulsion of the placenta and of inversion of the uterus.

Among the symptoms ascribed to a short or shortened cord, not all of which, however, are met with conjunctively, are marked retraction of the head following the pains, which cannot be accounted for by undue resistance of the soft parts of the mother or by a contracted pelvis. This symptom is by no means distinctive of short cord; indeed, to a certain extent it characterizes normal labor. In addition, there is described a depression of the fundus accompanying each pain; a defined area of pain and tenderness corresponding to the placental site; hæmorrhages following each expulsive effort, due to partial placental detachment. One of the most constant symptoms is the gradual diminution of the pains, with irregularity of uterine action, which may result in the so-called hour-glass contraction. This interference with the natural rhythm of the uterine muscular movements is liable to lead to post-partum hæmorrhage. It also is accompanied by imperfect head flexion, and sometimes by superrotation of the occiput. When the neck reaches the lower third of the genital canal the existence of a coiled cord can usually be determined by the finger.

The treatment often requires early rupture of the membranes to intensify the uterine action. If no progress is made, the forceps of course are to be applied, under ether. If the cord can be felt to be made tense under the extractive efforts, and thus to be holding back the child, it is to be divided by a bistoury guided upon the finger into the vagina. The delivery of the head must, of course, be completed as promptly as possible after the cord has been divided.

Dorsal or nuchal displacement of an arm may be a cause of dystocia. The less common and more difficult form of this displacement to recognize is that which occurs in head presentation, the forearm being flexed and the hand resting between the shoulders. A ridge is thus formed by the elbow and forearm, along the back of the neck, which forms an obstacle to the extraction of the child by forceps

(see Fig. 1965). Nothing but introduction of the hand serves to discover the cause of the obstruction. It is, perhaps, possible to bring down such an arm by extending it, and thus to convert the presentation into one of the head and hand together. But the preferable course is to perform version.

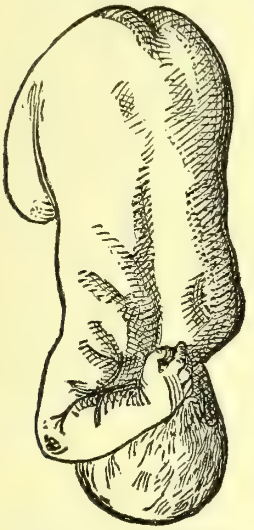

FIG. 1965. — Nuchal Displacement of Arm. (Playfair.)

A similar dorsal displacement of the hand occurs in delivery by the breech, when too rapid extraction has carried the arm above the head, and rotation of the body has left the arm behind it (see Fig. 1966). This occurrence is easily recognized after the delivery of the body has failed to bring with it the arms. The trunk is to be carried backward, and the forefinger passed between the symphysis and the child's shoulder, hooked over the elbow, and the arm thus brought down in front of the child. A careful rotation of the trunk in the opposite direction from that which was the cause of the dorsal displacement may be useful in bringing the arm to the front of the child's body.

Hydramnios—for a detailed description of which the reader is referred to the article on Disorders of Pregnancy—is, if at all considerable, usually inconsistent with a continuance of pregnancy to term, the chorion either yielding spontaneously, or the grave condition of the patient requiring the induction of premature labor. But a moderate increase of the amniotic fluid may persist till labor begins, and may act as a cause of delay in the first stage. As soon as this condition is recognized the membranes are to be ruptured a little distance inside the os, so that the fluid may drain away gradually and relieve the distention which has been paralyzing the uterine action.

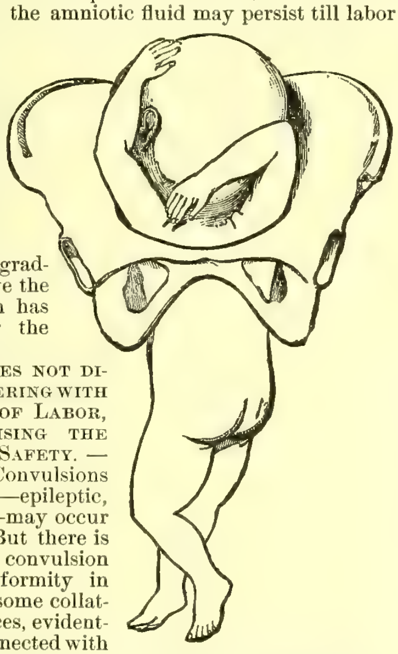

FIG. 1966.—Arms Displaced Upward and Backward by too active Traction in Breech Presentation. (Barnes.)

VI. ANOMALIES NOT DIRECTLY INTERFERING WITH THE PROGRESS OF LABOR, BUT COMPROMISING THE MOTHER'S SAFETY. — *Eclampsia.* — Convulsions of various kinds—epileptic, hysterical, etc.—may occur during labor. But there is a special form of convulsion of general uniformity in symptoms and some collateral circumstances, evidently peculiarly connected with pregnancy and parturition, to which the name puerperal convulsions is by general consent given. Its frequency is about one in five hundred labors. Schroeder found that of 316 cases of eclampsia 62 occurred during pregnancy, 190 during labor, and 64 in the puerperium, but all of the last within two days after the labor. Barnes quotes Von Wieger as finding in a total of 455 cases, 109, 236, and 110 in these three periods respectively. The accident is especially liable to occur in primiparæ.

Regarding the nature and pathogenesis of eclampsia, it must be admitted that our knowledge is as yet imperfect, although many theories have been propounded. Among them the most important are the following: That held, perhaps, by a majority at the present time, and set forth most fully by Braun—ascribing eclampsia to lesions of the kidney, which may consist simply of hyperæmia, or, if more advanced, of exudation and fatty metamorphosis, or of atrophic changes consequent to those previously mentioned. Allied to this view is that which considers eclampsia a manifestation of uræmia, or, as Frerichs puts it, of ammonæmia, the urea that existed having been oxidized to the further extent of carbonate of ammonia, and in that form contaminating the blood. Cazeaux and others lay stress upon conditions of compression as producing the renal insufficiency through interference with the vessels of the kidney, while Halbertsma believes that it is through encroachment upon the ureters that the kidney becomes affected. Traube proposed an explanation, which was adopted and enlarged by Rosenstein, to the effect that the renal difficulty merely intensified, through the loss of albumen, that state of hydræmia which is physiological in pregnancy; that the exalted arterial pressure produced by the hypertrophy of the left heart led, in conjunction with this hydræmia, to watery effusions in various parts of the body, and that such effusions, when occurring in the brain, caused anæmia of that organ through compression of the blood-vessels. On the other hand, we have Gubler's theory of hyperalbuminosis, according to which the albumen of the blood is more increased than the demands of the pregnancy require, so that some of this excess merely drains off by the kidney. These and other more or less plausible views are held by different authors, but objections can be raised to them all, and it is not practicable to go further into their discussion in this place.

Certain points may be considered fairly established, namely: That in the great majority of cases albuminuria attends eclampsia, though each has been observed without the other, and albuminuria seems sometimes to be caused by convulsions; that in the majority of fatal cases well-marked lesions of the kidney are to be found, constituting for the most part the so-called acute desquamative nephritis, or acute Bright's disease of pregnancy; that this disease is in the great majority of cases entirely recovered from within a short time after the expiration of the pregnancy; that insufficiency of functional activity, rather than extent and gravity of structural change, usually determines the eclamptic attack, inasmuch as women having antecedent chronic Bright's disease often go through pregnancy and labor without convulsions, while in some of the fatal cases the amount of renal degeneration is inconsiderable; that the alterations in the central nervous organs are usually the result, and not the cause, of the eclamptic seizure; that while cases of renal origin constitute the great majority of these attacks, yet there is a minority in which some at present ill-understood condition of the nervous system is the cause, involving, perhaps, increased nervous tension and reflex nervous irritability, and that these latter cases are more benign than those due to imperfect elimination of waste matter by the natural emunctories.

The eclamptic seizure may come on without any warning. More commonly, however, some one or more of the following prodromata occur: Headache, mental depression, dizziness, vertigo, amblyopia or hemiopia, severe epigastric pain with or without nausea, œdema of some portion of the body. Examination of the urine shows albumen, renal epithelium, and hyaline, epithelial, and granular casts. The amount of urine passed is of great importance. If it keeps up to 350 c.c. or more daily, even though its character be as above indicated, the danger of convulsions is much less than if it falls much below that amount. Ophthalmoscopic examination reveals the retinal changes characteristic of albuminuria, including both hæmorrhages and white patches. White atrophy of the optic disk is also described. Observations, sphygmographic and otherwise, upon the blood-tension are also sometimes of significance in the

prodromal stage, a high tension being a cause for increased apprehension.

The attack itself resembles an epileptic convulsion without the initial scream. A slight twitching of the eyelids or the corners of the mouth may precede for an instant the general convulsion, which twists the face to one side, fixes the pupils, either in dilatation or contraction; rolls the eyeballs, flexes the limbs, with tonic and clonic contractions of the muscles; bends the trunk sideways or backward, swells the neck, congests the visage; the consciousness is lost, the sphincters often relax, causing incontinence of urine and fæces; the mouth foams, the tongue is bitten, sometimes is nearly severed; the respiration, at first suspended by the tonic contraction of those muscles on which it depends, becomes stertorous. After a period varying in length from two to twenty minutes the twitchings cease, and the patient passes off into the stage of coma. Here the bounding pulse becomes softer, perspiration attends the relaxed state of muscles and skin, and if no new convulsion supervene the period of remission follows, in which the patient gradually regains consciousness and the nervous storm subsides. If, however, there is to be a repetition of the convulsion, nervous irritability returns until under some slight peripheral excitation, or even from no perceptible cause, a second convulsion ensues. The recurrence of the fits may be so frequent as to permit no intervals of consciousness, while the successive shocks shatter the vital forces by their continuous concussion till death ensues. If the seizures are multiple, even if recovery ensues, a period of days remains a permanent vacuum to the memory.

The possible sequelæ of eclampsia comprise phlegmasiæ, amaurosis, deafness, mania, and apoplexy, cerebral and pulmonary, with various paralyses.

The prognosis is exceedingly fatal to the child. Braxton Hicks discovered that coincidently with the convulsions there was a spasm of the muscles of organic life, including those in the uterus, the latter serving to exert dangerous compression on the fœtus. Fœtal asphyxia is also favored by the carbonic-oxide poisoning of the mother's blood. To the mother, in spite of the sequelæ noted above, the prognosis, if proper treatment is pursued, while still grave, is yet better than for the child.

The treatment may be made prophylactic when the prodromata are present. As indicated above, a careful measuring of the urine is necessary, as a help to judging of the urgency of the need of treatment. By diuretics, in connection with suitable tonic treatment, the amount of urine may be considerably increased in many cases. A recumbent position is of great advantage, as it tends to relieve the pressure upon the renal vessels. A milk diet may be prescribed with advantage. If, in spite of treatment, the urine diminish to less than 350 c.c. (℥ xij.) per day, with much albumen and casts, and the symptoms of danger become imminent, it is proper to induce premature labor if the child is of viable age. Under seven months, however, this is not justifiable, as it sacrifices the child, and cases where there was every reason to expect convulsions sometimes escape them.

After one attack of eclampsia has occurred, others may be expected until the uterus is emptied, so that the best policy is to hasten labor at once. The cervix should be dilated manually, and version or forceps employed. As a preliminary to this, and at the same time as a useful sedative to the nervous excitability, ether should be administered to the extent of surgical anæsthesia. Morphine subcutaneously, with or without a full dose of chloral per enema, is of value in the same line as the ether, and may be added to the use of that anæsthetic.

When the labor has been completed, unfortunately, the danger of convulsions is not over. The sedatives just mentioned are to be continued, and with the onset of a convulsion ether is to be administered. Care should be given in each convulsion that the tongue is protected by some sort of a gag from injury. The ether may be continued even during the comatose state, though it is proper at that time to diminish the amount inhaled. If necessary, on account of the frequency of the fits, the administration of ether may be prolonged for many hours.

Meantime more radical measures for eliminating any retained excretory products should be made through the three channels of the bowels, skin, and kidneys. So far as possible it is well to favor a vicarious function of the first two, in order to spare the crippled kidneys as much as possible. A brisk purgative, such as elaterium or croton-oil, should be administered as soon as the patient can swallow. For the increase of the function of the skin pilocarpin is especially useful. It may be given subcutaneously in doses of one to two centigrams ($= \frac{1}{6}$ to $\frac{1}{3}$ gr.), repeated as needed. Its action is enhanced by putting about the patient bottles of hot water encased in moist flannels, and heaping on the bedclothes. Hot baths have been highly recommended by Breus, as also favoring diaphoresis. Finally, the kidneys themselves may be stimulated by digitalis, acetate and citrate of potassium, and by dry cups to the back.

Bleeding was formerly in high repute for eclampsia, the patient being bled till she fell over. The immediate results of this treatment are often very satisfactory, especially when there is a strong and bounding pulse, indicating greatly increased tension. It is true that the reduced tension thus secured is not permanent, but that the pressure rises again, and the fact of the blood then being more watery than before the bleeding is not favorable. Sometimes the immediate effect is what is especially important, and the gaining of a few hours without a convulsion is the salvation of the patient. Still, it is undoubtedly the fact that venesection has largely given place to the line of treatment above indicated in the general practice of the profession.

Placenta Prævia.—This is the most common and by far the most serious cause of ante-partum hæmorrhage. Normally and usually the impregnated ovum, after passing down through the Fallopian tube, lodges in a sulcus of the endometrium near the mouth of the tube. The portion of the decidua vera, lining the whole uterine cavity, against which the ovum lodges is called the decidua serotina, and marks the site of the future placenta. According to a recent and plausible theory, placenta prævia is the result of an arrested abortion, the ovum having become dislodged from its original and normal resting-place, but not having been expelled from the uterus. If such dislodgement occurs, or if for any reason the ovum on first entering the uterus does not fix itself at the fundal extremity, it drops down into the lower segment, and the placental site comes to be at or near the os internum. The circumstances, other than arrested abortion, which favor this occurrence are (1) an increase in the size of the uterine cavity, which is liable to be produced by repeated and frequent pregnancies preventing complete involution of the womb; and (2) intra-uterine inflammation, not in that active stage which would cause the sweeping away of the ovum altogether, but where a formerly existing catarrh has so smoothed off the mucous membrane that the folds, in some one of which the ovum might have lodged, have become too shallow to retain it.

As would be expected from what has just been said, placenta prævia occurs chiefly in multiparæ, and often in those who have suffered from leucorrhœal discharge of uterine origin. Rapidly succeeding pregnancies also predispose to it. In 136 cases collected by Lower, in Berlin, sixty per cent. of the women had been delivered at least five times before, and a like proportion were upward of thirty years of age; while only eight per cent. of the whole number of women were primiparæ. The absolute frequency of this complication in obstetrical practice is, unfortunately, quite considerable, Lower's cases showing for two of the Berlin hospitals alone 65 cases in a year, while the total births of the city numbered 46,000. This would give a minimum frequency of 1 case in 723 deliveries. Other statistics give a ratio as high as 1 in 500.

A distinction is ordinarily made between placenta prævia centralis, in which the placenta is implanted entirely over the inner os, and placenta prævia lateralis, when the examining-finger, passing through the os, can touch

some part of the fœtal membranes and does not impinge on placenta only. The placenta may be somewhat lateral, and yet in the early stages of dilatation entirely conceal the fœtus from the examining-finger so that the case appears to be one of central implantation; while as dilatation progresses an edge of the organ comes within reach, and the diagnosis is changed to that of lateral or marginal placenta. The importance of distinguishing between complete and marginal implantation consists only in the fact that the more of the placenta that lies over the os, the greater is the gravity of the situation; while if the margin only impinges on the edge of the dilating portion of the cervix (a true marginal placenta), the labor may go on as naturally as though the implantation were at the fundus. In central or complete cases the symptom hæmorrhage is more liable to occur and recur during the course of the pregnancy, while in lateral cases there is often no bleeding until uterine contractions and cervical dilatation begin.

The obvious and important symptom of placenta prævia is bleeding—"unavoidable hæmorrhage," as it was called by Rigby, to distinguish it from that "accidental" hæmorrhage which is due to premature detachment of a normally placed placenta, or to other causes not inevitable in their nature. In cases of central implantation the patient is liable to be seized suddenly and without apparent cause, perhaps during sleep, at any time in the last three months of pregnancy, with a severe hæmorrhage. It may leave her blanched and pulseless, or it may cease spontaneously. But the important thing to remember is that such a hæmorrhage having once occurred, there is no safety to that patient until the child is born. The bleeding is always liable to return at any moment with the most alarming, and even fatal, consequences. Sometimes a slight oozing continues for a long time, until the patient is quite worn out with anæmia. In about one-half of these cases the pregnancy is prematurely terminated—a conservative measure of nature for the mother's life. In another class of cases, chiefly of lateral implantation, but rarely of central, no symptom appears until labor sets in, when a sudden gush of blood causes, perhaps, syncope, and is followed after every succeeding pain by further hæmorrhage, until all of the placenta which lies upon the cervix has become detached, or the head pushed down through the expanding canal checks by compression any further bleeding. If the placenta is quite central in its situation, it not infrequently happens that it is born before the child. If the amount of blood lost has been large, the patient shows the signs of acute anæmia, syncope, giddiness, headache, restlessness, jactitation, rapid, feeble, thready pulse, sighing respirations, and convulsions.

In placenta prævia, whether from the laxness of the lower uterine segment or from early interference on the part of the operator, an unusual proportion of abnormal presentations are found. Cross births are especially frequent, amounting by Charpentier's figures to twenty-four per cent., and in Lower's cases to thirty-two per cent.

Diagnosis.—A painless and apparently causeless hæmorrhage during the later months of pregnancy, or free bleeding during the first stage of labor, always causes strong suspicion of this abnormity. The stethoscope gives confirmatory evidence if the placental bruit is heard nowhere else so plainly as over the lower uterine segment. The diagnosis is completed, however, by digital examination. If the cervix is closed, we can often detect a thickening of the walls of the lower uterine segment as felt through the vaginal fornices on one or more sides. It is also said that ballottement is not easily made out. As soon as the os will admit the finger-tip, the latter recognizes, not the smooth surface of the fœtal membranes, but the thick, fleshy structure of the placenta. The feeling of the surface is uneven, spongy, granular. We may or may not detect an edge of it with the fœtal membranes on the other side. If the cervix is high up and but slightly dilated, it may be difficult to reach the placental surface, but in such a case the importance of the diagnosis justifies the introduction of two or more fingers, or even of the whole hand, into the vagina. The unusual vascular development often reveals itself in pulsating arteries about the os.

The *prognosis* of this condition is grave both for mother and child, though the elements of danger are different for the two individuals. The former is in peril from loss of blood. The bleeding is almost entirely from the maternal vessels, what comes from the chorion being quite insignificant. The child's danger, on the other hand, is from asphyxia, his means for oxidation being withdrawn *pari passu* with the detachment of the placenta. To a certain extent there is a conflict of interest between mother and child. The completion of a partial placental detachment sometimes checks the hæmorrhage by allowing the sinuses to close together, while the fœtus' source of oxygen is thereby destroyed; and a hasty delivery, which is in the interest of the child, is, as we shall see later, unfavorable for the mother if it involves rapid dilatation, with danger of laceration, of the highly vascular cervix. The prognosis to the child under any circumstances is bad. Various authors give the infantile mortality as from fifty to seventy-five per cent., and half of those who are born alive die in the first ten days. As to the mother, the prognosis depends largely upon the treatment. The older authors give the mortality as forty per cent., but later figures, with improved methods of treatment, have been as low as ten per cent. Of course, with central implantations the prognosis is worse than with lateral. Incomplete uterine contraction following delivery adds elements of danger, even after the primary peril is over. Post-partum hæmorrhage may occur, and puerperal fever is especially common after such cases.

Treatment.—The treatment in placenta prævia is made chiefly in the interest of the mother, for two reasons: First, that among most civilized people the maternal life, upon which depend so largely the family life, the care of earlier-born and the hope of later-born offspring, is considered of more value than that of the fœtus, which is of less immediate importance in the domestic economy, particularly liable, even if born alive, to speedy dissolution, and in any event exposed to the multiform diseases and casualties of infant life; and second, because while rational therapeutic means have succeeded in greatly reducing the maternal mortality, no treatment has as yet been discovered which, even directed primarily to the saving of the child, has achieved any degree of success.

In considering the question of treatment, a distinction must be observed as to whether or not the patient is at term when the hæmorrhage first demands attention. In the former case uterine contractions have probably already begun; in fact, it is to these that the hæmorrhage is due, and even if no visible signs of labor are yet present, they will soon appear. In the latter case it may be necessary to decide the question of the premature induction of labor, if nature does not interfere and settle the matter for us.

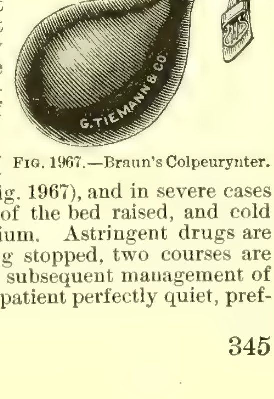

FIG. 1967.—Braun's Colpeurynter.

Let us suppose, first, the case of a woman between the sixth and seventh month of pregnancy, who has a sudden, painless, and, so far as we know, causeless hæmorrhage. (Before the twenty-eighth week such hæmorrhage is not common, and if it occurs is not dangerous in amount, but may lead to abortion without the true condition being recognized.) The woman is, of course, at once put to bed, perfectly recumbent, with a vaginal tampon or Braun's colpeurynter if necessary (see Fig. 1967), and in severe cases with the head low, the foot of the bed raised, and cold applications to the hypogastrium. Astringent drugs are useless. The bleeding having stopped, two courses are open to the attendant for the subsequent management of the case. One is to keep the patient perfectly quiet, pref-

erably in bed, during the remainder of the pregnancy, with incessant watchfulness, both on the part of the friends and the physician, during the whole of this time. If professional attendance is to be always readily accessible, especially the child not being as yet viable, this course is defensible. But inasmuch as the peril in placenta prævia is from the hæmorrhage coming at an hour or in a place where skilled attention cannot be at once had, the safer course is the following: So soon as the diagnosis is established, and confirmed by one or more hæmorrhages, the pregnancy is to be ended immediately by the separation of the membranes and the early introduction of a cervical plug which shall at once dilate the cervix and restrain bleeding. It is hardly necessary to say that the physician should not leave his patient until the labor is completed.

When this complication first reveals itself at the onset of a full-term labor, the indications are not to prevent the detachment of the presenting part of the placenta. The cervix must expand before the child can be born; the uterine contractions will necessarily separate the placenta, and instead of the vessels closing, as they ordinarily do, at the detachment of the placenta, they are actually pulled open. We must shorten as much as possible the duration of this dangerous stage, and during it must devote ourselves to lessening the hæmorrhage by pressure (the only available hæmostatic). But while up to this point haste is desirable, it is not well, as is sometimes taught, to hurry the completion of the labor. Anything like an *accouchement forcé*, involving a sudden or violent strain of the cervical structures, is dangerous. A considerable rigidity of the cervix is not uncommon, and the unusual development of blood-vessels in that locality makes a laceration exceedingly unfortunate.

If, when the physician is called, there has been free bleeding, and the cervix is as yet closed, a vaginal tampon or the colpeurynter should be applied. This should

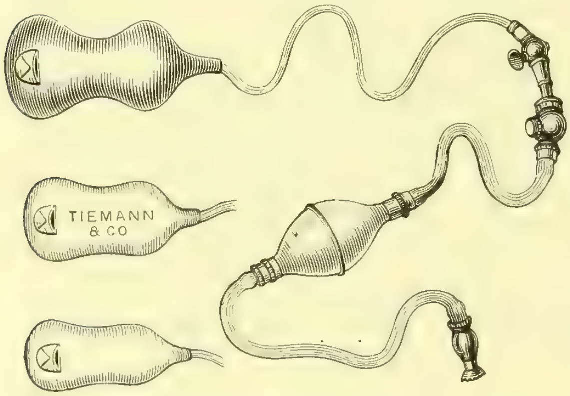

FIG. 1968.—Barnes' Uterine Dilators.

be removed after an hour, unless the earlier occurrence of pains makes it likely that dilatation has begun. If the bleeding is in abeyance, it is well to give an antiseptic vaginal douche before proceeding (carbolic acid, 1 to 100, or corrosive sublimate, 1 to 2,000), as there is especial susceptibility to puerperal septicæmia in these cases. Then insert a cervical plug to increase the dilatation. A sponge-tent should never be used for this purpose. A Barnes' bag or any hydrostatic or pneumostatic dilator of appropriate size is carried through the os on a staff or sound, then the bag is inflated, and its constriction serves to retain it (see Fig. 1968). This fulfils three indications—pressure, dilatation, and the reflex stimulation of pains. No means of accomplishing these ends, however, is more efficient than rapid manual dilatation of the cervix under anæsthesia. Hofmeier's and Lower's Berlin statistics, in fact, show better results for this than for the more gradual plan of dilatation. As soon as the os will admit two fingers the whole hand is to be introduced into the vagina, and bimanual version performed after the manner of Braxton Hicks. This operation (for the details of which see Obstetric Operations, Version) is the sheet-anchor of the management of placenta prævia. In cases of lateral implantation the fingers will, of course, pass in by that edge of the placenta which impinges upon the circle of the os. In case the implantation is central, or if with the degree of dilatation nothing but placental tissue can be felt, the finger must seek for that edge which is nearest, separating as much of the placenta as may be necessary in order to reach it. In strictly central cases we should try to reach the margin at any available point. In rare instances it may be necessary to force the finger through the substance of the placenta, but this causes such free hæmorrhage that it should be done only as a last resort. When it is done, the fingers or hand should remain as a plug in the opening, until a part of the fœtus can be drawn down into it. Except in rare cases, the knee or foot will be brought down past one edge of the partially detached placenta, and not through its substance.

At this point, in the interest of the mother, activity would give place to expectancy. The operator, holding the leg, has the case under almost perfect control. The large mass of the half-breech exerts a strong pressure on the placental vessels, and the case can usually be left to itself. When the cervix is sufficiently prepared, it transmits the fœtus without laceration. If bleeding recommences, the operator can draw down upon the leg sufficiently to hold the hæmorrhage in check. When the duration and extent of the bleeding have been sufficient to make it likely that the child is dead, it is justifiable to resist the temptation to complete the extraction at once, since uterine inertia would be a likely result of such a procedure. Of course, if the child shows signs of life, it must be extracted at once, even at the risk of some injury to the mother.

If the bimanual version has not succeeded, we may, before withdrawing the hand, sweep the fingers around inside the os, thereby detaching the placenta over as much of an area as can be thus reached. Some authorities recommend also rupturing the membranes. This sometimes stimulates the pains and brings the hard presenting surface more directly against the bleeding vessels. But even this added pressure does not always suffice to check the bleeding, and if it fails, it is then so much the more difficult to perform version without introducing the hand into the uterus—a resort to be avoided, if possible. So, in the writer's judgment, it is better to complete and maintain the dilatation, and to attempt again, after a while, the Braxton Hicks manœuvre. When the bimanual version is definitely abandoned, if the head presents, it is proper to rupture the membranes. If this does not check the bleeding, the whole hand may be introduced for the ordinary operation of version; or, if the head has become engaged, the forceps may be applied.

Accidental Hæmorrhage.—Much the most common cause of hæmorrhage during labor is placenta prævia. But we have in addition a variety of hæmorrhage known as accidental, to distinguish it from the unavoidable bleeding that attends the expansion of a cervix which is covered by placenta.

Accidental hæmorrhage is due to the premature detachment of a normally situated placenta. Some unusually violent wave of that imperceptible uterine action that goes on just before labor sets in may cause a minute vessel of the placenta to yield, and a small effusion excites greater uterine action and tends to increase itself. Emotional and traumatic causes and over-exertion may also start a separation of the placenta. The accident rarely occurs after the completion of the first stage, and is more frequent before dilatation begins. The blood effused may escape from the uterus, in which case we have a warning of what is going on; or, what is more dangerous, it may be retained, constituting the internal or concealed hæmorrhage. In the latter case the blood collects either in the cavity formed by the central detachment of the placenta, or between the uterine wall and the membranes, or in the amniotic cavity, or free in the uterus, but detained through a completely obstructing presenting part.

The symptoms of this alarming accident are sometimes obscure. Pain is usually present, and is sometimes severe; there are the symptoms of anæmia and shock, which may go to the extent of actual collapse, with imperceptible pulse, sighing respiration, etc. There is distention of the uterine tumor which may cause marked dyspnœa. The shape of the uterus becomes irregular and the contour of the fœtus cannot be made out, and by auscultation the heart-beat is found to be very feeble. The labor pains diminish or cease. On the whole, the most striking sign is the great prostration without any evident cause to account for it. The condition suggests uterine rupture, for which accident the other may indeed, in some cases, be considered vicarious. But in rupture the uterus rather diminishes in size than increases, the presenting part recedes, and the fœtus may even be felt lying free in the abdominal cavity. If any of the blood escapes from the cervix, it serves to clear up the diagnosis, and the prognosis in such cases is believed to be better, not alone because we know with what we have to deal, but because the uterine walls are less flaccid than when the blood is pent in. In general we may say that the prognosis is very bad, both as regards mother and child; worse, in fact, for the same amount of hæmorrhage, than in placenta prævia.

The treatment must be directed to emptying and securing contraction of the uterus as soon as possible, as this affords the only chance of closing the bleeding vessels, as well as of saving the child from asphyxia. If dilatation has not begun it must be performed manually or with Barnes's bags, and the child delivered by version; or, if the head has descended, by forceps. Some authorities, dreading the shock of the artificial delivery in the patient's weak state, advise rupturing the membranes and waiting, or using the tampon. If no part of the ovum have escaped from the uterus, the tampon may safely control the bleeding, because no great amount of stretching of the uterine wall can occur. But if the waters have escaped, a dangerous distention with blood of the space formerly occupied by the amniotic fluid may be going on. Constant pressure upon the fundus must be maintained to prevent the uterus from refilling after the escape of a portion or the whole of the fœtus. Sometimes the placenta is expelled with a great gush of blood, meaning that the blood has accumulated under a central separation of the placenta, and escaped only when the margin of the placenta gave way.

The condition of the mother must not be neglected during and after the emptying of the uterus, but symptoms of shock must be met by subcutaneous injections of ether or brandy, heat applied to the extremities, etc. Ergot should be administered, and the uterus held by the hand for hours, if necessary, till permanent contraction is assured.

Post-partum hæmorrhage is spoken of as primary when it occurs within twenty-four hours after the birth of the child. Later than that it is called secondary hæmorrhage. The primary form only will be considered in this connection; so far as it is dependent on retained or adherent placenta, it has been already described under the head of impaired action of the mechanical forces of labor. The more frequent condition accompanying the accident is that of simple uterine relaxation. The predisposing causes of this atony are great distention (hydramnios, twins), rapid labor, and constitutional weakness, as manifested by albuminuria, spanæmia, leucocythæmia. The same women are subject to it in successive pregnancies, irrespective of any general hæmorrhagic diathesis, though, of course, if the latter exist, labor is perilous, like any other accident that involves the shedding of blood.

The more immediate causes are exhaustion, over-hasty extraction of the placenta, retention of urine, uterine malpositions and tumors, especially fibroid. The employment of anæsthetics during labor is generally regarded as in some degree predisposing to hæmorrhage. A quick pulse after labor is a sign that the normal reduction of vascular tension has not occurred, and should cause special watchfulness in the attendant lest hæmorrhage follow.

The diagnosis is usually painfully obvious. The only precaution to be observed here is to make sure that the blood escapes from the interior of the uterus, and not from laceration or thrombus of the lower genital tract. The usual symptoms of acute anæmia rapidly supervene, and, if the bleeding is not checked, the patient dies at once, even in the midst of the gratulations of her friends on the apparently successful completion of her labor.

Treatment.—Prophylaxis should be attempted in women who have seriously flooded after previous confinements. This consists in improving the constitutional condition, as far as possible, during the pregnancy, by the administration of tonics. At about the beginning of labor a full dose of quinine (0.7 to 1. Gm.) is very useful. Ergot may be administered earlier in the labor than is otherwise prudent, namely, during the second stage, and must be given, at latest, as soon as the child is born, preferably subcutaneously.

To treat intelligently a case of post-partum flooding, it is important to remember just how nature ordinarily prevents bleeding. The muscular walls in which the sinuses ramify contract firmly, thereby closing the torn ends of the vessels, flattening and obliterating the venous sinuses, and thus holding in the blood. This contraction, at first rhythmical, speedily becomes tonic, and obviously must remain so in order that there may be no danger of recurrent hæmorrhages. It may be pointed out here that just this tonic contraction is what ergot produces. It would be disastrous if it occurred before the uterus was emptied, but after that time is most desirable. The uterine vessels themselves undergo a certain amount of retraction which narrows their gaping mouths. Thrombi, of course, form in the ends of these vessels, but it should be distinctly remembered that their part in the control of hæmorrhage is secondary to that of mechanical compression of the vessels through muscular contraction. When the latter means fail, the former may serve to keep back the blood; but naturally the thrombi are superficial and do not reach far into the intermuscular veins. If by relaxation of a uterus which has once been contracted, the blood again fills the uterine sinuses, of course whatever thrombi have formed are washed out, and must form anew after the sinuses have again been closed.

All treatment, then, should be directed primarily to securing firm uterine contraction. If every means tried fails to do this, we may, as a last resort, try to stanch the blood by promoting thrombosis through the introduction of a styptic like Monsel's solution, or liq. ferri perchloridi, each diluted with four or five times its volume of water, and swabbed about the inner uterine wall. But such thrombi afford a nidus for septic infection, besides that any later attempt to secure completer contraction of the uterus is liable to dislodge them.

The simpler means for aiding the uterus to contract—frictions of the fundus, ergot, etc.—have been already described under the management of normal labor.

As a prerequisite to complete uterine contraction, the viscus must be empty. Hence the necessity, if the uterus remains relaxed, of passing in the hand and removing whatever is in the interior, whether it be placenta or blood-clots. The presence of the hand also acts as a stimulus to the organ to contract, and sometimes the action will be so strong as to expel the hand. If it does not respond, however, a piece of ice may be introduced, or that failing, a stream of water (to which it is well to add some antiseptic like carbolic acid, 1 to 1,000; or corrosive sublimate, 1 to 3,000) at a temperature of 120° F. The alternate application of heat and cold sometimes has a better effect than either agent alone; or warm water may be used internally, with ice externally, over the fundus. During all this time the uterus must be stimulated from without by friction; in fact, the hand of an attendant should be kept over the womb constantly till the contraction is permanent.

Faradic electricity has been found very useful in these cases. If an intra-uterine electrode is at hand, it is to be passed to the fundus, and the other electrode applied externally; or both electrodes may be used over the abdomen.

Vinegar is sometimes effective, and possesses the advan-

tage of being generally at hand. It may be introduced into the uterus on a piece of compress cloth, and, at the same time, be given internally in doses of an ounce, repeated if necessary. Its effect, when taken into the stomach, has been claimed as even more rapid and satisfactory than that of ergot.

The unquestioned advantage of the latter drug may be attained, and even increased, by subcutaneous injection of the so-called ergotine, which is usually only an extract of ergot, in doses of three to five grains. The so-called egotinine of Tanret, though claimed to be the true alkaloid of ergot, is, it is to be feared, quite inert. The dose recommended is one-half a milligramme ($\frac{1}{120}$ of grain) of ergotinine, injected in the gluteal region.

If there is much feebleness of pulse from the loss of blood, a hypodermatic injection of ether (Gm. 2, = ♏ 30) is indicated. The head should be low, and the foot of the bed raised.

Compression of the abdominal aorta, though usually only of temporary effect, may turn the scale in the patient's favor in some very critical cases. It should be pressed against the spinal column.

Transfusion or intravenous injection has saved some lives that would otherwise have been lost from post-partum hæmorrhage. While defibrinated blood is doubtless a good fluid to use, it is not always attainable, and takes time to prepare. As the great need of the anæmiated system is something to fill up the blood-vessels and to give the heart material to work upon, a simple saline solution is as good as anything. It may be prepared thus:

Sodii chloridi	6. = ℥ jss.
Sodii bicarbonatis	1. = gr. xv.
Aquæ destillatæ (vel puræ) ..	1,000. = O ij. +

It should be kept at a temperature of 100° to 104° F., and filtered free of all suspended matters. A vein should be opened (most conveniently at the bend of the elbow), a cannula introduced centripetally, and tied in. The solution is then allowed to run into the vein slowly from a fountain-syringe with a "head" of two or three feet. The chief care necessary is to avoid introducing any air. One to four pints of the fluid are introduced, according to the effect on the circulation. If for any reason the vein cannot be found an artery may be used.

Should a moderate flow continue, despite the measures above advised for checking it, it is probably due to retained portions of the secundines, and a thorough curetting of the uterus with a dull curette is proper, though this measure is more usually necessitated by the so-called "secondary" hæmorrhages.

The obstetric binder should never be applied in cases of post-partum hæmorrhage till some hours after uterine contraction is assured. It cannot prevent the relaxation of the uterus, and may serve to conceal the fact that it has taken place. Moreover, it interferes with the friction of the fundus, which may be necessary to retain the contraction that has been secured.

Lacerations of the Genital Canal.—Ruptures of the uterus, inasmuch as they interfere with the mechanism of labor, have been considered above in their appropriate connection. The significance of lacerations below this situation is in connection with the subsequent welfare of the mother, rather than with any impediment caused to the birth of the child.

Beginning with the cervix, we may have transverse or longitudinal tears. The former may be so extensive as to involve the separation of a complete ring of tissue; or the anterior lip may be torn off. But a laceration of the cervix does not usually involve the peritoneum. At most there is infiltration of the adjacent connective tissue. Longitudinal fissures are more common than transverse, in fact, the former, if but slight in extent, may be considered physiological. The so-called "show" of labor is due to small rents of the mucous membrane. There is little pain even if the rent extends to the vaginal junction, though under these circumstances there may be considerable hæmorrhage. If the latter symptom be observed, the uterus being properly contracted, the state of the cervix should always be inquired into. If the hæmorrhage be moderate, and from a small tear, it can be controlled by ice or hot injection, and the laceration will usually heal kindly. If, however, the rent is of considerable extent, it should be sewed together at once, the patient being placed on the side, Sims' speculum introduced, and the cervix drawn down with vulsellum forceps. Silver wire or carbolized silk may be used for the suture.

Laceration of the vagina in its upper portion may perforate into the abdominal cavity. In an extreme case the vagina has been quite torn off from the uterus. Fistulous tracts into the bladder or rectum usually result from a slough, which has been produced by long-continued pressure of the head. The true rents of the vagina are usually longitudinal, and extend only through the mucous membrane or submucous tissue. They are caused by the transit of the head or the use of instruments. If superficial, they heal quickly by granulation; if deeper, there is infiltration, pain, and fever. Treatment is usually unnecessary further than to secure cleanliness, and to dust with iodoform. If, however, there should be much bleeding, this must be checked; for which ice, hot water, or even the tampon may be required.

The vaginal outlet is especially prone to laceration during labor. Small rents are to be seen in the labia minora, and about the urethra, while the fourchette is generally torn during the first labor. Infrequently there are deeper rents in the upper part of the vulva, in the neighborhood of the clitoris and urethra, where there is much erectile tissue. These may give rise to serious hæmorrhage, which is sometimes ascribed to the uterus, when a visual examination would show at once their true source. When arteries are thus ruptured, it is often difficult to ligature them, on account of the spongy and brittle tissues in which they are situated; and still, when a large vessel is torn, an attempt should be made to apply either the direct ligature, acupressure, or suture. Ice, hot water, compression, and finally styptics, are the means usually most available in controlling the free capillary hæmorrhages of this region.

Rupture of the perineum is by far the commonest laceration occurring during labor. Unlike the rents just described at the upper part of the vaginal outlet, these tears do not usually cause serious hæmorrhage. Their chief mischief is primarily in their exposure of a wounded surface to the risk of septic infection; and secondarily, in the impairment of the integrity of the sphincter, or, at least, in the abolition of the uterine support which is afforded by a whole perineum. As has been hinted, a rupture of the fourchette may be considered almost physiological. Schroeder says that it is preserved in thirty-nine per cent. of primiparæ, which seems a generous estimate. No treatment is required for such a rupture.

The more extensive fissures, which are, unfortunately, common, involve much more than the vaginal outlet. The posterior wall of the vagina, and more or less of the pyramidal-shaped perineal body, may be torn through, as well as the anterior portion of the rectum. If the latter is torn above the sphincter there will be incontinence of fæces and gas. A so-called central perineal laceration occurs, when some tissue remains intact between the wound and the vulva. Such a rent may affect only the skin of the perineum, or only the mucous membrane of the vagina, or both of these surfaces, with the immediately subjacent tissues, leaving an intermediate portion of the perineum intact. Or, more rarely, there is a complete perforating central rupture, with a bridge of tissue in front of it. It has been said even that the head has been expelled through such a fissure. A central rupture may occur, and then the perineum tear back from its edge to meet it, so that one continuous laceration is the result.

The rupture is usually caused by the distention produced by the head, but may be due to the emergence of the shoulders, or even to that of the placenta. It is also especially frequent when the head is delivered by forceps. Hence the advisability of removing the forceps when possible, just before the head emerges, and of al-

lowing it to be expelled without even the slight increase of bulk involved by the presence of the forceps blades. The prophylaxis of perineal laceration has already been considered under the management of normal labor. While this is of importance, it must not be assumed that the occurrence of rupture necessarily implies any lack of skill on the part of the attendant. A large head, a peculiarly friable perineal tissue, a narrow pubic arch, or a very slight degree of pelvic inclination, all conduce to this accident, yet none of them is within the control of the attendant.

Visual inspection should always be made, to see if the perineum is intact. If there is a rent of half an inch, or less, no suture is necessary, only cleanliness and a pledget of lint soaked in an antiseptic fluid or dusted with iodoform. These wounds occasionally heal by first intention, but cannot be depended upon to do so. Hence the necessity of sutures. For this purpose carbolized silk or catgut is best, though some prefer silver or iron wire. If twenty-four hours have elapsed after the rupture before its discovery, there is not much use in attempting its primary repair.

An anæsthetic should be used if more than three or four stitches are to be needed. If the patient has already been under ether, the influence of it had better be prolonged till the stitches are inserted.

Before placing them the oozing must be stopped, and any jagged piece of flesh snipped off with scissors, so that the adjacent sides will come smoothly together. Should the anterior wall of the rectum be torn, it must be sutured with silk, the knots being on the inner surface of the bowel. Then a suture is inserted well behind the ruptured edge of the sphincter, carried below the torn surface, and made to emerge at a corresponding point on the other side, so that when drawn tightly it holds the edges of the sphincter together. The other sutures are placed in front of this at intervals of 1 to 2 ctm., being entered about 1.5 ctm. from the margin of the fissure and buried beneath the torn surface. The anterior suture should have its points of entrance and emergence above the angle of the tear. A strong, moderately curved needle, with good needle-holder, answers the purpose sufficiently. The number of stitches varies with the extent of the laceration. In the ordinary moderate tears two or three suffice. Care must be taken against tying them too tight, as there will be swelling of the parts, which might cut out the sutures. Superficial sutures should be applied, if necessary to secure perfect apposition, either to the skin or the vaginal mucous membrane. Some advise tying the patient's thighs together, and having the urine drawn by catheter, but these requirements are unnecessary. The sutures may be removed after the fifth to the seventh day.

The separation of the pelvic articulations, which occasionally constitutes so important an obstacle to a woman's locomotive powers after labor, is not, like the phenomena just described, a rupture of the pelvic canal due to labor, but is merely an inordinate degree of that play of the joints of the pelvis which is physiological to pregnancy. Under rest and the use of a firm hip bandage it usually does well; though sometimes the condition persists for a considerable time.

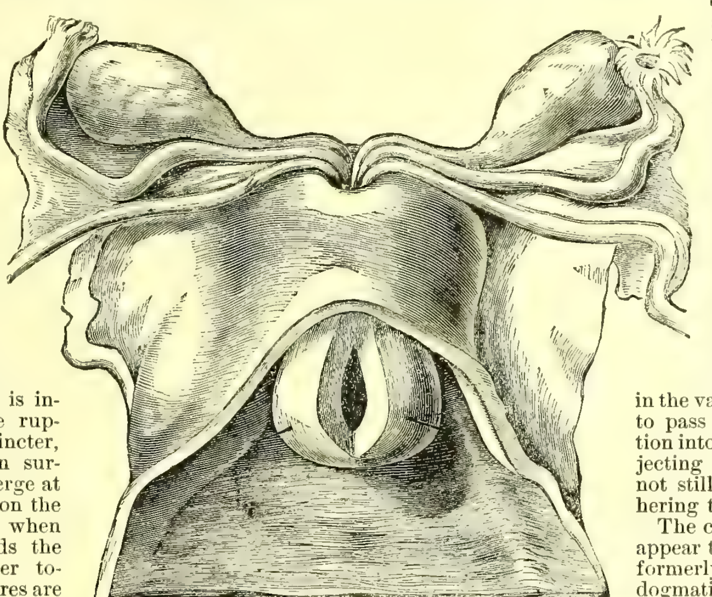

FIG. 1969.—Inversion of Uterus. (From Barnes, after Crosse.)

Inversion of the Uterus. — This accident occurs, according to the figures at the Rotunda Hospital, in 1 out of 190,000 labors. Other observers, particularly those more recent, assign to it a somewhat greater frequency. It may be either acute or chronic, the former occurring before involution is complete, the latter after that time or in the non-pregnant organ. In this connection we have to do with the acute form of the accident.

Inversion usually occurs immediately or within an hour after the birth of the child. Its proportional frequency seems to be about the same in primiparæ and multiparæ. It may occur in pregnancies of only three or four months. The inversion may vary in degree from a slight indentation to an introversion or depression of the whole fundus into a cup-shaped cavity, or may go on to a complete turning of the uterus inside out. In the severer cases the internal cavity of the uterus presents at or outside the vulva (see Fig. 1969).

The symptoms are those of hæmorrhage and shock, and are like those of rupture of the uterus and of postpartum hæmorrhage. The accident, however, does not occur till a time later than rupture of the uterus. Hæmorrhage is said to have been slight in some cases where the inverted portion is strongly compressed. But unless this compression is strong and constant enough to constitute an effective tourniquet, the bleeding is abundant, for the reason that the uterine sinuses cannot be closed, as normally, by contraction. There is pain and a sense of fulness with tenesmus. The diagnosis in acute cases is usually easy, a depression being felt in the normally rounded contour of the fundus, and a roughened body projecting downward in the vagina. The finger fails to pass upward in any direction into the cervix. The projecting fundus may or may not still have the placenta adhering to it.

The causes of this accident appear to be diverse. It was formerly stated, somewhat dogmatically, that it was always produced by mismanagement of the placenta, usually by traction upon the cord by "ignorant midwives." Doubtless this factor has been present in some of the cases, but certainly in by no means all. The same may be said as to its relation with a cord abnormally short, either naturally or because of its being wound about the fœtus' neck. A short cord is more likely to be ruptured or to detach the placenta prematurely than to invert the uterus. Manual expression of the placenta practised prematurely or unskilfully has been the immediate cause of inversion. Digital extraction and delivery in the vertical position have also been assigned as causes. It is probable, however, that the most potent causes are predisposing rather than immediate ones, so that the occurrence of inversion by no means brings any aspersion on the skill of the attendant.

Anæmia, uterine inertia, with slow, tedious delivery, and on the other hand stormy and precipitate labors, excessive amniotic fluid and hæmorrhage predispose to the accident. There is ground for believing that the common condition produced by these diverse causes is irregular uterine contraction, some of the fibres being relaxed while others act strongly; in this way the firmer parts are drawn down through the latter. Usually the fundus is contracted while the cervix is relaxed, though the op-

This manœuvre constitutes a factor in the Schultze method, which is not in general favor on account of the somewhat violent character of the oscillations imparted to the child's body.

If a catheter can be introduced into the larynx, the artificial respiration can be assisted by the operator blowing air into the child's lungs. But besides the difficulty of passing the instrument through the glottis there is some danger, through the application of too much force, of rupturing the air-vesicles. In an extreme case tracheotomy has been performed with success upon a neonatus. The application of the Faradic current to the vicinity of the diaphragm is a mode of treatment which has met with favor from some authorities. Of course, to be available the battery must be at hand and in prompt working order at the moment when its services are required.

For the after-treatment plenty of dry, warm air is essential, and in the case of feeble or premature children the couveuse may be employed with good effect. (See, also, under Labor, Premature Induction of.)

Charles Francis Withington.

LABOR, MECHANISM OF. Before we can render any intelligent assistance in labor it is essential that we have a clear understanding of the mechanism whereby nature is ordinarily able, unaided, to effect the birth of a child—or, in other words, its removal from the interior of the uterus to the outside world. In the study of this remarkable phenomenon we may properly examine (1) the route to be traversed; (2) the body which traverses it; and (3) the mechanical conditions attending the transit (see, also, the preceding article).

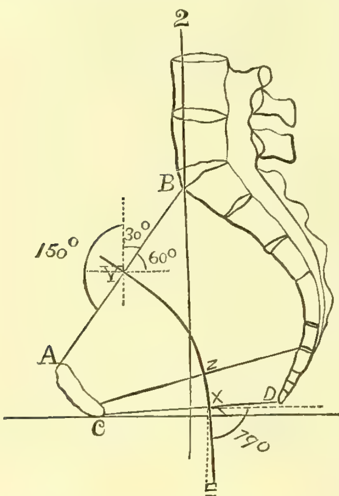

FIG. 1971.—Angles of Pelvic Planes. 1, horizontal plane; 2, vertical; *AB*, plane of pelvic brim; *CD*, plane of pelvic outlet; *XY*, axial curve, formed by the perpendiculars to the various planes.

1. *The Route.*—This is composed of the bony pelvis and of the soft parts attached thereto. We must presuppose a knowledge of the descriptive anatomy of the bony pelvis, and shall limit our remarks to some special points regarding the normal adult female pelvis. It is a curved canal, deep posteriorly, shallow anteriorly; the length of the former dimension corresponding to that of the sacrum and coccyx (an arc whose chord from promontory to apex is 12.5 ctm., or 5 inches), and that of the latter dimension corresponding to the length of the symphysis pubis, about one and three-fourths of an inch. It is not only curved, but twisted, the longest diameter at the entrance being the lateral one, and at the exit, the antero-posterior. The upper plane of the pelvis, the plane of the "brim," is that which passes through the promontory of the sacrum and the ilio-pectineal lines. This plane, when the woman is in an upright attitude, forms with the horizon an angle of about sixty degrees. The plane of the pelvic outlet includes the lower edge of the pubic symphysis and the tip of the coccyx. This plane forms with the horizon an angle of about eleven degrees. Between these two limiting planes of the pelvic canal it is obvious that any number of other planes may be passed at angles with the horizon varying between these limits. A succession of lines drawn in these planes, from symphysis to sacrum, will look like the sticks of a partially opened fan. As these planes are constantly changing their direction, it is evident that their axes (*i.e.*, perpendiculars to their middle points) will undergo similar change of direction. If, then, one line be drawn through the pelvis from brim to outlet so as to be perpendicular to each successive plane of the pelvis, this line will describe a curve, and at its point of emergence from the bony pelvis above will be at an angle of thirty degrees with the horizon, while at its point of emergence from the pelvis below its angle with the horizon will be seventy-nine degrees. The accompanying diagram (Fig. 1971) illustrates the angles of the pelvic planes and axes. As will be seen below, however, it is only the portion YZ of the axial curve which remains constant during labor, important modifications occurring both above and below those points on account of the soft parts which prolong the bony pelvic canal, as well as from a change in the direction of the coccyx taking place during labor.

A knowledge of the pelvic diameters is important to bear in mind. Their relation varies in the different planes. The plane of the inlet, one representing about the middle of the cavity, and that of the outlet are usually selected as paradigms of the general shape of the pelvic cavity. Three diameters are given in each plane—an antero-posterior or conjugate, a transverse, and an oblique; the last from the sacro-iliac articulation to the ilio-pectineal eminence opposite. The oblique diameter takes its name, right or left, from the side of the

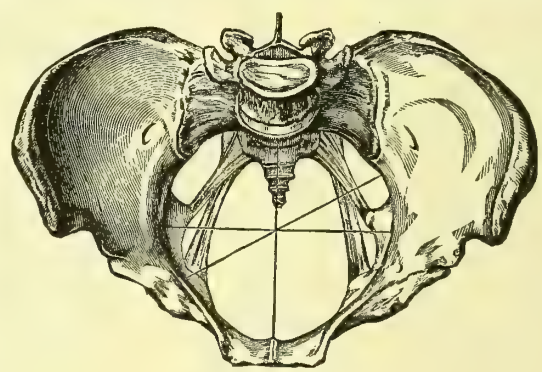
FIG. 1972.—(Galabin.)

sacro-iliac articulation from which it is measured. The spiral direction of the pelvic canal, to which reference has been already made, will appear from a comparison of the longest diameter, conjugate, at the brim with the transverse at the outlet. It may be compared to a rifle-bore with a twist of ninety degrees. The true conjugate at the brim is measured from the promontory to the upper border of the pubic symphysis. The diagonal conjugate, from the promontory to the lower edge of the symphysis, is about two-thirds of an inch longer than the true conjugate, and does not, like the latter, lie wholly in one of the so-called pelvic planes. But, for the reason of its greater facility of estimation in the living subject, it is of much practical importance. The diameters given at the outlet are not strictly all in one plane, because the tuberosities of the ischium, between which the transverse diameter of the outlet is taken, project below a plane passed through the tip of the coccyx and the lower border of the symphysis. In other words, the pelvic outlet is defined by three prominent points, the two tuberosities and the apex of the coccyx, separated by three depressions, the two sciatic notches and the pubic arch; the transverse diameter is taken from one elevation to another, while the conjugate is taken from an elevation, the coccyx, to a depression, the pubic arch. The last-mentioned diameter, while not seemingly longer than the transverse, is yet capable of increase by the backward movement of the coccyx on its articulation, so that during labor it becomes the long diameter of the outlet and transmits the long diameter of the head. The oblique diameters of the outlet are not of importance, as they would be taken from the sacro-sciatic ligaments, which

are too movable to afford fixed points. The accompanying figures (Figs. 1972 and 1973) show the location of these diameters, and the following table shows their average length in each plane, as taken from a large number of measurements :

	Conjugate.	Oblique.	Transverse.
Brim......	10.8 ctm. (4¼ in.)	12.7 ctm. (5 in.)	13.3 ctm. (5¼ in.)
Cavity.....	12.0 ctm. (4¾ in.)	12.7 ctm. (5 in.)	12.0 ctm. (4¾ in.)
Outlet.....	10.2 ctm. (4 in.)*	......	10.2 ctm. (4 in.)

The narrowing which the pelvic canal undergoes from the inlet to the outlet is shown by the fact that the circumference of the former is 40.6 ctm. (16 inches), while that of the latter is but 30.4 ctm. (13½ inches). The normal measurements of the bony pelvis externally are well to bear in mind, as affording a means of judging of the existence of certain important deformities. The distance between the anterior superior spines is about 25.4 ctm. (10 inches) ; between the widest parts of the crests of the ilia, 26.7 ctm. (10½ inches) ; from the spinous process of the last lumbar vertebra to the upper and outer edge of the symphysis pubis, 17.7 ctm. (7 inches).

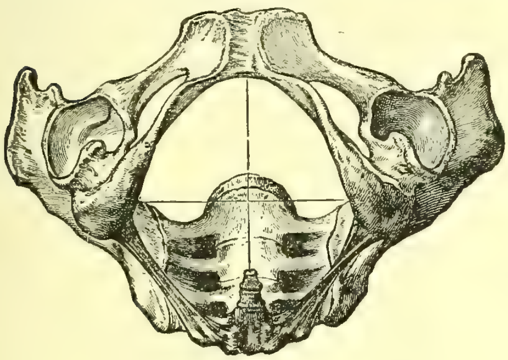

FIG. 1973.—(Galabin.)

The cavity of the pelvis is encroached upon toward its lower extremity by the two ischial spines, which narrow the transverse diameter at that point to four inches. The projection of these two spines marks on either side the limit between the anterior inclined plane of the pelvis (extending from the spine to the symphysis) and the posterior inclined plane (extending backward to join its fellow at the median line of the sacrum). The former is so placed as to direct a spherical body impinging upon it forward toward the symphysis, and hence, as will be seen below, favors the forward rotation of the occiput. The latter or posterior plane in like manner facilitates the backward rotation of that part of the vertex about the anterior fontanelle.

The pelvic articulations are amphiarthroses ; that is, surfaces connected by fibro-cartilage, but not having for the most part in the ordinary state synovial sacs. The ones chiefly concerned in parturition are the sacro-iliac, the sacro-coccygeal, and the pubic. In the last-named articulation there is always a partial synovial cavity. In all of them pregnancy causes the development of synovia, either *de novo* or in addition to that already existing, as the case may be. The motion thus allowed gains a certain amount of space for the passage of the child. When the head occupies the cavity, the woman, by bending her body forward, causes a movement of the sacrum backward, which increases the available space antero-posteriorly. This tilting back of the lower extremity of the sacrum diminishes the space at the inlet, but the head, having passed that point, is not affected thereby. At the same time the pubic symphysis permits of a little play, and the ramus of the side corresponding to the child's occiput may rise a little to accommodate its passage. The coccyx also moves backward upon its articulation, increasing, as has been shown, the antero-posterior diameter of the outlet.

* Capable of extension to 11.4 ctm. (4½ inches) by extension of coccyx.

The bony framework of the pelvis is somewhat modified by the soft structures with which it is lined. The great psoas muscles, coming down from the lumbar vertebræ, pass across the brim of the pelvis, partially filling up the depressions on either side of the promontory. The iliac muscles, which join their fibres to the tendons of the psoæ as they converge from their origins over the internal iliac fossæ, diminish the transverse diameter of the brim, so that that dimension has not in the living female the predominance over the conjugate which it has in the skeleton. The pyramidales muscles, filling in the great sacro-sciatic notch on either side, and the internal obturator muscles, covering the obturator foramina, serve to give a fleshy lining which, with the internal pelvic fascia, covers in the walls of the pelvis.

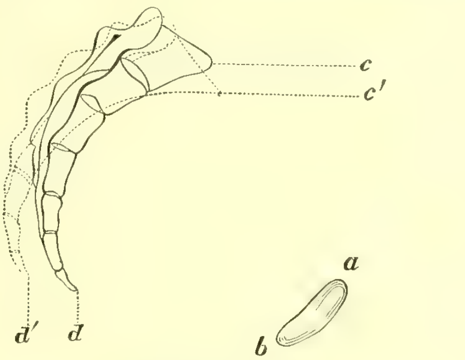

FIG. 1974.—(Galabin.)

The most important of the soft structures connected with the pelvis, however, are those which close it in from below, converting it into a true " basin," and which, during labor, admits of great modification. These consist of muscles, the most important of which are the levator ani and the coccygeus, covered above by the strong internal pelvic fascia, which in turn lies under the peritoneum, and having below (externally) three different layers of perineal fascia which enclose vessels, nerves, and, superficially, other muscles, of which one, the transversus perinei, is of special obstetric importance, in that when the perineum is ruptured during labor its fibres cause

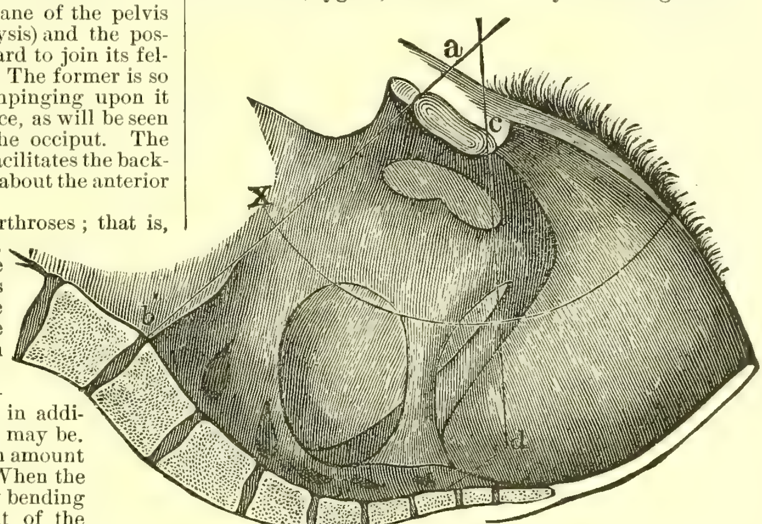

FIG. 1975.—*X*, Canal of bony pelvis continued by the soft parts ; *ab*, plane of brim ; *cd*, plane of outlet extended by deflection of the coccyx backward. (Hodge.)

gaping of the wound and tend to prevent union. These structures, with the abundant connective tissue which fills up their interstices, make up the pelvic floor and the perineal body. The latter body, whose sagittal section is pyramidal, having its base cutaneous and filling the space between rectum and vagina, extends about half-way up the latter canal, and is, during labor, remarkably distensible. The firmness of the pelvic floor at first plays a prominent part in producing, as will presently be seen, rotation of the head, and the elasticity which it acquires later permits it to yield four or five inches in a posterior direction, and hence increases and extends in a marked degree the curve of the parturient pelvic canal from that which we saw in the skeleton.

2. *The Body to be Transmitted.*—As in normal labors the head of the fœtus presents, and as after its birth the

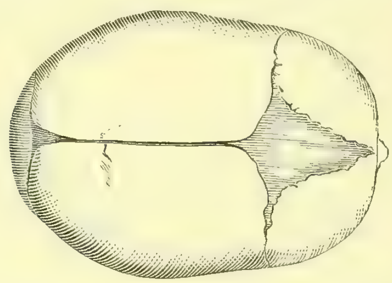

Fig. 1976.—Superior Aspect of Fœtal Skull, showing both Fontanelles with Connecting Sutures. (Galabin.)

remainder of the body usually follows without difficulty, it is to the configuration of this part that special attention must be paid. The several bones of the skull, besides being soft and bending under pressure, are separated by sutures in which membranous tissue allows considerable play of the adjacent bones upon each other. Pressure not only diminishes the size of the head by forcing some of the cerebro-spinal fluid into the spinal canal, but causes overriding of the bones at the sutures, the parietal bones usually overlapping the frontal and occipital. The parietal bone, which is anterior in the pelvis, also usually overrides the posterior one—a point of occasional value in diagnosis.

The important landmarks of the skull for the attendant to recognize during labor are the frontal suture, separating the two halves of the frontal bone; the coronal suture, separating the frontal from the parietal bones. The point of junction of these two sutures is the bregma, so called, and about it is formed, by the defective ossification of the corners of the adjacent bones, the large or anterior fontanelle. This is an irregular rhombus, having a long or acute angle anteriorly, running down into the frontal suture, and a shorter, more obtuse angle posteriorly, at the beginning of the sagittal suture. Into its two remaining lateral angles runs the coronal suture on either side. The sagittal suture runs backward in the mesial line of the body to the posterior or small fontanelle, which, unlike the large fontanelle, is not an open membranous space, but merely the junction of three sutures. Those entering at the lateral angles are the two legs of the lambdoidal suture.

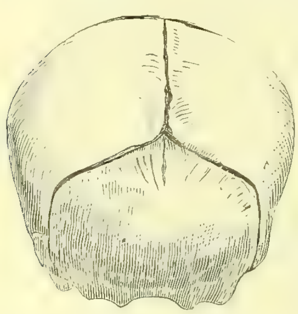

Fig. 1977.—Posterior Fontanelle, Sagittal and Lambdoidal Sutures. (Galabin.)

The measurements of the fœtal head now demand attention, and it will be seen that certain diameters are so much less than others that much will be gained if the position of the head during birth can be such as to bring these shorter rather than the longer diameters athwart the pelvic canal. As a matter of fact, the mobility of the head upon the atlas, and of the cervical vertebræ upon each other, does permit the head to take just that attitude which gives it the greatest economy of room in passing through the pelvis. What that attitude is may be gathered from the accompanying figure and measurements.

The diameters of the fœtal skull require to be measured between definite points. They are these: (1) The maximum, from the point of the chin to a somewhat variable point on the sagittal suture between the point of the occiput and the posterior fontanelle. (2) The occipito-mental, from the posterior fontanelle to the tip of the chin. (3) The occipito-frontal, from the posterior fontanelle to the root of the nose. (4) The suboccipito-bregmatic, from the point of meeting of the occipital bone with the nucha to the point of junction of the frontal and coronal sutures. (5) The cervico-bregmatic, from the centre of the foramen magnum to the bregma. (6) The fronto-mental, from the upper edge of the frontal bone to the tip of the chin. (7) The biparietal, between the tu-

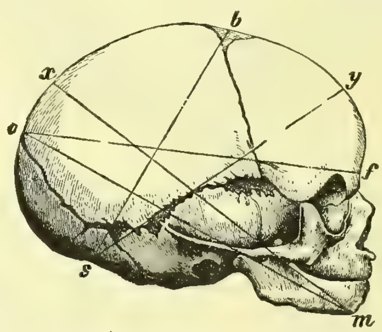

Fig. 1978.—More Important Diameters of the Fœtal Head. *mx*, Maximum; *om*, occipito-mental; *of*, occipito-frontal; *sb*, suboccipito-bregmatic; *sy*, the maximum suboccipital diameter. (Galabin.)

berosities of the parietal bones. (8) The bitemporal, between the widest separated points on the coronal suture.

Other measures, as bizygomatic, bimastoid, and maximum vertico-mental, are given by some authors, but are of less obstetrical importance. The following table shows these average values for the fœtal skull, unmoulded, but is also sufficiently accurate for the average head with scalp.

	Symbol.	Ctm.	Inches.
1. Maximum	M.M.	13.33	5.25
2. Occipito-mental	O.M.	12.70	5.00
3. Occipito-frontal	O.F.	12.28	4.60
4. Suboccipito-bregmatic	S.B.	9.52	3.75
5. Cervico-bregmatic	C.B.	9.65	3.80
6. Fronto-mental	F.M.	8.25	3.25
7. Biparietal	P.P.	9.52	3.75
8. Bitemporal	T.T.	8.25	3.25

It will be observed that, with the head well flexed on the sternum, the shortest of the antero-posterior diameters of the head, viz., 9.52 ctm., being the suboccipito-bregmatic, is brought perpendicular to the axis of the child's body, and therefore to that of the pelvic canal. This dimension is exactly the same as the biparietal diameter, which also must pass through the canal. So that the presenting part becomes practically a perfect sphere, and the longer diameters, such as the occipito-frontal and the occipito-mental, which if brought directly across the canal might experience great resistance, are, so to speak, folded in out of the way.

The attitude of the fœtus, as a whole, is produced by a preponderant action of the flexors over the extensors: the back is arched, the head bent upon the sternum, the forearms crossed or close to each other upon the chest, the thighs flexed upon the abdomen, the legs upon the thighs, and the feet upon the legs. The heels are thus brought near the buttocks and the soles of the feet are turned toward each other. The umbilical cord lies in the space between the legs and arms. Under pressure the various parts making up the two poles of the fœtal ovoid are moulded closely together, making a tolerably smooth and compact outline.

3. *The Transmission of the Fœtus.*—At the beginning of labor the head rests upon the inner os. In primiparæ, and less commonly in multiparæ, unperceived and painless uterine contractions open the inner os before the recognized onset of the labor. Clinically, it is convenient to date the commencement of the labor from the beginning of conscious pains.

For the discussion of the much-mooted question of the preservation of the whole, or only a part, of the cervical canal during pregnancy, the reader is referred to the appropriate title. Its only bearing on the present subject is that, according to those who maintain with Stoltz, Duncan, and Lusk that the cervix persists throughout pregnancy, the lower uterine segment is uterus, and not cervix, the latter canal being limited above by the so-called ring of Müller, which marks the termination of the cervical mucous membrane. According to Bandl and Braune, on the other hand, who believe that always, at least in primiparæ, a portion of the cervix expands to contribute to the uterine cavity, the true inner os is at that point on the muscular walls corresponding to where the peritoneum is reflected from the uterus; while the thinned portion of the uterine wall which lies between that zone, above, and Müller's ring, or the "spurious internal os," below, is true cervical tissue. A well-marked band is sometimes to be felt at about the level of the pelvic brim, known as "Bandl's ring" (see Fig. 1979). This sometimes remains contracted during labor, forming the so-called "hourglass constriction" of the uterus. Whether this ring shall be considered to coincide with the true os internum will depend upon which of the two opposing views is adopted regarding the history of the cervix during pregnancy.

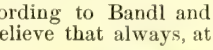

FIG. 1979.—Section of Uterine Wall in Eighth Month of Gestation. Cæsarean Section, after Death. *UC*, upper uterine segment; *UI*, lower uterine segment; *a*, Bandl's ring, seat of Braune's os internum; *b*, Müller's ring, and so-called os internum; *c,d*, wall of cervix; *C*, cervical mucous membrane; *oe*, os externum; *Vg*, vagina. (Barnes, after Bandl.)

The force which is destined to propel the fœtus through the pelvis is furnished largely by the intrinsic muscles of the uterus, of which there are three layers. The outermost consists chiefly of longitudinal and transverse bands, the former on the back and front of the uterus, and the latter at the sides, spreading out over the broad ligaments. The middle layer is the thickest and strongest, consisting of a powerful network of muscles surrounding the uterine arteries, whose lumen is occluded by their contraction—a provision of great importance for the checking of hæmorrhage. The inner coat circles about the axis of the uterus inferiorly, and at the upper part about the orifices of the Fallopian tubes.

The first stage of labor, preparatory to any expulsive action upon the fœtus, is accomplished by the intrinsic uterine muscles, which dilate the inner os, and then the outer, until the mouth of the womb entirely disappears and the cavity of that organ becomes continuous with that of the pelvic canal. The presenting bag of membranes, acting like a wedge, aids in forcing open the inner os. The work of expulsion is performed by the involuntary uterine muscles, chiefly of the fundus, acting intermittently. The unstriped fibres of the hypertrophied vaginal walls aid in the extrusion. The work of the unstriated muscles is effectively supplemented by the abdominal muscles, which, being composed of striated tissue, are under the control of the will, though at the height of the pains they act also reflexly. The diaphragm being fixed, the woman in "bearing down" during a pain produces a compression of the whole abdominal contents, with a corresponding tendency to diminish them by forcing a portion (the fœtus) through the only channel of egress. The united force of the voluntary and involuntary muscles in emptying the uterus has been found to vary from seventeen to fifty-five pounds.

At the outset of labor the long diameter of the fœtal ovoid coincides pretty nearly with the axis of the pelvic brim. An exception is to be made to this statement in the case of multiparæ with lax, pendulous abdomens, which permit the fundus of the uterus to fall forward. There is usually some deviation of the uterus to the right of the median line of the body, due, perhaps, to the presence of the distended sigmoid flexure.

During the whole process of labor an abundant secretion of glairy mucus is poured out along the whole genital canal, which lubricates the passage and greatly facilitates the transit of the child.

After the expulsion of the child, which completes the second stage of labor, the same muscular action of the uterus effects extrusion of the detached placenta, and the maintenance of tonic contraction of these muscles keeps the blood-vessels of the organ constricted and prevents hæmorrhage.

In considering the mechanism of labor, it is necessary at the outset to understand clearly the distinction between the terms presentation and position. The former is used with reference to the part of the fœtus which lies over the internal os, and on which, accordingly, during labor, the examining finger impinges. The word position, on the other hand, applies to the direction of the planes of the child's body in relation to those of the mother's body; in other words, the position shows to which side of the mother the child looks. To determine the position by vaginal examination, some particular point on the circumference of the presenting surface is selected as an index-point, and the position is named from the relation borne by this point to the sagittal and coronal planes of the mother's body; *e.g.*, occiput right anterior, O. R. A., means that the child's vertex presenting, the occiput, and hence the back of the child, is toward the mother's right and front sides. It is obvious that for each presentation there are several positions. Theoretically, any portion of the fœtus may present, but, practically, we may confine our attention to those of the vertex, face, breech, and shoulder. The points conventionally chosen to give names to the positions under these several presentations are respectively the occiput, the chin, the sacrum, and the back. Theoretically, we may imagine an infinite number of positions, the child's occiput, for instance, looking toward every possible plane of the mother's body; but, practically, it is sufficient to distinguish whether it is to the mother's right or left, and in each case whether it looks forward, backward, or transversely. The various presentations and positions may be represented in tabular form as follows. The numbers applied by some writers to the various positions are appended, but the abbreviations indicated are to be preferred, as representing a more logical and precise nomenclature.

	Presentations.		*Positions.*
Cephalic extremity.	Flexed = *Vertex.*	occiput, left iliac.	anterior, 1st, O. L. A.
			(transverse.)
			posterior, 4th, O. L. P.
		occiput, right iliac.	anterior, 2d, O. R. A.
			(transverse.)
			posterior, 3d, O. R. P.
	Extended = *Face.*	(chin, mentum), left iliac.	anterior, 3d, M. L. A.
			(transverse.)
			posterior, 2d, M. L. P.
		mentum, right iliac.	anterior, 4th, M. R. A.
			(transverse.)
			posterior, 1st, M. R. P.
Pelvic extremity.	Breech.	sacrum, left iliac.	anterior, 1st, S. L. A.
			(transverse.)
			posterior, 4th, S. L. P.
		sacrum, right iliac.	anterior, 2d, S. R. A.
			(transverse.)
			posterior, 3d, S. R. P.
Trunk (transverse.)	Right shoulder.	head, left iliac.	dorso-anterior, D. L. A.
		head, right iliac.	dorso-posterior, D. R. P.
	Left shoulder.	head, left iliac.	dorso-posterior, D. L. P.
		head, right iliac.	dorso-anterior, D. R. A.

From the above table we have omitted, for the sake of simplicity, mention of the brow presentation, which results from incomplete flexion of the head, but of which the positions are named precisely like those of the vertex. Under pelvic presentations no mention is made of knee and footling cases, because the completeness or incompleteness of the breech does not affect the question of position. The same is true of elbow and hand cases, which do not essentially differ as to the matter of position from shoulder presentation. It should be noted that in naming the positions of the shoulder presentations the terms right and left refer to the side of the mother on which the child's head lies, and not, as under other presentations, to the side toward which the occiput, sacrum, etc., are directed.

The relative frequency of these different presentations and positions is variously given, according to the number of observations upon which averages have been made, and also according to the nationality of the observer. The following figures may be taken as approximately correct. In 1,000 cases of miscellaneous midwifery we may expect to find about 970 of vertex presentation; 19 of the pelvis; 4 of the face; 4 of the shoulder, and 3 of the brow. In 1,000 cases of vertex presentation the different positions will occur about as follows: O. L. A., in 705; O. R. P., in 275; O. R. A., in 15, and O. L. P., in 5. In other words, rather more than seven-tenths of the cases will have the occiput to the left.

Vertex Presentations.—In view of the enormous preponderance of the vertical presentation, our study of the mechanism of labor will have primary reference to that condition. In the expulsion of the head most authors describe five different stages, which, while not all mutually exclusive in point of time, are yet distinct as different acts. Especially do the first two, and to some extent the first three, stages go on synchronously. These stages are *flexion, descent, rotation, extension, external rotation.*

Fig. 1980.—Showing the Predominance of the Anterior Arm (*FB*) of the Lever over the Posterior (*OB*) in Vertex Presentations. (Lusk, after Tarnier and Chantreuil.)

1. *Flexion.*—The head, resting by the condyles on either side of the foramen magnum upon the atlas, forms a lever of two unequal arms, the longer being the anterior. Supposing the occiput and sinciput to meet with equal resistance to the downward progress of the head, it is obvious that that resistance will have the greater effect which is applied to the longer arm of the lever. Hence the forehead will be more retarded than the occiput; the latter will descend and the head will become flexed, the chin approximating to the sternum. Reference to the diameters of the fœtal head given above will show that this flexion of the head presents its smallest diameters—the suboccipito-bregmatic, and the bitemporal. Were the head not flexed, the long occipito-frontal, and were the head partially extended, the still longer occipito-mental, diameters would be driven into the pelvic canal. Considerable discussion has arisen as to the time at which this flexion of the head occurs. It is probable that it takes place at about the time when it is necessary for the descent to take place. Thus, with a large head and somewhat scanty pelvis it would take place upon the iliac fossæ or at the superior strait; with a medium-sized head, upon the lower uterine segment; and with a small head, possibly not till it reaches a strong resistance upon the pelvic floor. It should be said, however, that it is probable that a certain amount of flexion exists from the natural posture of the child before labor sets in, which paves the way for the more complete flexion resulting, as described above, from the uterine contraction forcing the head against the resistance of some portion of the pelvis. One other effect of flexion deserves to be mentioned besides the substitution of small for large cranial diameters. The fixation of the chin upon the sternum imparts a firmness to the fœtal body which greatly facilitates the action of the expelling force. If the head were oscillating backward and forward, as in life, a great part of the propulsive force would be wasted. But its fixation makes of the whole fœtus one firm, resisting body, capable of transmitting throughout its whole extent the *vis a tergo* of the contracting uterus. Moreover, the fixity of the fœtal body permits of that moulding of the cranial bones which allows the head to accommodate itself to the pelvic cavity as it passes through.

A question which has given rise to much difference of opinion is, whether the head passes through the brim having its biparietal diameter parallel with the plane of the brim, or whether, as Naegele first taught, the anterior parietal bone (in the first position, the right) is lower than its fellow. Those who believe in synclitism, or the coincidence of the biparietal diameter with the plane of the brim, as, for instance, Leishman, Künecke, and Duncan, hold that the axis of the uterus and of the fœtus is practically coincident with that of the brim, though, of course, the anterior parietal bone is lower with reference to a *horizontal* plane. Those who hold to the asynclitism of the head, on the other hand, claim that the axis of the parturient uterus deviates several degrees from the perpendicular of the brim toward the spinal column, and that the body of the child conforms still more to the curve of the lumbar and sacral vertebræ. This accounts for the preponderance of dorso-anterior positions, because the back of the child less readily than the belly apposes itself to the lumbar curve of the mother's vertebræ, and at the same time the effort of the head to round the promontory and to accommodate itself to the deep concavity of the sacrum brings the anterior parietal bone farther down than the posterior with reference to the plane of the brim. Thus, for the biparietal diameter at the passage of the conjugate of the brim is substituted the shorter subparieto-supraparietal diameter. Dr. Galabin showed, from measurements on a number of heads, that the diameter measured at an angle of a few degrees with the biparietal from points six-tenths of an inch above and below the right parietal tubes was always less than the biparietal diameter. In cases of any, even the slightest, contraction of the brim, this gain would be very useful. The prevalent belief at present is that it is only when there is contraction of the brim that this obliquity occurs. Naegele insisted that this obliquity, which normally began at the brim, was maintained throughout the labor. Others maintain that this obliquity begins only after the head reaches the pelvic floor. For a clear statement of the arguments in favor of the existence of Naegele's obliquity, the reader is referred to a paper by Dr. Robert Barnes, "Obstetrical Transactions," vol. xxv.; also, a paper by Dr. Galabin, *ibid.* (See Fig. 1981.)

2. *Descent.*—Little need be said under this head. The stage of descent or progression accompanies in point of time the preceding and the two following stages. It lasts from the engagement of the head to its expulsion from the vulva. It is produced by contractions of the uterus and of the voluntary muscles, especially those of the abdominal wall.

3. *Rotation.*—This is one of the most important stages in the mechanism of labor. By it the occiput, no matter what its position at the beginning of labor, is brought under the pubic arch, and the long diameter of the head, which at the superior strait had occupied a more or less nearly transverse position, in order to conform to the greatest diameter of the pelvis at that level, assumes nearly an antero-posterior direction, so as to correspond with the longest diameter of the outlet. The rotation imparted to the head by means to be immediately considered is communicated to the trunk, so that the whole body revolves. It was taught by Baudelocque that the head alone underwent rotation, causing thereby a torsion of the neck; but the contrary view is important to em-

phasize in view of the mechanism in the stage of external rotation of the head. The causes of this phenomenon have been somewhat in dispute. It was thought by early observers that the forward rotation occurred only when the occiput was originally forward of the mid point of the pelvis, and that in occipito-posterior positions

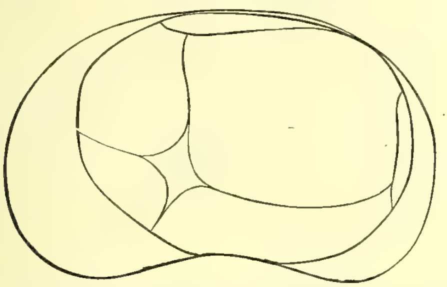

Fig. 1981.—Engagement of Head in Brim of Slightly Flattened Pelvis, Viewed from Below, Showing Nægele's Obliquity. The sagittal suture is displaced toward the sacrum, the anterior parietal bone is slightly in advance of the posterior, and the head is flexed toward the posterior shoulder. Such an obliquity, if between 12° and 15°, would give a mechanical advantage. The diagram also shows how, in such cases, the bulk of the head glides to on side of the promontory in order that the bitemporal diameter (shorter than the biparietal) may traverse the conjugate of the brim. (Altered from Galabin.)

the occiput rotated to the sacrum. To explain these supposed facts the direction of the inclined planes of the pelvis was cited, the anterior directing the occiput forward and the posterior backward. A striking experiment by Dubois disproved this view. In a woman dead just after confinement the uterus was opened at the fundus, and her own dead fœtus introduced, occiput posteriorly. Force was applied *a tergo* by manual pressure, and the head rotated to the front. Repetitions of the experiment gave the same result, until the maternal parts were considerably stretched; then a larger fœtus being substituted, forward rotation again occurred. It is evident that, while the inclined planes may, after the rotatory movement has been imparted, facilitate the movement of the occiput forward and of the sinciput backward, they are not the efficient cause of the rotation, otherwise, in the experiment, the occiput would have gone to the sacrum. When the head is fully flexed the lowest part of it, as it descends, is the region between the vertex and the occiput. This part, then, is most exposed to resistance. But the resistance offered by the pelvic canal is strongest in its posterior part, by reason of the greater curve being at the rear, against which the uterus, contracting in the line of the axis of the brim, drives the presenting part. This lowermost part (the occipital region) is, therefore, driven toward the front. Hence forward rotation. Or, again, speaking more generally, to use the argument of M. Pajot: "When a solid body is contained in another, if the container is the seat of alternations of movement and of repose, if the surfaces are smooth and slippery, the contained will always tend to accommodate its form and dimensions to the form and capacity of the container." This author cites as an example the laying of an egg, in which process, even if the egg started on its passage in a transverse position, it ends by rotating so as to bring its shorter diameter across the calibre of the canal, and is expelled end first. The lubricity necessary in parturition to permit this accommodation of the form of the contained to that of the container is secured by the mother's secretion and the smegma of the fœtus. The directing forward by the resisting vaginal wall of the impinging lowest part of the fœtal head is a point of great practical importance; for it follows that, if flexion is not perfect, the occipital region, not being lowest, fails to be rotated forward. Hence perfect flexion is essential to perfect rotation. This stage of rotation may be compared with the twist that is imparted to the Minié-ball in passing through the rifle-bore. Its object is merely to bring the long diameter of the fœtal head into such a direction that it will gain the most room for its emergence, which, by the backward yielding of the coccyx, is found in the conjugate of the outlet.

4. *Extension.*—The third stage having brought the occiput to the pubic arch, and the expulsive force having driven the head down till each side of the occipital bone is firmly apposed to the ascending ramus of the pubes on either hand, this occipital region becomes a fulcrum around which the head swings as it passes from a state of flexion to one of full extension (see Fig. 1982). The mechanism of this movement depends simply on the continuance of the expelling force, while a portion of the fœtus, viz., the occiput, is completely arrested. Hence the non-arrested part, viz., the sinciput, alone descends, and the head is extended. The action is that of a lever of the third class, the fulcrum being at the point of contact of the nucha with the pubic arch, the weight or resistance at the point of contact of the chin with the pelvic floor, and the force being applied between the fulcrum and the weight, viz., at the occipital condyles. The long occipito-mental diameter (13.5 ctm.), which it was the object of flexion to prevent from coming directly athwart the pelvic canal, is provided for at the vulva by the prior emergence of the occiput, which really has taken place at the time the neck becomes fixed against the rami. To use a homely illustration, if a rod three feet long is to be passed through a barrel whose average diameter is two feet nine inches, one end must be in advance of the other. When, however, the more advanced end of the rod has emerged at the further end of the barrel, it can be made a pivot upon which the rod may be swung forward until, passing through the transverse plane (which would have been impossible until the forward end had emerged), the posterior end itself becomes the more advanced. The occipito-mental diameter is such a stiff rod passing through a canal whose calibre is less than the length of the rod which passes through it. As the head emerges by extrusion the following diameters successively present themselves at the vulvar orifice: suboccipito-bregmatic, suboccipito-frontal, suboccipito-mental, and suboccipito-submental. In a word, the birth of the head in vertex presentations always takes place by suboccipital diameters.

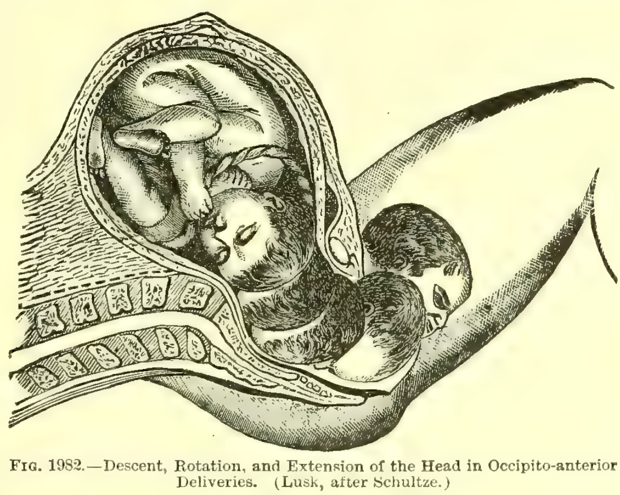

Fig. 1982.—Descent, Rotation, and Extension of the Head in Occipito-anterior Deliveries. (Lusk, after Schultze.)

5. *External Rotation.*—With the end of the previous stage the head of the child has been born. During the rotation of the head, preparatory to its descent to the vulva, the trunk participated in the movement, and when the head became antero-posterior the shoulders were approximately transverse, therein accommodating themselves to the width of the inlet. But as they come farther down and approach the outlet, it is obvious that they must change direction in order to bring the long bi-

acromial diameter into coincidence with the long diameter of the outlet. The same mechanism which has just been described as acting to produce rotation of the head is now brought to bear upon the shoulders, and with the same effect, in accordance with the necessity for accommodation between the "form and dimensions of the contained and the form and capacity of the container." The shoulder which was anterior before rotation of the head occurred, and which with that rotation has swung over to the other side of the mother, is now directed back to the median line, and appears at the arch of the pubes. In this motion of the trunk the head, carried on the neck, participates, and the occiput is turned toward that thigh of the mother which corresponds to its original position. Hence the external rotation of the head. Meantime the anterior shoulder, the analogue of the occiput, has fixed itself under the pubic arch. The posterior shoulder, the analogue of the sinciput, traverses the curve of the sacrum, curving the trunk as it does so, until it appears at the posterior commissure. This mechanism is most perfectly carried out in primiparæ. When the perineum is weakened or torn, the emergence of the two shoulders is often nearly simultaneous. The birth of the shoulders is immediately followed by that of the rest of the fœtal body, a single contraction of the womb being enough to expel the smaller parts in the wake of their larger predecessors.

The foregoing description of the mechanism of normal labor is applicable to all the positions of head presentation. The only difference is that in the left positions the head rotates to the right, and in the right positions to the left. In the posterior positions the amount of rotation is greater than in the anterior. In the left positions the stage of external rotation brings the occiput to the mother's left thigh, and in the right to the right thigh.

Certain anomalies occasionally take place in the mechanism of parturition in vertex presentations. These anomalies have reference chiefly to the third stage, that of rotation. With a small fœtus and energetic uterine action rotation may not occur, and the head may come down in the same position it originally had. Malrotation sometimes takes place, especially in posterior positions. In these cases the occiput, instead of going to the pubes, as it should, turns back into the cavity of the sacrum.

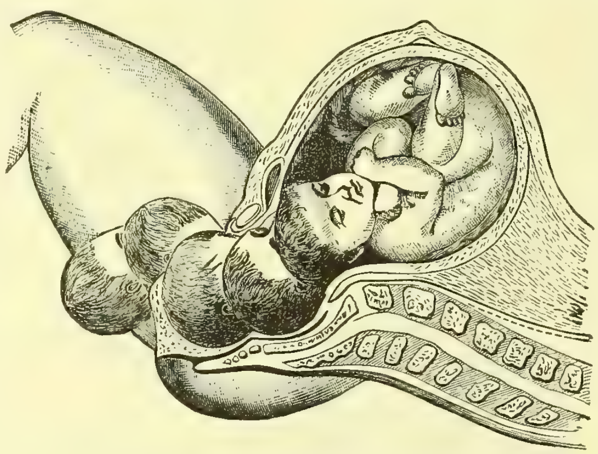

Fig. 1983.—Mechanism of Delivery in Cases of Posterior Rotation. (Lusk, after Schultze.)

This accident occurs, according to Dr. Uvedale West, in one case in twenty-five of occipito-posterior positions. Its cause is usually incompleteness of the foregoing stage of flexion. If the head is not thoroughly flexed, the anterior fontanelle is the lowest part, and as such is rotated forward, the occiput of necessity turning to the rear. Even in cases where this manœuvre has begun to be executed the descent of the head into the pelvic cavity sometimes causes a more complete flexion, and the normal rotation of the occiput is accordingly effected, even when a posterior delivery had seemed inevitable. When, however, the occiput is destined to remain at the rear, it comes down upon the perineum while the forehead appears at the pubes. The forehead cannot pass under the pubic arch, as does the occiput in normal cases, but becomes fixed against it, usually a little laterally, the right frontal bone being in contact with the arch in first positions and the left in second (see Fig. 1983). Around this pivotal point the head moves by flexion, the occiput greatly distending the perineum until the nape of the neck appears at the posterior commissure. This point in turn becomes a fulcrum, while a movement of extension causes the forehead to emerge at the anterior part of the vulva, and the head is born. The twofold movement of flexion and extension causes the birth under such circumstances to be tedious, and forceps are often necessary. Moreover, the pressure of the great bulk of the occiput upon the perineum predisposes to rupture of that body.

An important element in the mechanism of delivery in all vertex cases is the moulding of the head, which allows it to conform to the varying shape of the maternal passage. This moulding is made possible by the openness of the sutures, which allows the edge of each bone either to slip under or to override that of its fellow of the opposite side; also by the fontanelles, and by the mobility of the frontal and occipital bones. The biparietal and suboccipito-bregmatic diameters are lessened at the expense of the occipito-mental, which latter may well be lengthened as it does not become transverse in the pelvic canal.

This result is attained by the frontal and occipital bones folding under the edges of the parietal on either side. In occipito-posterior positions a remarkable lengthening of the fœtal head occurs. However great deformity of the head may result from these causes, and in difficult cases it is sometimes considerable, it is remedied in the first few days following birth by the elasticity of the growing bones, so that any attempt on the part of the physician to restore the normal shape of the head is quite superfluous.

A certain portion of the presenting part is subjected to a diminished pressure compared with that undergone by the greater part of the fœtal head. This is that part which is opposite the dilating os, and which, therefore, meets but little resistance. This diminished or, as it might perhaps better be called, unsupported pressure causes a swelling, consisting in part of serum and in part of extravasated blood, to which is applied the name caput succedaneum, from the old idea that this tumor in some sense takes the place of the fœtal head.

This swelling, whose size is dependent upon the length and amount of pressure brought to bear on the presenting part, rarely gives any trouble after the birth, the effused fluid becoming absorbed in the first two or three weeks.

The caput does not usually form until the membranes have ruptured, and its chief clinical value is that when discovered at the brim it is evidence of effective pains, and that after birth it affords information as to the position of the head during labor.

Thus in O. L. A. the caput succedaneum forms on the upper posterior corner of the right parietal bone, because that part comes opposite the dilating cervix in that position.

In O. R. A. it is at the corresponding corner of the left parietal bone.

In O. L. P. it is at the upper anterior corner of the right parietal bone, and in O. R. P. in the same corner of the left parietal bone.

In the cases last spoken of, where, by reason of imperfect flexion, the occiput rotates backward, the caput succedaneum is to be found in the vicinity of the anterior fontanelle.

Mechanism of Delivery in Face Presentation.—The lever action of the head, poised upon its condyles, has been already referred to. The greater length of the

anterior arm tends, as has been shown, to give a greater effect to the resistance acting upon that arm, and so to flex the head. The head is probably slightly flexed before labor begins; but even were it exactly at right angles with the spinal column, flexion would be produced. If, however, the head is surprised at the outset of labor in a position of partial extension, the anterior arm of the lever may not preponderate (Fig. 1984). The occiput is brought near the neck, and the capacity of the pelvis is not sufficient to readily allow the transit of that greater diameter, the occipito-frontal, which must pass across it before the head can get into a position of flexion. In order, then, to present the best possible diameters under the circumstances, the head becomes further extended, and the chin descends to its utmost extent, while the bregma lags behind. Thus the mento-bregmatic diameter gives place to the sub-mento-frontal, which is in position to pass through the passage. Again, face presentations may be produced as follows: When a transverse presentation is converted into a longitudinal one by the pushing of the breech up to the fundus through uterine contractions, if the child's chest is directed toward the pelvis, the resistance of the side of the uterus opposite that toward which the breech was directed will approximate the occiput to the nape of the neck and cause extension; whereas, the child's back being toward the pelvis, the same uterine action would flex the head. This process of extension may happen in any one of the four vertex positions, and the position of the trunk remaining just as before, we have four corresponding face positions, the forehead pointing to the side where the occiput would be if the head were flexed. Instead, however, of taking the forehead as the representative point by which to describe the position in face presentations, it is customary to speak of the chin, because the chin is the part that (like the occiput), as being the lowest, must rotate to the pubes. Thus the commonest face position, corresponding to the first vertex position, is not called, as it might have been, left fronto-anterior, but right mento-posterior, which amounts to the same thing. It is to be remembered that a face presentation cannot with an ordinary-sized child occur in the cavity of the pelvis. The extension upon which it originated took place above the brim, and the face entered the pelvis. The only change possible in the cavity is a little more completeness of extension. Hence may be seen the general uselessness of endeavors to convert a face presentation into one of the vertex after the head has entered the pelvic cavity.

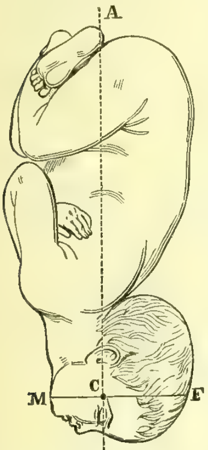

FIG. 1984.—Showing the Predominence of the Posterior Arm of the Lever in Face Presentations. (Galabin.)

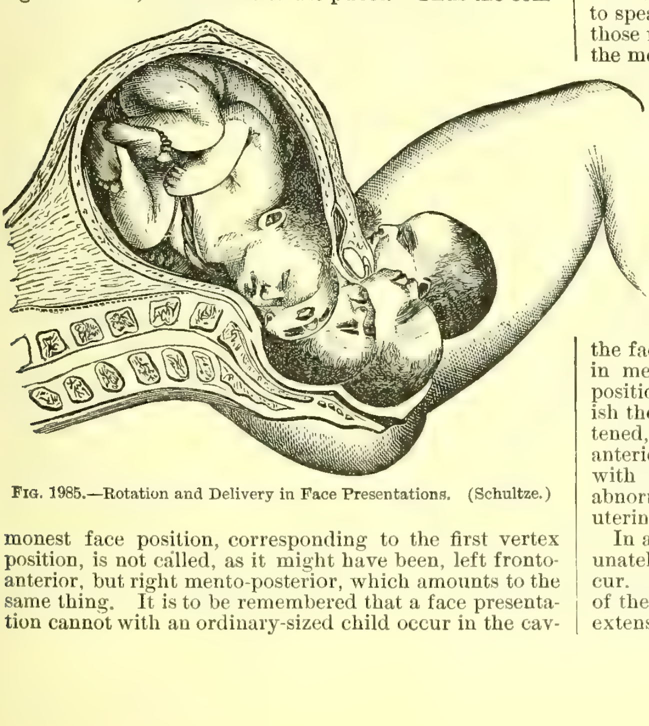

FIG. 1985.—Rotation and Delivery in Face Presentations. (Schultze.)

The various stages in face presentation correspond to those in presentation of the vertex. As, however, extension takes the place of flexion in the first stage, so flexion takes the place of extension as the head emerges. Interest especially centres about the stage of rotation, which is indispensable to a proper termination of the case (see Fig. 1985). The chin has become the lowest part of the fœtus, and is directed forward by the resistance which it experiences, precisely as the occiput is in vertex presentation. There is not that preponderance in frequency of M. R. P. which analogy of the vertex positions would lead us to expect. In face presentations the proportion of the dorso-left to the dorso-right positions is only as 1.4 to 1, while in vertex presentations the ratio is nearly 3 to 1. This is perhaps due to the fact that it is the, so to speak, less normal positions of the vertex which are those most readily converted into face presentations. In the mental-left positions the chin is rotated to the right, and in the mental-right to the left. It is evident that a less degree of rotation is required to be effected in mento-anterior than in mento-posterior positions. When rotation has been completed the head descends until the chin becomes fixed under the pubic arch. Around this point, as a fulcrum, the head revolves, the occiput leaving the back of the neck, and the face, brow, anterior fontanelle, and occiput successively emerging from the vulva (see Fig. 1985). Following this stage there is external rotation of the head just as in the vertex presentation.

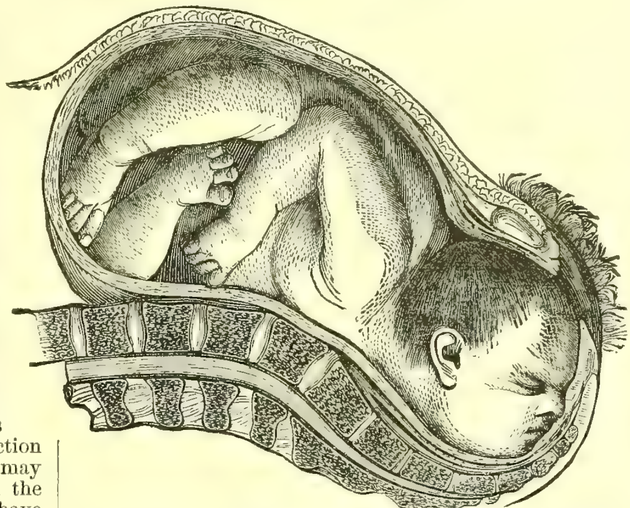

FIG. 1986.—Chin to the Sacrum from Failure of Rotation. (Dictionnaire de Médecine.)

The caput succedaneum in these cases is upon the face near the corner of the mouth, on the right cheek in mento-right iliac and on the left in mento-left iliac positions. The moulding of the head is such as to diminish the vertical diameter, the top of the head being flattened, sometimes with a saddle-shaped depression at the anterior fontanelle and with the occiput elongated. As with similar phenomena in vertex presentations, these abnormalities disappear in the first few days of extra-uterine life.

In a certain number of cases of face presentation, fortunately small, anterior rotation of the chin does not occur. These are chiefly those where rachitic narrowing of the brim or other deformity has prevented complete extension of the head so that the chin is not the lowest

part. As a rule, it may be said that when forward rotation of the chin does not occur, the birth of the child by natural means is impossible. This subject, therefore, fails properly to belong under the mechanism of labor, and has been considered in its proper connection under the management of labor. In a very few instances, however, nature is able to complete the birth even under these untoward circumstances. Even when the head has come down into the cavity, with the forehead turning forward, and a proper rotation seems no longer possible, it sometimes happens that the contractions of the uterus complete extension, and the resistance of the pelvic floor brings the chin forward. If, however, the chin finally remains posterior, while, as a rule, birth is impossible without assistance, yet cases have occurred where the head was expelled by the following manœuvre : An attempt is begun to substitute a vertex presentation for the abnormal one by a partial flexion, which brings the forehead and anterior fontanelle under the pubes ; then the great fontanelle becomes fixed at this point, and the head becoming extended, the face sweeps over the perineum. Thus the birth occurs by flexion followed by extension. Much more rarely nature effects her work by a movement of extension followed by flexion ; that is, the forehead is fixed against the anterior pubic wall, and eyes, nose, mouth, and chin successively sweep over the perineum, after which the forehead and cranium in turn clear the pubic arch. In these cases the caput succedaneum is to be looked for on that part of the cheek adjacent to the eye and root of the nose, chiefly on the right side when the chin is to the right ilium, and on the left when the chin is to the left.

Brow Presentations.—These may be properly considered in this connection, the difference being only one of degree between them and such cases as were last considered, viz., incomplete extension. The majority of instances, where the arms of the lever already referred to are at right angles with the spinal axis, become converted by preponderance of pressure on one or the other arm into either vertex or face presentations. In the rare cases in which the head enters the pelvic cavity with the brow presenting, the brow usually rotates forward. Then the head is born thus : The forehead and eyes appear at the vulva ; then the superior maxilla is fixed against the pubes, while the occiput emerges over the perineum ; finally the nose, mouth, and chin successively appear under the pubes ; the manœuvre being, in fact, one of flexion followed by extension. Much more rarely the head comes down to the inferior strait in a transverse position, and the upper maxilla fixes itself against one of the pubic rami, while the occiput swings down under the opposite ramus. When the forehead rotates backward to the sacrum, delivery by natural means is practically impossible. Indeed, in the most favorable case of brow presentation persisting unconverted into that of either vertex or face, the unusually long diameter which traverses the pelvic canal, viz., the occipito-frontal, which is 2 ctm. ($\frac{4}{5}$ inch) longer than the suboccipito-bregmatic (see Fig. 1978), makes the labor very tedious and frequently requires the subvention of obstetrical assistance. This will be seen again from the fact that the cranial circumference, measured at the extremities of the occipito-frontal diameter, is 37.5 ctm. (14$\frac{3}{4}$ inches), against 33 ctm. (13 inches), the maximum circumference of the flexed head.

The moulding of the head in brow presentations is characteristic. The occiput is drawn out posteriorly by compression between the pelvis and the dorsal surface of the child, and in compensation the forehead is pushed out anteriorly, while the diameter drawn from the chin to a point in front of the posterior fontanelle is shortened. Thus the head is made pyramidal, the apex being in the frontal region. The caput succedaneum forms from the root of the nose to the posterior angle of the great fontanelle.

Breech Presentations.—In a majority of cases of presentation by the pelvic extremity the attitude of the child is the same as in presentations of the vertex as far as concerns flexion of the head and limbs, the fœtus being simply inverted. It is to be regarded as a malpresentation, and, like other malpresentations, is favored by whatever disturbs the normal relation between the fœtus and the maternal structures—premature labor, excess of amniotic fluid, contracted pelvis, death of the fœtus, plural births, etc. In the full breech presentation, the legs

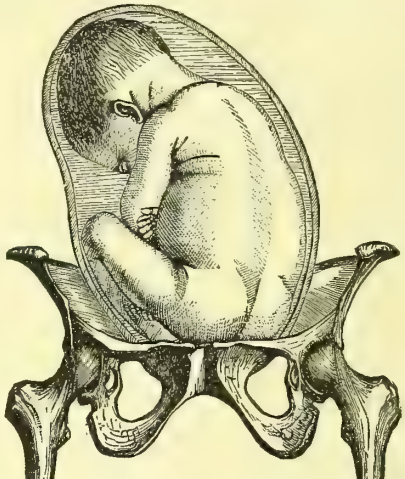

Fig. 1987.—Breech Presentation. (Lusk, after Pinard.)

being flexed at the hip, the knee, and the ankle, the heels are on the same plane with the breech, and the toes a little above. In this case the presenting part is at its maximum size, and this may therefore be taken as the most normal type of this variety. But whether we have the "incomplete breech," as when the flexed legs are carried straight up along the fœtal trunk, the footling, which is less frequent than the breech, or the very rare knee presentations, the mechanism is substantially the same as for the breech, the only difference being that as the presenting part is

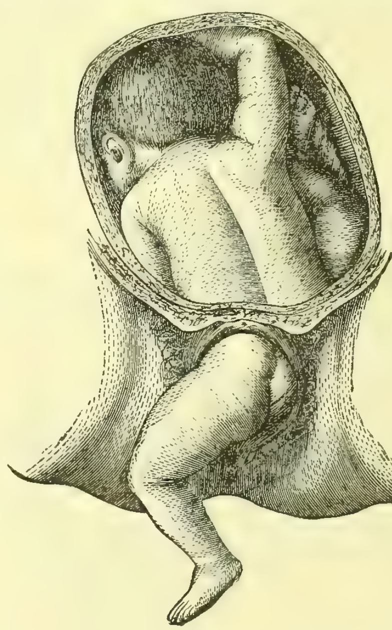

Fig. 1988.—Birth by the Pelvis, S.L.A. Prolapse of the Left Lower Extremity. (Dictionnaire de Médecine.)

smaller, the various stages of the mechanism are less distinct.

The mechanism of delivery in pelvic presentations falls into five stages. Of these the first is that of *moulding and diminution of the parts.* The parts which at first were

loosely apposed become, as the trunk engages in the pelvic canal and feels the opposition of the propulsive and resistant forces, closely apposed. All vacant spaces are filled out. The thighs press against the abdomen, the calves against the thighs, the back of the feet against the front of the legs. Thus the bulk of the presenting part is reduced to a minimum.

2. *Descent.*—This stage of course extends over the time of all the others, and requires no further mention.

3. *Rotation.*—This is effected by causes identical with those which we have seen to operate in the other presentations.

FIG. 1989.—Occiput to Pubis in Breech Presentations. (Galabin.)

In left iliac-sacral positions (S.L.A. and S.L.P.) the left hip is anterior. As the breech descends, the tendency to accommodate its form to the shape of its container brings the long bitrochanteric diameter in correspondence with the long antero-posterior diameter of the outlet. In the first position, S.L.A., the left hip of the child impinges on the right pubic ramus, and then, as the right side of the child's body glides down over the left sacro-iliac synchondrosis, the left hip fixes itself under the pubic arch, still a little to the right, rotation not being perfect, in readiness for the succeeding stage of the delivery. In right sacral positions (S.R.A. or S.R.P.) the child's right hip impinges upon the left or the right pubic ramus respectively, and there fixes itself under the pubic arch, while the left hip and side of the child turn back toward the sacrum.

4. *Expulsion of the Trunk.*—The anterior hip being fixed below the pubic arch, the posterior side of the body passes down along the curvature formed by the sacrum, the coccyx, and the pelvic floor, the body of the child adopting a corresponding curve, of which the concavity looks toward the pubes. Besides this curve there is also a twist in the child's body, owing to the fact that the shoulders are somewhat transverse at the brim. The posterior buttock now appears from the posterior commissure, and soon after the anterior one slips out from under the pubes. The legs and thighs then, being no longer held in their flexed posture, fall out into a position of extension. The shoulders have now rotated into an antero-posterior direction and are speedily born, unless the arms have become extended so as to add to the bulk of the head and prevent that part from coming down into the hollow of the sacrum.

5. *Internal Rotation and Birth of the Head.*—The birth of the shoulders leaves the head transverse in the pelvis, the occiput being to right or left, according as the right or left hip, side and shoulder of the child, were brought to the pubes. A rotation of the head is now effected which brings the occiput to the front, the causes being just the same with the after-coming head as we have already seen them to be with the presentation of the vertex. This internal rotation of the head causes an external rotation of the trunk which brings its dorsum toward the front of the mother. The suboccipital region is now fixed under the pubic arch. The chin, closely applied to the chest, appears at the posterior commissure, followed by the mouth, nose, eyes, forehead, and vertex in turn, and the birth is complete. It is worthy of note that the same diameters, viz., the suboccipital ones, appear successively at the vulva, as in delivery of the head in vertex presentation; but in the reverse order, that is, the suboccipito-bregmatic, which emerges first in the vertex delivery, is the last to be born in the after-coming head. In the former case the successive diameters are brought out by an extension of the head; in the latter by a flexion, which flexion, however, is rendered less marked than it would otherwise be by the fact that the portion of the body already born is usually carried upward toward the mother's abdomen (see Fig. 1990).

The principal exception found to the foregoing mechanism takes place in the last stage, when, instead of the occiput rotating to the pubes, the face comes to the front and the occiput goes back to the sacrum. Under these circumstances one of two things happens: either the head remains flexed on the chest, or it has become extended. In the former case the chin, closely applied to the breast, has passed under the pubic arch. Then the occiput rests against the posterior commissure as a fulcrum, and the chin, mouth, eyes, and forehead are successively born from under the pubes, the various suboccipital diameters emerging successively, as in vertex presentation, or in the ordinary delivery of the after-coming head (occiput anterior) in breech cases. Here the child's body, already born, has a tendency, as it lies in the accoucheur's hands, to ride backward between the mother's thighs, instead of forward toward her abdomen. On the other hand, if the head is extended in the pelvic cavity, the occiput still remaining posterior, the chin remains above the pubic arch, and becomes fixed there as a point of revolution. Then at the posterior commissure appear successively the occiput, the bregma, eyes, nose, and chin, the successive emergent diameters all being submental, as in the delivery of face presentations.

The caput succedaneum in pelvic presentations is usually situated principally upon the anterior breech, though the whole genito-anal region, and particularly the soft tissues of the scrotum, share in the swelling and ecchymosis. The after-coming head is moulded into an unusually round shape, due to an increased convexity of the cranial vault.

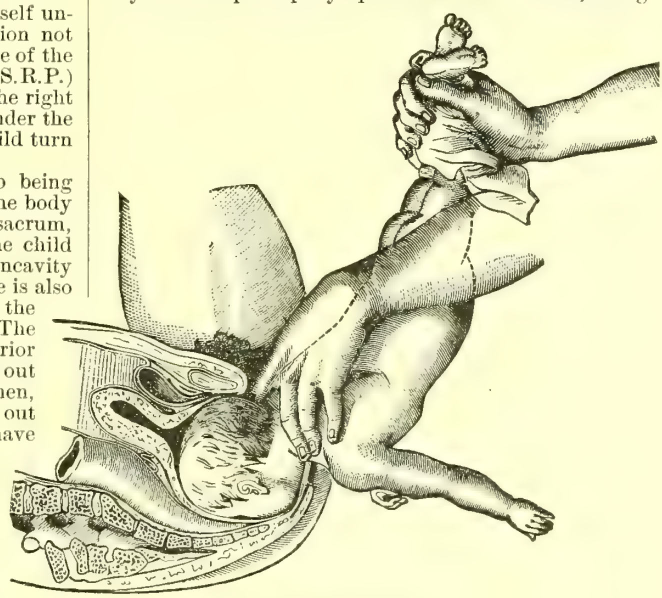

FIG. 1990.—(Galabin.)

SHOULDER PRESENTATIONS.—Little need be said of the mechanism of labor in these cases, for the reason that the presentation is so entirely abnormal that nature is rarely competent to effect delivery. So that the rule is to inter-

fere at once, and not to expect anything from nature. In some few rare instances, however, the work has been accomplished by a natural mechanism which deserves mention at this place. There are two modes in which this may occur, called respectively spontaneous version and spontaneous evolution. By *spontaneous version* is meant the withdrawal of the presenting part and the substitution therefor of a part which is capable of leading to a natural delivery. The substituted part may be either head or pelvis. The conversion of a longitudinal presentation into its antipodes also comes under the head of spontaneous version, and is not infrequent during pregnancy. The manœuvre is, however, rare after labor begins. A multiparous, somewhat lax uterus, a full-term living child, the shoulder freely movable, and an os not fully dilated, are conditions favorable to its occurrence. The manner in which the version takes place seems to be by sporadic contraction of parts of the uterine muscle. The fundus on one side acting forcibly, drives down the corresponding part of the fœtus, and the os being unyielding, does not retain the presenting part, so that it gives place to the head, or breech, as the case may be.

Spontaneous Evolution is possible only when the fœtus is small or premature, hence soft and non-resisting; when the pelvis is capacious and the pains powerful. In this manœuvre the original presenting part is not withdrawn, and the body undergoes such extreme flexion

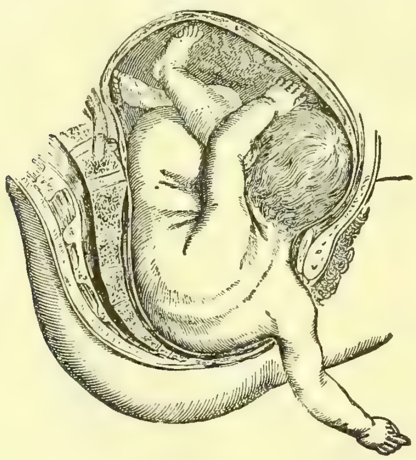

FIG. 1991.—Spontaneous Evolution. (Galabin.)

upon itself as to be forced out at the vulva (Figs. 1991 and 1992). In most of the recorded cases the method has been as follows: The arm being driven through the os the neck is elongated, and the head, by enormous stretching, flexed upon the breech. Then the shoulder and neck, being fixed against the pubes as a centre of revolution, the back and breech are forced down into the hollow of the sacrum and brought to the posterior commissure, whence they emerge, to be followed by the other side of the body, the other arm, and finally by the head. A second and rarer method, called by its first observer *evolutio conduplicate corpore,* is hardly more deserving of the name than was the one just described. In both there is a doubling of the body completely upon itself, the bend being at a point where there is no natural joint, namely, in the thoracic region. In the latter case the flexion is somewhat more extreme, for instead of a revolution about a pivotal point bringing out the breech before the head, the head is indented into the trunk, and both emerge together, followed by the legs. This tremendous distortion of the body is possible only for an immature, and usually a macerated, fœtus; while even the first method of spontaneous evolution can hardly occur without being fatal to an otherwise viable child.

In cases where spontaneous version has taken place the labor goes on as if the substituted part had been that originally presenting, and the appearance of the child corresponds. In a case of spontaneous evolution the caput succedaneum would form about the presenting shoulder or on the prolapsed arm. The deformity and limpness of the child are such as would be expected from the flexion and compression which it has undergone.

THE DIAGNOSIS of the various stages in the natural mechanism of labor is a matter of great importance and now demands attention. Such parts of the process as take place outside the mother's body, and are therefore within the vision of the attendant, require no further mention. Such are the fourth and fifth stages in all the presentations. The emergence of the presenting part, by flexion or extension, as the case may be, and the external rotation of that part can be readily watched. It is, therefore, to the first three stages that we must apply the more difficult means of observation which we will now consider. These means need be directed to the ascertaining of only three points, viz., the presentation, the position, and the degree of descent. A perfect diagnosis of the first carries with it a knowledge of the degree of flexion or of extension, as will be seen in a few moments, and therefore informs us regarding the first stage in the mechanism of labor. The measure taken from time to time of the distance from the vulva of the presenting part tells us of the rate of descent. And a series of observations giving the position of a given part of the fœtal head, in relation to the pelvis, at the different stages of the descent, enables us to trace the degree of rotation. If,

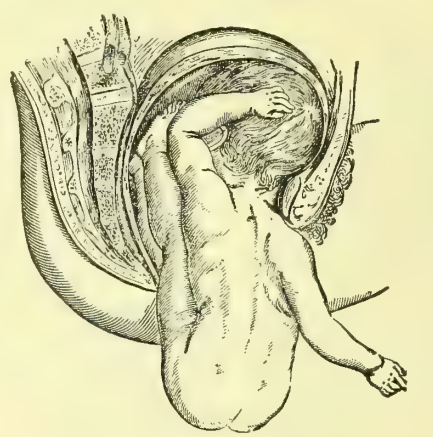

FIG. 1992.—Spontaneous Evolution. (Galabin.)

for instance, the examining finger, introduced to its full length, detects the occiput toward the right sacro-iliac synchondrosis, and later, at the height of two phalanges we feel the occiput toward the right acetabulum, and again, inserting only one joint, discover the occiput toward the pubes, we have established the fact of anterior rotation.

The diagnosis of the presentation may be made in two ways—by external means or by internal. In practice it is convenient to combine the two. In the former method, the patient's abdomen being uncovered, inspection will show whether the uterine tumor is a regular ovoid, having its long diameter nearly coincident with that of the patient's body. In this case we may be sure that one or other pole of the fœtus presents, *i.e.*, the head or the breech. If, on the other hand, the longest diameter of the fœtus lies across the mother's abdomen, we are led to suspect a shoulder presentation. Now, placing a hand on either side of the abdomen, with the fingers pointing toward the pelvis, and carrying the ulnar border of each hand well down along Poupart's ligament, unless the patient be exceedingly corpulent, we can usually detect the head as a round, hard, smooth body, which can be grasped between the two hands and can often be traced into the sulcus of the neck separating it from the trunk. Confirmatory evidence is obtained by finding at the fundus of the uterus another rounded body, but of smaller size, softer consistence, and less regular shape. In pelvic presentations, on the other hand, the hard, round

sphere of the head is to be felt at the fundus, and is, of course, wanting from the lower segment of the uterus.

The position of the child's back, and thereby, in vertex presentations, of the occiput, can usually be determined through the abdominal walls: its regular, smooth and hard convexity contrasting with the softer and more uneven contour of the ventral surface. Usually auscultation reveals the fœtal heart-beat most distinctly on the side corresponding to the back of the child, because in vertex presentations the back is most closely apposed to the uterine wall, and therefore transmits the sound most readily. Sometimes, however, the heart-beat is most distinct on the side toward which the child's breast is turned, and there is then reason to suspect that the head is extended (face presentation), which would appose the chest more closely than the back to the uterine wall. In such cases the globe of the occiput is sometimes to be felt at one side of the pubes, with the deep furrow separating it from the dorsum.

Fuller information as to the presentation is gained by vaginal examination. At the beginning of labor the finger will ordinarily detect the sphere of the fœtal head bulging the fornices, particularly the anterior one. This is especially the case with primiparæ, in whom the head has descended into the pelvis before the onset of labor. As the cervix dilates, the presenting part can be felt through the membranes, the bony vault of the cranium being the most obvious to the examining finger of any of the presentations.

After rupture of the membranes the sutures and fontanelles, which will be seen below to be so essential to the diagnosis of the position, become clearly recognizable. If in any given case the presenting part is very high up, and not accessible, that fact causes us to suspect that the presentation is not that of the cervix, because no other part is so well adapted in shape as the vertex to fill out uniformly and fully the lower uterine segment. If, on passing the finger very high up, we find the vaginal fornix not bulged roundly, but flattened, and feel through one side of the uterine segment a smooth surface (the forehead), with roughness elsewhere, we suspect a face presentation, and, as the cervix dilates, the shape of the face is detected through the membranes. If the distortion from pressure has been great, we may have to wait for rupture of the membranes before distinguishing cheeks from buttocks, mouth from anus, and, in short, a face from a breech. If the finger is inserted into the anus, it is stained with meconium; there is a feeling of constriction, provided the child is alive; and nothing can be found corresponding to the alveolar arches. In the mouth, on the other hand, the finger may be sucked. The roughened processes of the sacrum are like nothing in the face. The orbital arches and the nostrils, if they can be reached, are like nothing in the breech. The penis and scrotum, unless enormously swollen, are usually recognizable. Care must be taken in feeling the face not to do injury to the eyes. The brow presentation is detected, after the rupture of the membranes, by the diamond-shaped anterior fontanelle, against which the finger readily impinges, and from which it can be slid down till it meets the root of the nose and the orbital arches. In breech cases, before rupture, little can be made out distinctly; but the bag of waters takes a much elongated, conical shape, owing to the entire amount of amniotic fluid gravitating to that part on account of there being no large, closely fitting part like the head to retain it above. This, or some other malpresentation, may always be suspected in much elongated membranes. The phenomena attending rupture are somewhat peculiar in breech cases. The gush is not at first so marked as in vertex cases, but, there being no "ball-valve" to shut off the flow, it nearly all trickles away before the child is born. The diagnosis of the full breech from the face after rupture has been already given. If the foot should present, it may be distinguished from the hand by the rounded projection of the heel, by the difficulty of straightening the foot into a line with the leg, and of flexing the toes into the sole as the fingers can be bent upon the palm. If the knee presents, it is distinguished from the elbow by the fact that its extremity consists of a depression (the intercondyloid notch), having on either side an elevation (the condyles); whereas the elbow has in its centre a prominence (the olecranon) with a depression on either side between it and the condyles of the humerus. In shoulder cases there are, before rupture, the general remoteness of the parts from the tip of the examining finger and the elongated amniotic sac already spoken of as characteristic of malpresentations. After rupture the rounded shoulder-joint is distinguished from the knee by the sharp acromion process, from which the finger passes on to the clavicle, while, on the other side, the spine of the scapula may be felt. As the fœtus descends farther the finger reaches the axilla, and even the ribs.

The diagnosis of *position* may be made provisionally, and often with certainty, in connection with that of the presentation, by abdominal palpation and auscultation in the manner above described. Not only can we thus often detect to which side the back is turned, but also whether it (and hence the occiput) is anterior or posterior. If the former, the hard outline of the back passes somewhat over the median line, and sometimes the spinous processes even can be made out. The frontal end of the child's head is also higher up in the mother's abdomen than the occiput, and is therefore reached first by the finger-tips as they are moved down toward the pubes, while the hand on the side toward the occiput is permitted by the flexion to pass lower into the pelvic cavity. If, on the other hand, the back is posterior, the resisting surface which can be felt is more limited, and attains its maximum of hardness as one gets farther from the median line toward the lateral border of the uterus.

The accurate determination of the position, however, usually requires the recognition, through the examining finger, of some distinguishing feature of the presenting part and its reference in the mind of the observer to the appropriate quarter of the maternal pelvis. In vertex cases this can often be done prior to the rupture of the membranes, but in other presentations the position can generally be studied to advantage only after the rupture. For this examination the woman may lie on either her left side or her back. For the novice it is well, by alternating these two attitudes to confirm and correct his observations. In vertex cases the finger impinges upon the wrinkled scalp, perhaps partly obscured by a caput succedaneum. Pressure with the finger-tip will, however, reveal one or more of the following landmarks: The sagittal suture, the posterior fontanelle, characterized by its small size and triangular shape; from its angles lead the sagittal suture, the one most easily traced and followed, and the two lambdoidal sutures, of which only the beginning can usually be felt. In cases where flexion is not complete the small fontanelle becomes less accessible, and, *pari passu*, the anterior more so. This is large, of somewhat irregular lozenge-shape, and the peculiarities by which it is to be recognized have been already referred to.

When the os is dilated to the size of a silver quarter-dollar a suture can generally be felt traversing it. As dilatation goes on, we try in the intervals of the pains to follow the suture to a fontanelle. The head not being as yet fully flexed, we may reach either one, recognizing each according to the distinctions just laid down. In the commonest position the posterior fontanelle will look toward the left, anteriorly. Subsequent examinations show the line of the suture gradually diverging from its transverse direction, while the great fontanelle, if it has been accessible at first, now ceases to be so under the more perfect flexion. Finally, after dilatation has become complete, the posterior fontanelle is clearly made out, with its three entering sutures, of which the sagittal runs nearly backward. These successive observations of position record as many stages in the process of normal rotation, besides keeping us informed of the maintenance of flexion, with which we have seen rotation to have so close a connection. If the anterior fontanelle can be felt at any later period than the beginning of dilatation, we may be sure that flexion is not going on as it should, and may expect to find rotation slow and difficult.

The diagnosis of the position in the other presentations is usually easy, remembering that the forehead in face cases and the sacrum in presentations of the breech are the parts to be felt for.

The third point essential to the diagnosis of the mechanism of a natural labor, namely, the recognition of the degree of descent, is easily accomplished by sounding with the finger the distance to the nearest point of the advancing head. It is well to remember in this connection that in primiparæ the head at the beginning of labor lies below the brim in the pelvic cavity, and is therefore not as high to the examining-finger as in multiparæ, in whom it rests at the brim or upon one of the iliac fossæ.

Charles Francis Withington.

LABOR, PREMATURE INDUCTION OF. The question of the wisdom and propriety of artificially terminating a pregnancy is one that frequently involves great responsibilities in its solution. In the early months of pregnancy the operation, which necessarily destroys the life of the child, should never be performed without consultation, not only for the sake of dividing responsibility, but because the illegitimate practices of professional abortionists make it incumbent upon the honest practitioner to fortify himself against all possible suspicion by securing the moral support and, if need be, the legal testimony of a trustworthy colleague. A broad and important distinction exists between the induction of labor before and after the child is viable, the number of cases when the latter is called for being of course much greater than that of the former. Below the age of one hundred and eighty days it may be said that the chance of survival of the fœtus is practically *nil.* From one hundred and eighty to two hundred days there is a possibility, very faint at first but increasing with each added day, that with the utmost care life may be preserved. About two hundred and thirty days is considered, in cases demanding operation, as a limit of reasonable safety for the life of the child.

THE PROGNOSIS of induced labor, irrespective of the cause which occasioned the interference, is for the child of course dependent on his age, as above stated. For the mother, even with the most improved methods of performing the operation, it is less good than that of labor at term. All the unfavorable sequelæ of natural labor may follow premature labor, as pelvic inflammations, thrombosis, and puerperal fever. Moreover, the preparation of the maternal passages, which nature ordinarily effects, has not taken place, and the detachment of the placenta is likely to be delayed. The uterus has not completed that full cycle of development which is its most proper preparation for subsequent retrogressive changes and which is accompanied by the storing up of that nervous energy that is to be drawn upon during the act of parturition. On the other hand, there is one element of advantage to the mother in a premature labor, namely, that the small size of the child conduces, *quoad hoc,* to an easier birth.

INDICATIONS.—These may be grouped into three classes, as follows:

1. Diseases of the mother which will be aggravated to a dangerous degree by a completion of the pregnancy. Such are advanced phthisis, cardiac disease, especially when accompanied by much œdema; cirrhosis of the liver, attended with ascites; convulsions, or marked renal disease, with onset of uræmic symptoms making convulsions probable; chorea; hydramnios and abdominal tumors causing great distention; placenta prævia; uncontrollable vomiting; irreducibly retroverted uterus.

2. Considerations involving the interest of the child. These of course are operative only after about the two hundred and thirtieth day. Such are hydrocephalus; syphilis, in which for any reason there has been a failure to administer treatment through the mother during pregnancy; placental diseases, especially in the light of a bad history of this sort in previous pregnancies.

Finally, those delicate and responsible cases where impending death of the mother, as by progressive anæmia and phthisis, imperils the existence of the child if it remain longer in utero but where operative interference may cut short the few remaining days of the mother's life.

3. The operation demanded in the interest both of mother and child. This includes cases in which, from mechanical obstructions, a disproportion exists between maternal and fœtal dimensions which so increases in later months of pregnancy as to render birth at term impossible, while it might have taken place before the child attained its full uterine growth. This category comprises the great majority of the cases for which premature labor is properly brought on. Especially it includes cases of pelvic deformity. By anticipating the time of labor in these cases we secure the advantage not only of a smaller fœtal head, but of one that is more readily moulded. Theoretically, the smallest conjugate diameter of the brim which will admit the passage of a living adult fœtus is 9.5 ctm. (3.75 inches). But practically, by the moulding of the bones, many children will pass through pelves contracted in the slighter degrees. Schroeder claims even to have extracted a living child at term through a conjugate diameter of only 7.5 ctm. (3 inches). It is certainly unwise in the slighter degrees of pelvic narrowing to resort, as a matter of course in all cases, to premature induction of labor. When the conjugate measures from 9 ctm. (3½ inches) to 7 ctm. (2¾ inches), however, the operation should be advised.

If the degree of narrowing is slight it is well to add two hundred and thirty days (the safe viable period) to the day after the completion of the last menstruation, and then, because there is always a possibility of an error of fifteen days which might make the real age of the fœtus too young for viability, to add that amount to the two hundred and thirty days and fix the time for the induction of labor at the end of the thirty-fifth week. With the greater degrees of deformity, of course, we cannot defer the operation so long, but must select the thirty-fourth, or the thirty-second, week. When the conjugate diameter is smaller than 2¾ inches the period of the operation must be moved so far back that the chance of the child's living is much compromised. For a statement of the time for inducing labor in the varying degrees of pelvic deformity see, under Labor, Management of, anomalies of the bony pelvis.

Other varieties of obstruction besides pelvic deformity may call for interference with the course of pregnancy, as tumors of the uterus and ovary, contracted cicatrices of the soft parts, rapidly growing carcinoma of the cervix.

THE OPERATION.—Certain preliminaries should be attended to, especially in the interest of the child, which, of course, has less resistant power against untoward surroundings than when born at term. We should be prepared, therefore, with appliances for resuscitation, and a warm receptacle should be in readiness for its accommodation. The *couveuse,* a device recently invented by M. Tarnier, is especially useful in such cases. It consists essentially of a chamber kept at high and uniform temperature by hot water introduced into a part of the instrument provided therefor. As the name indicates it is an artificial "nest." The child should not be disturbed except for feeding, and should not be washed till old enough to bear it.

Of the various agents which have been employed to bring on artificial labor we may first mention certain drugs, such as ergot, borax, cinnamon, quinine, tansy, cotton-root. These are all unreliable. There is, in fact, no drug known which, of itself, in non-poisonous doses, can be depended upon to originate uterine contractions. Some of the foregoing list will accelerate a labor which has been begun by other means. Of mechanical methods certain ones are occasionally efficient, but are slow and not to be relied upon. Such are hot rectal and vaginal douches, the use of the colpeurynter, the detachment of the membranes from the lower uterine segment. Certain other methods are dangerous and are not, therefore, to be countenanced. Such are the injection into the uterus of either water, air, or carbonic-acid gas. In all these cases there is risk of shock and collapse from the sudden distention of the uterus, which, as Barnes has pointed out, will *grow* to accommodate the development of a body contained in it, but will not safely *stretch* for that purpose. The injection of gases adds to the peril just

alluded to the danger of gas emboli entering the circulation and passing to the right side of the heart, where their presence causes sudden death. Galvanism, if strong enough to bring on labor, is dangerous to the life of the child. The rupturing of the presenting parts of the fœtal membranes, while efficacious in inducing labor sooner or later, is prejudicial to the child by exposing him directly to the compressing and resisting force of the maternal structures, and to the mother by removing the water-bag which is nature's provision for dilating the cervix.

The means most to be recommended for the artificial induction of labor are two, which in practice may often be advantageously combined. They may also be combined with the methods spoken of above as safe, but of themselves uncertain. These are the introduction of a foreign body into the uterus and artificial dilatation of the cervix. In a given case, then, premature labor being indicated, but without urgent haste, we should proceed somewhat as follows: First, we may give a hot antiseptic vaginal douche, which answers the double purpose of softening the cervix, with the possibility of setting up contractions and of forestalling the chance of septic absorption in the later steps of the operation. Next, a *new* bougie or elastic catheter is introduced through the os on either side, the index-finger guiding it, if possible, up to the internal os, and by gentle to-and-fro motion insinuated between the membranes and the uterine wall to a distance of six or seven inches from the os. The bougie will pass more readily along the posterior than the anterior wall. If any bleeding results it is probably due to separation of the placenta. The direction of the bougie should be changed so as to avoid separating it further. Some authorities advise that the stylet be placed in the catheter before introduction, with a sharp bend near its extremity, and that after the catheter has been carried in to its full depth the stylet be withdrawn after turning its tip inward so as to cause rupture of the membranes at that point. The advantage of such a rupture is that the amniotic fluid trickles away instead of coming with a rush, as when the puncture is at the most dependent part of the bag; enough fluid is thus retained to assist in the natural dilatation of the os. When special haste is not required this high rupture of the membranes is unnecessary, and the introduction of the stylet has the disadvantage of converting an otherwise soft and flexible instrument into one with sufficient stiffness to make it capable of injury to the soft structures between which it passes. Moreover, even in cases of haste, the labor can be accelerated by other means to be described. The elastic bougie acts in a twofold manner, first, by detaching the membranes, and secondly, by remaining as a foreign body in the uterus. It is almost certain to bring on labor, but the time requisite for this result varies. In most cases one may introduce the bougie over night with a reasonable expectation that the labor will have begun by morning, at which time accelerative measures may be applied if desired. The end of the bougie which protrudes from the os may be allowed to rest against the vaginal wall, but some operators are in the habit of inserting a vaginal tampon, which both retains the bougie and stimulates uterine contraction. In case the end of the bougie protrudes from the vulva, a short piece of the stylet may be inserted and tapes tied to its ring. If the operation were undertaken for contracted pelvis, or any other cause which requires no pressing haste, the case may now be left to itself. The os gradually dilates, the pains increase in severity, extrude the bougie and finally the fœtus.

If the operator is at a distance from home, or for any other reason cannot await the action of nature, he may proceed to the next step, viz., artificial dilatation of the os, which is also applicable in all cases of immediate urgency, as in convulsions.

The best method of effecting dilatation of the os is that by means of the introduction of the hand. Its advantages are the fact that no instrument is required, that it is less injurious to the maternal structures than other methods, that it requires no preliminary opening of the cervix as do the rubber dilators, and that it is as rapid as any other means that are consistent with safety. The patient being anæsthetized and having received an antiseptic injection, the hand is oiled, and the fingers, in the form of a cone, are insinuated into the vagina. Then the tip of one finger is slowly inserted into the os. Gentle pressure is thus maintained until the wall of the cervix yields, from a physiological fatigue, and not from a mechanical divulsion. Then one finger after another is inserted, and then the thumb, till the whole hand passes through into the uterus. The difficulty consists in the fatigue in the operator's hand from the cramped attitude, which may necessitate his being relieved by another person. The chief precaution to be taken is not to hurry the operation and so produce a laceration. The average time needed to effect complete dilatation is from sixty to ninety minutes. The membranes should not be ruptured. The hand is in position to perform immediate version if desired.

Other dilators have been employed. Laminaria and tupelo tents may be used, but sponge-tents, on account of the danger of infection, should be avoided. Steel dilators are likely to lacerate the cervix, and their effect is transient, the cervix returning to its normal shape when they are removed. They may be employed as preliminary to the use of Barnes' bags. The latter come in three sizes: as soon as the cervix is open to the extent of two centimetres the smallest sized bag can be introduced.

This is to be carried in, wrapped about a sound or staff having an extremity sufficiently large not to be readily driven through the wall of the pouch in which it is placed. The extremity of the bag being carried inside the uterus and its constricted portion falling within the cervical canal, the bag is inflated with air. Its presence usually starts up uterine contractions, which dilate the cervix. When the bag is forced out or becomes loose another hot antiseptic injection should be given, and the next larger bag substituted. The third sized bag carries the diameter of the os up to two inches or more. The membranes may then be ruptured, the bag reintroduced, and complete dilatation effected. Barnes has himself, in a case of placenta prævia, carried dilatation from zero up to the maximum amount in half an hour, though this is probably much more rapid work than most operators can do with this instrument.

At the completion of the first stage, if the pains are good, we may leave the case to nature, unless hæmorrhage, convulsions, or other urgent necessity exists for speedy delivery; in which cases version, forceps, or any other appropriate operation may be performed. Under ordinary circumstances the labor should be completed in twenty-four hours from the introduction of the bougie. And in view of the fact that malpresentations, prolapse of the funis, and other abnormalities, are especially liable to occur in premature labors, the obstetrician should always hold himself in readiness to be more than a passive spectator of the labor that he has provoked, and to step in and assume control at any time when it becomes desirable.

The induction of artificial *abortion*, which is made justifiable by those conditions already mentioned and which are so urgent as not to allow postponement till the child is viable, is, perhaps, oftenest called for on account of uncontrollable vomiting which threatens the mother's life. In such cases, of course, one waits, if possible, till after the third month, but in other conditions, like extreme pelvic deformity, if one has his choice of time for the operation, there is an advantage in undertaking it before the formation of the placenta, that is, during the first eight or ten weeks of pregnancy. But if this period is passed, it is then desirable to postpone the operation, if possible, to the twentieth week, because then there is likely to be less difficulty either in puncturing the membranes or in separating the placenta. In the early weeks of pregnancy a sound may be introduced into the fundus and swept to and fro over the inner surface of the uterus. A scraping or dislodgement, rather than a puncture of the ovum, is to be sought. If this method does not prove successful after one or two repetitions, a steel dilator may be applied to the cervix, when, if uterine action does not follow, the finger or a curette may be introduced into the cavity. A

later abortion is almost sure not to expel the ovum entire, so that puncture of it is not to be especially avoided.

Faradization, which has given such success in the treatment of extra-uterine gestation, would seem a feasible method for ending an early pregnancy, and several cases have been reported where it has succeeded. But in others it has proved slow and uncertain, while the strength of the current necessarily proves painful to the patient. The use of the Dieulafoy aspirator has been effective in inducing abortion. It is especially applicable in cases of incarcerated retroflexed uterus, where the os is not accessible, the needle being plunged through the uterine wall *per vaginam* or *per rectum*.

Charles Francis Withington.

LA BOURBOULE is a small place in the Department of Puy-de-Dôme, France, picturesquely situated in a sheltered valley at an elevation of about 2,700 feet above the level of the sea. There are seven warm springs at Bourboule, the temperature of which varies between 66° and 142° F. The composition of the different waters would seem, from the varying results of different analyses, not to be constant. The following is the composition of the four principal springs, according to the analyses of M. Jules Lefort. The proportions are given in grammes per litre :

	Source du Grand Bain.	Source du Bagnassou.	Source des Fièvres.	Source de la Rotonde.
Sodium chloride	3.3457	3.1972	0.0298	3.0458
Potassium chloride	0.2353	0.2295	0.2213	0.2164
Magnesium chloride	0.0390	0.0332	0.0384	0.0255
Sodium sulphate	0.2788	0.2829	0 2324	0.2342
Sodium bicarbonate	2.2719	2.0157	2.0455	2.0260
Calcium bicarbonate	0.1964	0.1911	0.1774	0.1771
Ferrous bicarbonate	......	0.0033	0.0063	0.0025
Sodium arseniate	0.0126	0.0146	0.0717	0.0722
Silicic acid	0.1093	0.1075	0.1080	0.1080
Alumina	0.0301	0.0218	0.0182	0.0185
Total solids	6.5191	6.0968	2.9490	5.9262

There are, in addition, traces in all the springs of lithium and rubidium chlorides, manganese and ammonium bicarbonate, sodium phosphate, and sodium iodide and bromide, besides organic matters. There is also some free carbonic-acid gas.

The waters are used chiefly internally, although baths are also employed, and are recommended in various so-called scrofulous affections of the bones, glands, and skin, in obstinate herpes, erythema, some forms of eczema, and various other skin diseases, in chronic rheumatism, in the later manifestations of syphilis, and in rebellious intermittent fever and neuralgia of malarial origin. The season at Bourboule lasts from June 1st to the middle of September. The waters are exported in considerable quantity. *T. L. S.*

LACHRYMAL APPARATUS, AFFECTIONS OF. The lachrymal apparatus consists of two distinct parts—the lachrymal gland, described by anatomists as divisible into an orbital and a palpebral portion, divided by a fibrous septum, which lies in a fossa just within the upper margin of the orbit near to its outer angle, and which has for its function the secretion of the tears ; and the puncta, the canaliculi, the lachrymal sac, and the nasal duct, which together form the drainage system of the eye, carrying away the tears from the neighborhood of the inner canthus, where they tend to accumulate after having accomplished their purpose of moistening the conjunctival sac. It is commonly taught that under ordinary conditions the lachrymal gland is quiescent, and that it is only in response to some unusual stimulus that it becomes active and secretes tears. It seems probable, however, that this view is incorrect ; for in occlusion of the nasal duct the lachrymal sac soon refills with tears after having been emptied by pressure, even when there is no inflammation of the eye or of the sac to act as a special stimulus. It is held by some that it is chiefly, if not solely, the palpebral portion of the gland which secretes habitually ; but, whether this be true or not, there seems to be little room for doubt that, at least when the eyes are open and in use, there is a constant, though slight, flow of tears, which disappear in part by evaporation from the surface of the eye, and in part by evaporation from the mucous membrane of the nostril after having passed through the nasal duct.* In order that the drainage of the eye shall be perfect, it is essential, not only that the puncta and the lachrymal canals shall be pervious, but that the eyelids shall be in such position that the puncta are in apposition with the ball, otherwise the tears fail to find their way into the canaliculi. The lachrymal gland is, comparatively speaking, rarely the seat of disease ; affections of the drainage apparatus are, on the other hand, of very common occurrence.

Luxation of the lachrymal gland, though from its protected position it is little exposed to external violence, has happened in a few instances, but is an accident of extreme rarity. Neuralgia of the gland has also been observed, and the name "dacryo-adenalgia" was given to it by A. Schmidt, who first described it. Severe lancinating pain in the region of the gland, intolerance of light, and, especially, excessive lachrymation, are the symptoms which characterize it. It is said to occur most frequently in children, and in women in the puerperal state ; also in gouty subjects. It is liable to become chronic, and relapses are apt to occur. In this country, at least, it is a very uncommon affection, and the writer, if he has ever met with such a case, has failed to recognize it. The application of moist heat is recommended as a useful remedy. The oleate of morphia, or of morphia and atropia, or of morphia and cocaine, to be rubbed into the brow and lid ; or a lotion of belladonna, or opium, to be applied over the closed lids, suggest themselves as the local remedies from which most benefit might be expected. Constitutional treatment, also, should not be neglected.

Simple hypertrophy of the lachrymal gland is occasionally met with. It is said to occur most frequently in children, and may even be congenital. The gland may in time become so large as to force the eye from the orbit, and, by pressure upon its nutrient vessels and traction upon the optic nerve, to destroy sight. Cases have been observed, however, in which there was great displacement of the eye, with an astonishing amount of elongation of the optic nerve and the external muscles of the globe, and yet a fair amount of sight and ability to rotate the eye in various directions were retained. The accompanying wood-cut (Fig. 1993), which is an accurate reproduction of a photograph of the patient, represents a remarkable case of this character which came under the observation of Professor Christopher Johnston, of Baltimore, in 1876. Notwithstanding the great displacement of the eye its movements were retained, and a visual acuteness equal, at least, to counting fingers. Professor Johnston removed the greatly hypertrophied gland, and the eye gradually became retracted into the orbit until it finally resumed nearly its normal position. This is the only plan of treatment likely to prove effectual in cases of this character, and to prevent impairment of vision resort to it should not be too long delayed. In the condition known as xerophthalmia the atrophic process is said to extend, in some instances, from the conjunctiva to the lachrymal gland, which undergoes atrophy and ceases to secrete tears.

Dacryo-adenitis, or inflammation of the lachrymal gland, is another affection which is seldom encountered. In explanation of this fact Power remarks : † "It is not difficult to assign reasons why inflammation of this gland should be of exceptional occurrence, for it occupies a position that is remarkably protected both from injury and from cold. Then, again, the product of its secretion is of so limpid and watery a character that concretions from inspissation or deposition are extremely rare ; while it is

* It is a common observation, with persons who have occlusion of one nasal duct, that the corresponding nostril is drier than the opposite one. This difference would hardly be remarked unless the nostril were habitually moistened by a constant flow of tears.

† In a very interesting lecture upon Affections of the Lachrymal Apparatus, published in the London Lancet, July 31, 1886.

discharged by ducts which, though very fine, are yet numerous, and perhaps communicate, so that there is little risk of the secretion being retained." In proof of the rarity of this disease, he mentions that Arlt states he has never seen a case of it; that Des Marres makes the same observation; that Hirschberg, among 22,000 cases of disease of the eye, saw but one case of suppurative dacryoadenitis; and that in the indices of the "Royal London Ophthalmic Hospital Reports," there occurs only one case of abscess of the lachrymal gland. On the other hand, however, it is to be remarked that the diagnosis of this affection is not always an easy matter, and that it is probable that it has not infrequently been mistaken for simple orbital cellulitis. Galezowski has pointed out that dacryo-adenitis sometimes assumes an epidemic character, and he states that he met with an unusual number of cases during an epidemic of mumps.

There are two varieties of inflammation of the lachrymal gland—a chronic form, which is the more common, and an acute variety, in which there may be a rapid formation of pus, or a resolution of the inflammation, without the occurrence of suppuration. In the chronic form the

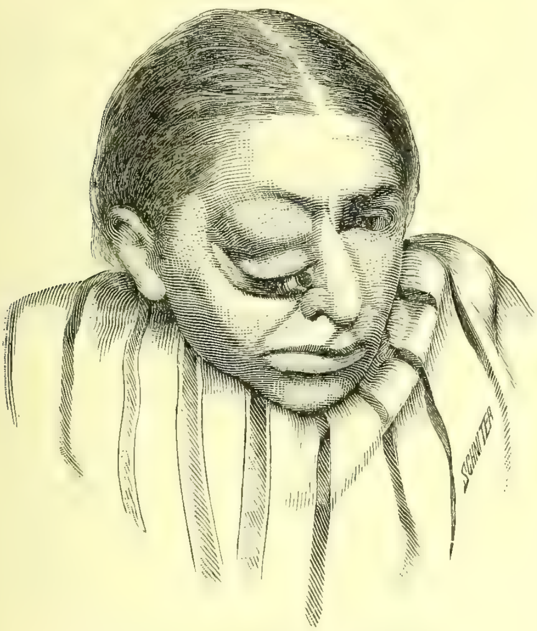

FIG. 1993.—Hypertrophied Lachrymal Gland.

gland becomes more or less enlarged, and may be felt as a "firm, nodulated, immovable swelling at the upper and outer margin of the orbit." The upper lid is usually somewhat swollen and red, and the conjunctiva, especially in the superior retro-tarsal fold, is injected. Pain is not a prominent symptom. Displacement of the eyeball downward and inward, with impairment of its mobility, may occur if the swelling of the gland be considerable. In the acute variety there is severe pain in the region of the gland, accompanied by redness and œdema of the upper lid. The gland itself becomes greatly enlarged, and in consequence the eyeball is displaced, and a squint is produced which may be accompanied by diplopia; the movements of the eyeball are also attended by pain. It is possible, at the beginning of the attack, to recognize the firm resistant border of the swollen gland, and by raising the upper lid to see it projecting into the conjunctival sinus; but the swelling of the lid which supervenes soon prevents the gland from being either felt or seen (Power). There is usually congestion and, in the neighborhood of the gland, chemosis, of the conjunctiva. Cerebral excitement, sleeplessness, and delirium are mentioned by some authors as occurring in the more severe cases, and are ascribed, in part, to implication of the dura mater. If suppuration supervene, which it may do within a few days, the pus may make its way to the external surface of the lid, or it may be discharged into the conjunctival sac. Usually the inflammation is unilateral, but both glands are sometimes simultaneously affected. The causes which are supposed to be capable of exciting inflammation of the lachrymal gland are various—traumatism, cold, rheumatism, gout, struma, syphilis, septic absorption, the poison of mumps, and the extension of inflammation from the cornea and conjunctiva, are among those which have been assigned. The treatment will, of course, vary with the character of the attack and the circumstances which have given rise to it. In the chronic form benefit may be expected from the local application of mercurial ointment, oleate of mercury, or compound iodine ointment; or an ointment of iodoform or of iodol may be tried. Mercury, iodide of potassium, salicylate of soda, and iron are the constitutional remedies which are most likely to be useful. Extirpation of the gland may be required, if it should become so enlarged as to endanger the integrity of the eye. In the acute variety, if there is hope of cutting short the attack, leeching should be resorted to, and a lotion of acetate of lead and opium should be applied externally, while, internally, a brisk calomel purge should be given, to be followed by the liberal administration of quinia, salicylate of soda, or pyrophosphate of soda. Opium or chloral may be required for the relief of pain. Poultices should take the place of the lead and opium wash if it becomes manifest that suppuration is to supervene; and when pus can be detected, a free incision should be made through the upper lid to permit of its escape. Some authorities recommend that the incision should be made beneath the upper lid, but the swelling of the parts makes this difficult of accomplishment.

It sometimes happens, after suppurative inflammation of the lachrymal gland, that a fistulous opening is left in the integument of the lid, through which there is a constant and annoying discharge of tears. Such lachrymal fistulæ are difficult to cure, and it is not always safe to attempt their closure, as this may be followed by a fresh attack of inflammation of the gland. Necrosis of the margin of the orbit and of the orbital plate has been known to occur as a result of severe inflammation of the gland, and temporary fistulæ may be produced in consequence.

From obstruction of one or more of the excretory ducts, cyst of the lachrymal gland, termed dacryops, is occasionally formed. Upon everting the lid it may be seen as "a bluish-pink, semi-transparent, elastic, and somewhat fluctuating swelling, consisting, perhaps, of several nodulated segments of varying size. . . . The swelling, moreover, increases suddenly and markedly in size if the patient cries, or the secretion of tears is stimulated by the application of some irritant to the conjunctiva" (Soelberg Wells). The wall of the cyst is so delicate and ill-defined that it is impossible to dissect it out. The treatment which has proved most successful is the establishment of an artificial opening between the cyst and the conjunctival sac, which may be done either by making an incision from the conjunctiva through the anterior wall of the cyst, and keeping the edges apart by the daily introduction of a probe until they have healed; or, as Von Graefe suggested, by introducing a suture through the wall of the cyst, tying it loosely, and allowing it to cut its way out.

In rare instances chalky concretions, known as dacryoliths, are found in the lachrymal gland. If so situated as to cause irritation, or make their presence felt, they should be removed by incision through the conjunctiva. Neoplasms of the lachrymal gland are rare. Sarcoma of the gland has, however, been observed, and Knapp has reported a case of carcinoma. Isolated cases of angioma, hydatid cysts, and dermoid growths have also been reported (Bull). As soon as the diagnosis can be established complete extirpation of the gland should be practised. This can be most readily accomplished by means of a free incision through the skin and fascia of the upper lid, close to the margin of the orbit.

Although the secretory portion of the lachrymal apparatus is so rarely affected by disease, those parts which have to do with the drainage of the eye are very frequently, as has been said, the seat of pathological changes. There is a twofold reason for this—first, the mechanism by which the tears are carried from the conjunctival sac to the nose is somewhat complex, and a disarrangement of any of its parts is likely to disturb the normal action of the whole; and, second, the whole drainage apparatus, while an appendage of the eye, is, pathologically considered, a part, rather, of the nasal cavity, and it is a question whether, under the conditions of modern civilization—paradoxical as the statement may appear—a perfectly healthy state of the latter is not an abnormal state. Whatever may be the nature of the pathological changes which affect the drainage apparatus, or wherever they may be located, a common symptom characterizes them all: the passage of the tears into the nose is more or less completely interrupted, and, in consequence, they overflow the lids. This is the condition known as stillicidium lachrymarum, a distinction being made, with some justification it would seem, between this condition and epiphora, which signifies a watering of the eye from undue activity of the lachrymal gland.

Considering the several conditions which may give rise to stillicidium lachrymarum in their anatomical order, we have, first, occlusion of the puncta (the closure of the lower punctum probably producing more disturbance than that of the upper), an affection of not very common occurrence, and mal-position of the puncta, a condition which may be brought about by a variety of causes, and is much more frequently encountered. The effect of each of these conditions, which are often associated, is the same—the tears are prevented from gaining entrance to the canaliculi. Complete obliteration of the punctum rarely happens, except, perhaps, as the result of traumatism (laceration, burn, or injury of the lid from some destructive chemical agent), or of inflammation attended by necrotic changes involving the tissues in its neighborhood. More or less complete occlusion, especially of the lower punctum, is, however, a common result of ectropion, and, indeed, of any condition which causes the punctum to turn outward, and so not only prevents the tears from entering it, but brings about a dessication of the parts. Under such circumstances the mucous membrane lining the punctum becomes dry and cuticle-like; the opposite walls of the orifice adhere together; and a layer of epidermis, continuous with that of the external surface of the lid, forms over it. In this condition it is not always easy to ascertain the position of the occluded punctum (though it is usually indicated by a slight depression); but, when it can be found, there is generally little difficulty in reopening it, the best instrument for the purpose being a straight, rather sharp-pointed probe, which, with a drill-like motion, can be made to penetrate the newly-formed epidermis, and so enter the still patent canaliculus. When there is complete obliteration of the orifice this method is not likely to be successful. By putting the lid upon the stretch we may, however, succeed in entering the canaliculus, near the punctum, with a sharp-pointed knife, and, having satisfied ourselves that we have accomplished this by passing a fine probe along the canaliculus into the lachrymal sac, we can then introduce Weber's probe-pointed knife, and slit the canaliculus throughout its whole length. The cut margins will have to be separated every twenty-four or forty-eight hours for three or four days, by which time they will have cicatrized, and henceforth the tears will find their way into the lachrymal sac through the divided canaliculus. Another method of dealing with such cases, proposed by Mr. Streatfield, is to slit the upper canaliculus, and to pass a fine, properly bent director through this aperture into the lachrymal sac, and then along the lower canaliculus to the occluded punctum. If practicable, the point of the director is then to be forced through the obstruction, or, if this cannot be done, it is to be cut down upon. Afterward the lower canaliculus may be slit in the manner described.

There are several mal-positions which the puncta may assume (the lower one especially), that give rise to stillicidium by preventing the tears from entering the canaliculi. They may be more or less completely everted, so that they no longer lie in contact with the eyeball; they may be so strongly inverted that a similar effect is produced; or, owing to the small size of the eyeball or its sunken position, they may lie away from it, a narrow, triangular space intervening in the neighborhood of the inner canthus, between the lids and the front of the eyeball. Eversion of the punctum is a usual accompaniment of the different varieties of ectropion. It may also be produced by chronic inflammation of the margin of the lids, and is frequently present in paralysis of the facial nerve. In persons advanced in life it is often met with as one of the evidences of senile decay, being due to relaxation of the tissues of the lid and loss of tone of the orbicularis muscle. The stillicidium which accompanies eversion tends to aggravate the mal-position of the punctum, for it is apt to excite an eczematous inflammation of the external surface of the lid, which, by inducing further contraction, increases the ectropion. Inversion of the punctum is usually due to entropion, and is not infrequently one of the later consequences of chronic trachoma.

The sovereign remedy for all mal-positions of the puncta is the operation, devised by Bowman, of slitting the canaliculus. There are several methods of performing this little operation (which can now be done almost painlessly under the influence of cocaine), and a variety of instruments have been contrived for the purpose. In the writer's opinion, much the best plan is to use the beak-pointed knife of Weber, or one of its many modifications. The lid should be put well upon the stretch while the knife is being introduced and the section completed, and care should be taken to hold the edge of the blade in such a way that the gutter made by the division of the canaliculus shall present rather toward, than away from, the eyeball. This precaution is not infrequently disregarded, and in consequence there not only results a conspicuous deformity, but the purpose of the operation is less perfectly accomplished. When properly done, the effect of this simple surgical procedure is in most cases very gratifying; not only is the stillicidium cured, but the palpebral conjunctivitis and blepharitis which it induces disappear, and the mal-position of the lid margin is corrected or, at least, improved. This commendation, it may be remarked, applies more especially to the slitting of the *lower* canaliculus. The division of the upper canaliculus is an operation which the writer has very rarely found necessary. If it is impossible to gain entrance to the lachrymal sac by way of the lower canaliculus, or to restore its permeability, we may operate upon the upper one; but, otherwise, there seems to be no advantage in doing so. When the eversion of the lower punctum is considerable, and is only partially remedied by the simple division of the canaliculus, we may increase the effect by excising the posterior wall of the latter, with a small piece of the adjoining conjunctiva, as suggested by Critchett. As a rule, the edges of the divided canaliculus show but slight tendency to reunite, and, if separated once or twice, will cicatrize and remain apart. In exceptional instances, however, they adhere and re-adhere in a most persistent manner. When this happens the difficulty can usually be overcome by the excision of the posterior lip of the canaliculus, as just described. After division of the canaliculus for mal-position of the punctum, an astringent collyrium is usually required to facilitate the cure of the attendant conjunctivitis. A solution of sulphate of zinc (gr. ss.–j. to ℥ j.), or of alum (gr. j.–ij. to ℥ j.), or a combination of either of these astringents with boracic acid (gr. v.–x. to ℥ j.), answers best for this purpose. If blepharitis also be present, an ointment of yellow oxide of mercury (hydrarg. ox. flav., gr. ij. to "vaseline cerate," ʒ j.) should be prescribed, and the margin of the lids should be touched occasionally with a crayon of nitrate of silver.

The puncta may be pervious and in normal position, and yet the tears may fail to reach the lachrymal sac because of occlusion of the canaliculi. Extensive oblitera-

tion of the canaliculus is usually of traumatic origin, but localized strictures may occur in consequence of plastic inflammation arising in other ways. The obstruction may be situated in any part of the canal, but is most apt to be near its inner extremity, either at the point where the upper and lower canaliculi join, or at the juncture of the common canal with the lachrymal sac. It is difficult to cure such strictures simply by probing, as they are very apt to re-form. The best plan is to slit up the canaliculus, preceding the introduction of the knife by the forcible passage of a fine, stiff probe, and being careful, if possible, to get the beak of the knife well into the lachrymal sac. If the probe cannot be made to enter the sac, a sharp-pointed knife must be employed instead. When both canaliculi are extensively obliterated, it is difficult, and may be impossible, to restore a permanent passage-way for the tears.

Foreign bodies, especially loose eyelashes, are liable to find their way through the puncta into the canaliculi, where they excite irritation and obstruct the passage of the tears. They require to be removed, and, if possible, should be extracted through the punctum ; but, if this cannot be done, their removal may be accomplished by slitting the canaliculus. Concretions of lime (dacryoliths) occasionally form in the canaliculi, and small polypi may develop in them. They are also sometimes obstructed by a vegetable fungus (leptothrix), which, as it grows, distends the canaliculus, and projects through the punctum. In order to remove these growths completely, division of the canaliculus may be necessary.

The lachrymal sac, into which the canaliculi empty, and which is continuous below with the nasal duct, is frequently the seat of inflammation. An uncomplicated, primary inflammation of the lachrymal sac is, however, not often encountered. In a very large majority of cases the inflammation is secondary to, and dependent upon, disease of the nasal duct. In strumous children acute primary inflammation of the sac is occasionally met with, and it may also be produced by external violence—for example, a blow upon the eye—or by the entrance into the sac of an irritant fluid ; but these are exceptional causes. The usual, indeed the almost invariable, cause of dacryocystitis (as this affection is termed) is stricture of the nasal duct. When this condition exists the tears accumulate in the lachrymal sac, and remain there until they become acrid. In consequence of this a slight catarrh of the lining membrane of the sac is excited. Mucus then becomes mixed with the tears, and soon undergoes putrefactive changes, and thus the inflammation is aggravated. In this way a chronic catarrhal inflammation, or blennorrhœa, is set up, which may last for years, the sac being constantly distended with muco-purulent matter, which oozes out through the puncta and spreads over the eye, obscuring vision, or mixes with the tears, to overrun the lid, and so increase the annoyance of the stillicidium.

The individual who suffers in this way is fortunate, however, if he does not experience a periodical aggravation of his troubles ; for, in chronic blennorrhœa of the lachrymal sac, acute exacerbations of the inflammation are by no means unusual, while conjunctivitis and keratitis are complications which may occur at any time. Acute dacryo-cystitis, or abscess of the sac, as it is termed, is a serious malady ; at least, it is attended by intense suffering and very considerable constitutional disturbance. The swelling which accompanies it is not confined to the region of the lachrymal sac, but involves the lids and cheek ; indeed, the whole side of the face may be swollen, œdematous, and red, so that the appearance presented is not unlike that of facial erysipelas, for which it is often mistaken. If the inflammation be allowed to run its course, the sac becomes distended by pus which, after a time, makes its way through the walls and finally through the external integument. After this has occurred the acute symptoms subside, and usually the parts return to their former condition. It may happen, however, that the external opening through which the pus has found exit fails to cicatrize, because of the constant passage through it of tears and mucus, and there is then established the condition known as fistula lachrymalis.

It follows, from what has been said regarding the etiology of inflammation of the lachrymal sac, that the treatment of this affection—at least of the chronic variety of it—is, practically, the treatment of stricture of the nasal duct, and of this we shall speak presently. A few suggestions may be offered here, however, in regard to the treatment of acute dacryo-cystitis. It does not often happen that cases of this character are seen early enough to enable us to cut short the attack by antiphlogistic measures ; but when it does, every effort should be made to bring about this result. The abstraction of blood by leeches, the application of a lotion of lead and opium (ext. opii, gr. x. to xv., plumb. acetat., gr. xv. to aquæ destill. ℥ iv.), and the administration of a brisk calomel cathartic, to be followed by liberal doses of pyrophosphate of soda (gr. x. to xv. every two or three hours), or small, frequently repeated doses of sulphide of calcium, are the measures which are most likely to prove effectual. If these measures fail to subdue the inflammation, warm poultices (flaxseed-meal poultices are the best) should be prescribed, and as soon as fluctuation can be detected, or it is evident that pus has formed and is endeavoring to make its way to the surface, vent should be given it by an incision through the integument and the anterior wall of the sac. As such an incision leaves no perceptible scar (provided it is made in the direction in which the skin tends to wrinkle, that is, from above and toward the nose downward and outward), it is much better to give the pus free exit in this way than to attempt to drain the sac by slitting the canaliculus.

The close relationship which exists between affections of the nose and disorders of the drainage apparatus of the eye has already been alluded to. This, as might be expected, applies especially to pathological states of the nasal duct ; for this canal, which is continuous above with the lachrymal sac, and empties below into the inferior nasal fossa, is, in reality, almost a part of the nose cavity itself. The membrane which constitutes its walls is continuous with the lining membrane of the nose, and, like the latter, is extremely vascular, contains erectile tissue, and is at once both a periosteal and a mucous membrane. The calibre, as well as the length, of the bony canal varies considerably, and so also does its shape, which is usually nearly round, but may be decidedly oval. In exceptional instances adult skulls are met with in which it is so small as not to permit the passage of a probe having a diameter greater than three millimetres, while, on the other hand, it is sometimes so capacious as to admit a probe seven millimetres in diameter.

In view of the close anatomical and histological relationship which has been described as existing between the lachrymal duct and the nose, it is no matter of wonder, since nasal catarrh is so common a condition, that catarrh of the lachrymal duct should also be of frequent occurrence. If, too, we bear in mind the histological peculiarities of the tissues which compose the membranous canal, we shall comprehend at once why an inflammation commencing here as a simple mucous catarrh is so prone to lead to stenosis of the duct, and ultimately to the formation of periosteal or bony strictures ; for, owing to the vascularity of the parts and the erectile character of the submucous tissue, it is manifest that but a slight inflammation here must be attended by marked engorgement and tumefaction, which will quickly lead to obliteration of the cavity of the duct. And it is further evident that this temporary occlusion, by causing retention of the tears, will tend to aggravate and prolong the inflammatory process. And so what was at first simply a superficial mucous catarrh becomes presently a periosteal inflammation, attended by lymph effusion and nodular swellings, and producing, sooner or later, permanent stenosis of the duct. The usual sequence of events in obstructive lachrymal disease is, first, nasal catarrh, with secondary involvement of the lachrymal duct ; in consequence of this, temporary occlusion of the duct followed by periostitis, and ultimately by permanent stricture ; then, persistent blennorrhœa of the lachrymal sac, culminating at intervals in acute outbreaks of inflammation, which may give rise to lachrymal fistula. If it

be added that obstinate conjunctivitis and ulcerative or suppurative keratitis are complications of not infrequent occurrence, and that when stenosis of the lachrymal duct is once established it never undergoes spontaneous cure, but, with all its unpleasant consequences, lasts for a lifetime, we shall have a fair comprehension of this troublesome affection, which surgeons have for so long regarded with interest, and in the treatment of which they have expended so much ingenuity. It is doubtless true that inflammation of the lachrymal sac and stricture of the duct do not always arise in this manner, for we meet with cases that are clearly of traumatic origin, in which the starting point of the trouble is, perhaps, a blow upon the bridge of the nose or over the region of the lachrymal sac; and, moreover, it is commonly taught that inflammation of the ocular membranes may extend to the lachrymal passages; but, in the writer's opinion, the pathogenesis of a very large portion of these cases is such as has just been described. How slight a tendency inflammation of the conjunctiva has to involve the lachrymal passages, is shown by the fact that in so virulent a disease as gonorrhœal ophthalmia dacryo-cystitis scarcely ever occurs.

The history of the treatment of stricture of the nasal duct, or of fistula lachrymalis, as it was formerly termed, if fully written, would fill a volume of no mean proportions. Many distinguished surgeons have considered this affection worthy of their study, and innumerable plans for its cure have been devised from time to time. Anel, Petit, Wathen, Ware, Scarpa, Dupuytren, Beer, Desault, Travers, Des Marres, Hays, Bowman, Critchett, Weber, Stilling, Noyes, H. W. Williams, Green, and E. Williams are among those who have suggested methods of treatment, or modified those previously in vogue. More than a hundred years ago (1781) the plan of introducing a hollow tube of gold or silver into the nasal duct was proposed by Mr. Wathen, in England, and until quite recent times this method, which was revived by Dupuytren, was still practised. The intention was that the tube should remain permanently in the duct, and afford a passage-way for the tears. It was introduced through an incision made into the lachrymal sac below the tendon of the orbicularis muscle, and to prevent its falling through the duct it was made flange-shape at the upper extremity. In spite of this, however, the tubes usually fell out, sooner or later, generally dropping into the nose, or, if this did not happen, they became obstructed by calcareous matter, so that their usefulness was in a great measure destroyed. The writer has in his possession one of these tubes, made of gold, which was worn for over twenty-five years. During this period the patient was free from inflammation of the lachrymal sac, but was constantly annoyed by stillicidium. The tube, which finally fell into the pharynx while the patient one day was engaged in hanging pictures, was filled for about one-third of its length with calcareous material. A case has also come under the writer's observation in which a gold tube, after being worn for some time, passed through the alveolar process of the superior maxillary bone, and was finally removed through the socket of one of the incisor teeth which had been extracted some time before.

According to Des Marres, J. L. Petit was the first to attempt the cure of lachrymal stricture by the use of a contrivance intended to be worn temporarily in the nasal duct. His plan was to make an incision into the lachrymal sac, and then to pass a grooved director through the duct, and, by the aid of the latter, to introduce a bougie, which was changed every day. Des Marres himself practised essentially this same method of treatment. Anel attempted to overcome the obstruction of the duct by forcing water into the lachrymal sac, through the canaliculus, by means of the syringe which bears his name. He also endeavored to dilate the strictures by means of slender probes, which he introduced through the canaliculus; but he admitted that the latter method was only applicable to cases of slight obstruction. Benjamin Travers, who was very sceptical as to the utility of the gold cannulæ which Dupuytren used so extensively during his time, also made use of probes, which he passed through the nasal duct by way of the punctum and canaliculus. His probes were larger than those of Anel, and his results were, therefore, more satisfactory. Dr. Isaac Hays, in this country, early adopted this plan of treatment, and modified and improved the probes of Travers. The probes which he used varied in size from the thickness of No. 21 to that of No. 17 wire. Ware suggested the use of nail-headed styles, which were to be worn temporarily, with the expectation of curing the stricture. They were introduced through an incision in the lachrymal sac, the round flat head of the style being permitted to remain outside the opening. Beer employed catgut cords of different sizes, which he introduced in a similar way and passed slowly through the duct, a fresh portion of the cord (which was kept coiled upon the head) being drawn into the duct each day, while the part which had been used was pulled out through the nose, and cut off. Méjean used meshes of silk threads, which he introduced into the duct through the canaliculus by means of a slender needle-like probe. A more novel idea was that of Blizzard, who filled the lachrymal sac with quicksilver, expecting the obstruction of the duct to be overcome by the weight of the small globule of mercury which the sac is capable of holding. Probes intended to be passed by way of the inferior orifice of the duct, through the nose, were also devised, and great advantages claimed for them, but they were not received with favor.

Coming now to a more recent period, we find a great advance made over all previous methods of dealing with lachrymal obstructions in the operation, devised by Bowman, of slitting the canaliculus, to facilitate the passage of the probes which bear his name. This procedure not only enabled the surgeon to make use of larger probes than had been employed previously, but it facilitated the application of medicinal agents to the lachrymal passages. Still, however, the results obtained by those who followed Bowman's method were far from satisfactory, and relapses after the discontinuance of the treatment were discouragingly frequent. As a result of this, various modifications of his method were proposed. Mr. Pridgin Teale, of Leeds, and Mr. Critchett, employed probes with bulbous extremities. Dr. E. Williams, of Cincinnati, used similar probes, but with the bulbous portion considerably larger, the largest of his probes at the bulbous extremity having a diameter of 3½ mm. Dr. H. D. Noyes, of New York, following the example of Dr. E. Williams, insisted upon the necessity of more thorough dilatation of the duct than could be accomplished by means of Bowman's probes, and probably as early as 1870 (as he has recently informed the writer) made use of short, hard-rubber probes which in their higher numbers had a maximum diameter of 4 mm. He also devised a gouge and a bulbous probe of unusual length, "having a slight bend at the bulb," for the especial purpose of dealing with the very firm strictures which are occasionally encountered at the lower extremity of the duct.[1] Dr. H. W. Williams, of Boston, employed a bulb-pointed, flexible probe, which he claimed could be passed with greater ease through the sinuosities of the contracted duct, while Mr. Couper, of London, used bougies of laminaria digitata. Dr. Stilling, of Cassel, made a more decided departure, by recommending free incision of the strictures by means of a knife which he devised for the purpose, and which he introduced into the duct through the divided canaliculus. Dr. Warlmont, who followed Stilling's example, obtained good results, but others were not so fortunate, and this method has never come into general favor. The use of styles of various patterns was also combined with the slitting of the canaliculus. Dr. E. Williams, of Cincinnati, reported favorable results from the use of silver styles, while Dr. Green, of St. Louis, employed styles made of lead, because they could be easily fashioned to suit the peculiarities of each case, and because they adapted themselves to any irregularities in the shape or curvature of the duct. Instead of the nail-head of the older form of style, all of these, as they were introduced through the slit canaliculus, had curved necks, which were bent over the margin of the lid. Finally, in severe cases which were not relieved by any of these methods of

treatment, extirpation of the lachrymal sac (Berlin), or its destruction by means of nitrate of silver (Von Graefe), nitric acid (Agnew), chloride-of-zinc paste (Pagenstecher), or the galvano-cautery, was recommended. Removal of the lachrymal gland was also practised, under similar circumstances, by Mr. Zachariah Laurence and others.

More than fourteen years since, the writer, without being aware that Drs. E. Williams and H. D. Noyes had already reached a similar conclusion, and had modified their practice accordingly, became convinced that the chief cause of the unfavorable results which had been obtained by Bowman's method of dealing with lachrymal strictures was the inadequate size of the probes which he recommended, and he then began to employ somewhat larger sizes, adding three numbers to the series of six probes which he had obtained in Europe in 1871, the largest of the three having a diameter of 2¼ mm. The more satisfactory results which he gained with these soon induced him to try still larger ones, and shortly afterward he added four additional probes to his set, the largest of these being a trifle less than 3 mm. in diameter. In 1877, becoming more fully convinced that success was to be found in the use of probes large enough to restore fully the normal calibre of the contracted duct and obliterate every trace of stricture, and feeling satisfied that he had not yet reached this point, he determined to ascertain what is the usual size of the healthy nasal duct, and how large a probe might, as a rule, be passed through it. With this end in view, he had a number of large probes made of copper wire, varying in diameter from 3 to 7 mm., and with these he gauged the size of the bony canal of the nasal duct in all the skulls—thirty-nine in number—which were to be found in the Anatomical Museum of the University of Maryland, the method followed being simply to ascertain how large a probe could be passed, without violence, through each duct. In a similar manner a number of canals, with their membranous lining intact, were measured upon the dead subject. The result of these measurements was to show, what the writer had been almost convinced of before, that there was a ridiculous contrast between the size of the nasal duct and the size of the lachrymal probes which were commonly employed at that time. For example, while the largest of the six probes originally recommended by Bowman had a diameter of scarcely 1.3 mm., it was found that the smallest ducts in the thirty-seven adult skulls examined (there were only six as small as this) admitted a probe 3 mm. in diameter, and that twenty-three of the seventy ducts which these skulls possessed in a sufficiently perfect condition to be measured admitted probes varying from 4¾ to 7 mm. in diameter, four of them permitting a probe of 5¼ mm. to be passed through them. The results of the measurements made upon the cadavers were not less striking. Of the twelve ducts examined, one, which seemed to be pathologically contracted, would admit a probe of only 2¾ mm., but the next smallest admitted one of 3¾ mm., while through three of them a probe 5¼ mm. in diameter was passed without difficulty.* It is true that Bowman's No. 6 was not the largest probe in general use at this time; few operators, however, had ventured to go beyond a diameter of 2 mm.

The writer learned afterward that Dr. H. D. Noyes had previously made an investigation of similar character, and as the result of his measurements had reached the same conclusion which the writer subsequently did as to the inadequate size of Bowman's probes and the necessity for employing very much larger ones.†

In consequence of the knowledge gained by his investigation of the normal calibre of the nasal duct, the writer had a series of probes made, comprising sixteen different sizes, the smaller numbers, from 1 to 8, being made of coin-silver; the larger ones, from 9 to 16, of pure silver; No. 1, the smallest, having a diameter of ¼ mm.; No. 16, the largest, a diameter of 4 mm., with a difference of ¼ mm. in the diameter of each succeeding number. The ends of these probes were fashioned with especial care, being made more pointed than those of Bowman, to facilitate their introduction; for it was evident that the larger sizes could not be passed into the sac through the slit canaliculus, if their ends were made as square and blunt as his. The accompanying illustration, which represents the actual size of No. 16, the largest of the series, shows correctly the shape of the ends and also the curve which has been found most convenient.* The practicability of using the largest of these probes in the treatment of lachrymal strictures was soon demonstrated, and it was not long before the advantage of doing so became manifest. Although satisfied that they were not out of proportion to the actual size of the duct, the writer had at first some misgivings as to the possibility of introducing them into the sac through the divided canaliculus; but he soon found that this was not attended with difficulty. The considerable experience in the use of these probes which he has had during the last eleven years has satisfied him of their great utility, and he is now more than ever convinced that it is only by such thorough and complete dilatation as they afford that permanent benefit is to be gained in the treatment of lachrymal obstructions. The complete obliteration of all constrictions and the restoration of the normal calibre of the duct are the results which we should aim to accomplish; and to do this it is essential that probes as large as those which the writer has recommended shall be employed. When smaller ones, of 1½ or 2 mm. diameter, are used, we merely open a small passage-way through the constriction, instead of obliterating it completely and causing its absorption, and, as might be expected, a reclosure of this narrow channel is the usual result of a discontinuance of the probing. The large probes, on the other hand, not only open a free passage-way through the fibrous and bony obstructions, but, by the pressure which they exert, bring about their absorption, and in this way tend to restore the lining membrane of the duct to its normal state. This change in the condition of the walls of the duct can be detected during the introduction of the probe, and is a thing of frequent observation. The rough, grating sensation which is felt at first from the probe coming in contact with diseased bone gradually disappears, until, after a longer or shorter time, the probe glides smoothly through the duct, giving a sensation not unlike that which attends the introduction of a sound into the healthy urethra.

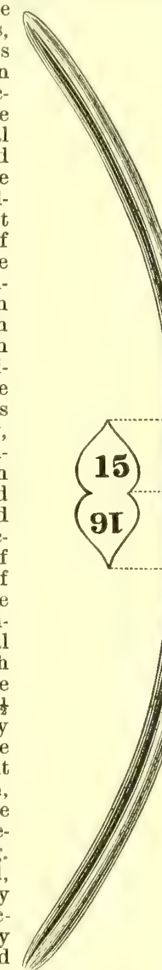

FIG. 1994.

* The inadequate size of Bowman's probes is made more manifest if, instead of comparing the diameter of his No. 6 with the diameter of the larger probes used by the writer in his investigation, the ratio of the calibre, or thickness of the former to that of the latter, be stated. For example, if we credit Bowman's No. 6 with a diameter of 1½ mm., which is larger than it is usually made, we find that a probe 4 mm. in diameter is actually more than 7 times as large as it; while one of 5¼ mm. (which is the size the writer passed through several ducts upon the cadaver) is 12¼ times as large, and one of 7 mm. (the largest introduced into the skulls) is nearly 22 times as large.

† Dr. Noyes measured the ducts in five skulls, in some of which sections had been made, so that the size of the lower as well as the upper extremity of the duct could be ascertained. They were all found to be more or less decidedly oval in cross sections, with the long axis from before backward, and he measured the long and short axis of each. At the upper end they varied in size from 8 × 6¼ mm. to 5 × 4 mm.; at the lower end, from 7¾ × 5 mm. to 8 × 4 mm. See his paper, already referred to, in the Transactions of the New York State Medical Society for the year 1876.

* A description of these probes, with an account of the measurements of the nasal duct referred to above, was first published in the Transactions of the Medical and Chirurgical Faculty of Maryland for the year 1877. See, also, Archives of Ophthalmology, vol. vi., and Transactions of the American Ophthalmological Society for the year 1879.

The writer has never contended that the largest probe of his series can be, or should be, passed through every strictured duct; but his experience has convinced him that the cases in which it cannot be used with advantage are exceptional. The question is frequently asked, Does the use of such very large probes never occasion any mischief? In reply it may be said that the surgeon is less likely to do harm with them than with probes of small size, since the risk of making a false passage is much less. It is undoubtedly true that they frequently leave the previously strictured duct rather more pervious than the canal usually is in its normal condition; but this causes no inconvenience, except that when the nose is blown some air is apt to find its way through the duct to the corner of the eye. If necessary, it is permissible to use a considerable amount of force in gaining a passage through the duct, and the writer would not be surprised if sometimes he had not only broken through bony strictures, but had "rectified" the boundaries of some physiologically contracted canals. A fracture of these thin plates of bone is, however, a matter of little moment, and less timidity in dealing with these cases should be encouraged.

It will not be out of place, perhaps, to give here a brief description of the method which the writer usually follows in treating strictures of the nasal duct: In most cases that apply for relief the watering of the eye is the chief cause of complaint. Mention of this symptom at once suggests the existence of lachrymal obstruction; and if this be situated in the nasal duct, pressure upon the lachrymal sac will almost always cause regurgitation of tears and mucus, or if there be no blenorrhœa, of tears only, through the puncta. If the patient is ready to submit to operative treatment, a few drops of cocaine (4 to 100 solution) should be instilled into the inner canthus of the eye, and when this has produced its effect a fine probe (No. 1) should be introduced into the lower canaliculus, to ascertain whether it is obstructed at any point; for it is not uncommon to find occlusion of the inner end of the lower canaliculus associated with stricture of the nasal duct; and if this be the case, it is better to make the discovery, and to relieve the obstruction before slitting the canaliculus, otherwise the beak of the knife will fail to enter the sac as it should, and the operation will be imperfectly accomplished. A straight, stiff, rather sharp-pointed probe is the best instrument with which to force this stricture, should one be encountered. It should be passed along the canaliculus to the stricture, and then, the lid being kept upon the stretch, should be forced through it, if possible, with a boring movement. If this cannot be done, a sharp-pointed knife must be used to make an opening into the sac, either before or after the division of the canaliculus, as the operator may prefer. If, however, no obstruction to the entrance of the small probe into the sac is encountered, Weber's probe-pointed knife should be next introduced, its blunt end carried well into the sac, and then the canaliculus freely divided, care being exercised (as has been previously suggested) to incline its cutting edge somewhat toward the eye, so that the gutter made by the division of the canaliculus shall present rather in that than in an outward direction. In performing this operation, as well as in introducing probes into the nasal duct, the writer prefers to stand behind the patient, using his right hand for the right eye, and his left for the left eye. In this position the patient's head can be held firmly by the operator, which is an important consideration, while at the same time it is convenient for his manipulations.

The canaliculus having been divided, an attempt should next be made to introduce a probe. It is not often practicable to pass into the sac, immediately after dividing the canaliculus, a larger probe than No. 5 of the writer's series, so this is the one which he usually introduces first; but if No. 6 or No. 7 can be gotten into the sac without difficulty, it is better to start with one of these, since the larger the probe the less the danger of getting out of the right track. It may happen that even No. 5 cannot be made to enter the sac, and then No. 4 or No. 3 must be tried. If, however, there is much difficulty in getting into the sac, it is better to wait twenty-four or forty-eight hours before making further attempts, as the changes which take place during this time in the cut edges of the canaliculus frequently enable the operator to introduce easily a probe which at first could not be gotten in at all. Having succeeded in introducing a No. 5 or No. 6 probe well into the sac, the writer does not hesitate to use such a degree of force as may be necessary to carry it, through every obstruction, to the floor of the nose. It is entirely safe to do this, provided the force is exerted in the right direction and we are sure the probe has fairly entered the lachrymal sac. Some nose-bleed, perhaps a little ecchymosis in the region of the lachrymal sac, and a slight temporary increase of the existing inflammation are the only ill consequences likely to ensue. If, during the early stages of the treatment, pain and soreness are complained of, a lotion of acetate of lead and opium should be prescribed, and will be found of much benefit. The writer, except in dealing with young children, when a few whiffs of chloroform answer a better purpose, always makes several applications of cocaine (4 to 100 solution) to the inner corner of the eye before probing the duct. Although this does not render the operation entirely painless, it makes it much more endurable. He has also thought that he derived benefit from adding cocaine to the vaseline with which the probes are smeared before being passed. This, of course, does not make the introduction of the probe less painful, but it lessens the pain caused by its presence in the duct and by its withdrawal. The length of the interval between the successive probings must be determined, in a great measure, by the sensitiveness of the sac and duct. If the irritation and soreness which the passage of the probe excites are not marked, and subside quickly, the probing may be repeated every other day; but if they are more pronounced, it is better not to repeat it oftener than once in three or four days. It is nearly always practicable, and is certainly desirable, each time that the probe is introduced to increase the size by one number; occasionally a number may be skipped, but this is not often the case. When a size has been reached that is quite tight, it is best not to go on at once to the next number until by passing this one several times it has become looser. It is well to allow the probes to remain in the duct for from twenty to thirty minutes. As to the size of the probe which should be used, it has been stated already that it is not necessary, in every case, to employ one of 4 mm. diameter (No. 16); but, as a rule, it is certainly best to do so, since by such thorough dilatation the cure of the case is hastened, and the danger of relapse greatly lessened. When a case is doing well, and No. 14 or No. 15 is passed with some difficulty, it is not expedient to employ a larger probe; but, on the other hand, if the improvement is not satisfactory, and the lining membrane of the duct gives evidence of still being diseased, the use of a larger probe (though it may be passed at first with some difficulty) is indicated, and will almost certainly be of benefit. After as large a probe has been introduced as seems desirable, the interval between the probings should be gradually increased, first to four or five days, then to a week, and then to ten days or a fortnight. Finally, when all evidence of inflammation has disappeared, and the strictures show no tendency to recontraction, we may allow a month or six weeks to intervene, and when two or three such intervals have passed, without any symptoms of a relapse, the probes may be laid aside, and the case dismissed as permanently cured. If, on the other hand, the use of the probes be discontinued while there is still a blennorrhœa of the sac or inflammation of the duct-walls, a recurrence of the strictures is altogether probable.

The writer has never thought any of the contrivances for applying astringents, or other medicated solutions, to the sac and duct—such as the syringe of Anel and the more recently proposed fenestrated hollow probe—of much practical value; but in every case he prescribes an astringent and antiseptic collyrium, which the patient is carefully instructed to drop into the inner corner of the eye, with a pipette, two or three times a day; and

this he regards as an important adjunct to the probing treatment, especially when there is blennorrhœa of the sac (which there usually is during the early part of the treatment) or inflammation of the lining membrane of the duct. Before making this application the patient empties the sac of any tears or mucus which it may contain by pressure with the finger, and then, to facilitate the entrance of the drops into the sac and duct, he is instructed, after having instilled them in the neighborhood of the inner canthus, to look upward and wink the lids. The collyrium which has been found most useful is a solution of alum and boracic acid—one or two grains of the former and five grains of the latter to an ounce of distilled water. In some cases from half a grain to one grain of sulphate of zinc may be substituted for the alum with advantage, and when there is a decidedly purulent discharge from the lachrymal sac a very weak solution of nitrate of silver (gr. $\frac{1}{8}$–$\frac{1}{4}$ to ℥ j.) will be found especially efficacious. The use of one or the other of these collyria should be kept up, not only throughout the treatment, but for some time after the introduction of the probes has been discontinued. The condition of the nasal mucous membrane should be looked to, and should receive such treatment as may be called for. Constitutional remedies may also be required, tonics and alteratives being useful in some cases, and muriate of ammonia being especially indicated when there is nasal catarrh.

The length of time during which the probing should be continued varies greatly in different cases. The strictures yield readily, and the stillicidium, the blennorrhœa of the sac, and the inflammation of the lining membrane of the duct disappear quickly in some cases, while in others the improvement is slow. It is never safe to stop the use of the probes altogether, so long as the stillicidium persists and there are any traces of inflammation present; but in obstinate cases we may vary the interval between the probings, increasing it considerably at times, for it occasionally happens that the inflammation is kept up by the too frequent use of the probes.

Are the results obtained by this rather tedious, and to the patient somewhat trying, plan of treatment satisfactory? Does it permanently cure a considerable portion of the cases in which it is employed? And is it really an improvement upon the innumerable other methods which have preceded it? The writer's judgment upon these points will, perhaps, hardly be regarded as unbiased; he has no hesitation, however, in giving an emphatic affirmative reply to each of these interrogatories. If the patient can be kept under the observation of the surgeon, and if, having confidence in him, he is willing to accept his *dictum* as to the size of the probes to be employed and the duration of the probing treatment, the cases are extremely few in which an absolute and permanent cure cannot be obtained.* The cases which fall by the wayside, the patients who become discouraged when the treatment is but half accomplished and discontinue their visits to the surgeon, are not few; but those who, having more pluck or a larger modicum of faith, hold out to the end are almost sure to reap their reward by obtaining entire relief from all the discomforts which they had before been subjected to. The writer does not claim, however, that no failures occur. They do happen in a small minority of cases, even when every detail of the treatment has been carried out. There are two classes of cases in which the treatment is more likely to be unsuccessful: When the stenosis of the duct is dependent upon, and associated with, ozæna or decided nasal catarrh, the strictures show an unusual tendency to recur, because, though the canal may have been widely dilated, its lining membrane is not apt to assume a healthy condition so long as there exists pronounced disease in the contiguous lining membrane of the nose. In another class the canaliculi exhibit a persistent inclination to become occluded at their point of juncture with the lachrymal sac, and in consequence of this we not only have the stillicidium reestablished, but, probably because of the tears not passing through it, the nasal duct itself is apt to become again obstructed.

There are also some sources of failure which, by being kept in mind, may be avoided. For example, the writer has in several instances met with cases that had previously been treated with only partial success by other surgeons, in which a stricture was discovered close to the lower extremity of the duct that there was good reason to believe had never before been penetrated by the probe. Under such circumstances, when the probe was first passed through this stricture to the floor of the nose, the patient at once exclaimed that the sensation produced was a new one, and that the instrument had never before seemed to go so far down. Of course, such a mistake as this must necessarily render the treatment of no avail. The operator should always bear in mind that in occlusion of the nasal duct multiple stricture is the rule rather than the exception, and that the strictures, which may be circumscribed and annular, or ill-defined and of large extent, are liable to be encountered at any point in the duct from its upper rim to its valve-like lower extremity. Another mistake which may be made is in the introduction of the probes into the lachrymal sac. At the outset of the treatment, especially, there is often considerable difficulty in accomplishing this, and if, by mistake, the probe is turned up and forced down into the nasal duct before its point has fairly entered the sac, a false passage may be made directly from the canaliculus into the duct. If the probes are afterward passed through this artificial channel, the probabilities are that the natural channel into the sac will, after a time, become closed, and as the false passage is very apt to share the same fate ultimately, it is evident that the treatment will come to naught.

During an attack of acute inflammation of the lachrymal sac it is never prudent to attempt the introduction of probes. It will be time enough to begin this after the acute symptoms have been relieved by the means which have been already described. The writer has not found it necessary to resort to any special measures to promote the closure of lachrymal fistulæ, except, perhaps, to touch exuberant granulations, if they are present, with a crayon of nitrate of silver or a crystal of sulphate of copper. He has always found that, as the condition of the lachrymal sac and the duct improved under the use of probes and astringent collyria, the fistulæ healed without difficulty.

Blennorrhœa of the lachrymal sac, with stillicidium and partial occlusion of the duct, is occasionally met with in infants. It is worth while in these cases to try first an astringent collyrium (alum and boracic acid); but if this fail to relieve the trouble, as it probably will, the canaliculus must be slit, and a probe passed through the duct a few times, after which the difficulty will most likely disappear. The possibility of mistaking tumors lying in the region of the lachrymal sac, or extra cystic abscesses, for distention of the sac should be borne in mind. The writer has once or twice seen cysts in this region, which in appearance closely resembled "mucocele."

At one time the writer used quite extensively the leaden styles of Dr. John Green; but the results obtained from them were not very encouraging, and of late he has not resorted to them. As a substitute for the probes, they may be used in cases which come from a distance and can remain only a short time under the care of the surgeon. Although they usually afford temporary relief while they are in the duct, a return of the former symptoms is very apt to follow their withdrawal. It has occurred to the writer, though he has not put the idea to a practical test, that when the systematic use of

* The following cases, in which it has been possible to ascertain the condition of the patient some time after the treatment had been discontinued, are taken from the writer's hospital and office case-books, and serve to show what may be accomplished by the method which he recommends, as well as the size of the probes which he commonly employs. The data are given in tabular form for the sake of brevity. A similar table, of very respectable proportions, might be constructed of cases in which the results of treatment were less satisfactory; in which, even after the introduction of the largest probes, there was a return of the strictures. But, with comparatively few exceptions, it would be made up of cases in which (for one reason or another) the treatment was interrupted and the use of the probes discontinued too soon, and in most of which a favorable result probably would have been obtained had the probing been kept up in the manner which the writer has contended is essential to permanent success.

Case.	Age.	Sex.	Eye.	Probable duration of stricture.	Probable cause.	Previous treatment received.	Condition when first seen.
1	....	F.	R.	Not noted	None assigned	Introduction of probes, which probably were not passed entirely through duct.	Stillicidium; blennorrhœa of sac; several firm strictures in duct.
2	40	M.	L.	13 years	None assigned	Small probes used, giving only temporary improvement.	Occasional stillicidium; several strictures.
3	40	M.	R.	13 years	None assigned	Small probes used, with only temporary improvement.	Constant stillicidium; one very close stricture.
4	46	F.	L.	2 years	Nasal catarrh	None	Stillicidium, with stricture (not very close) at upper extremity of duct.
5	About 25.	F.	R.	5 months	Scarlet fever and inherited tendency (mother has similar affection).	None	Stillicidium: occlusion of canaliculus at juncture with sac, and several close bony strictures in duct.
6	28	M.	L.	18 months	None assigned	None	Stillicidium; blennorrhœa of sac; conjunctivitis; blepharitis; several firm strictures in duct.
7	25	F.	R.	3 months	Nasal catarrh	None	Stillicidium; blennorrhœa of sac; two circumscribed strictures in duct.
8	48	M.	R.	4 months	Syphilis	None	Stillicidium; blennorrhœa of sac; conjunctivitis; several strictures in duct.
9	13	F.	L.	2 years	Measles	None	Stillicidium; blennorrhœa and fistula of sac; occlusion of inner extremity of canaliculus; stricture of upper part of duct.
10	45	F.	R.	10 months	None assigned	Canaliculus had been slit and probably small probes used.	Stillicidium; occlusion of inner extremity of canaliculus; close bony stricture at upper end of duct, and less tight ones below.
11	4	F.	L.	4 years	Struma	None	Stillicidium; blennorrhœa of sac; phlyctenular conjunctivitis; close bony strictures, especially in lower part of duct.
12	4	F.	R.	Not noted	Struma	None	Stillicidium; blennorrhœa of sac; close bony strictures, especially in lower part of duct.
13	26	F.	L.	2 years	Severe blow upon bridge of nose.	None	Stillicidium; blennorrhœa of sac; occlusion of inner extremity of canaliculus; duct constricted generally.
14	26	F.	R.	2 years	Severe blow upon bridge of nose.	None	Stillicidium; blennorrhœa of sac; strictures of duct not very close.
15	23	F.	R.	More than 1 year.	Nasal catarrh and struma.	Small probes, with but little benefit.	Stillicidium; blennorrhœa and fistula of sac; stricture near lower end of duct.
16	27	F.	L.	Not noted	Nasal catarrh and struma.	None	Stillicidium; blennorrhœa and fistula of sac; close stricture in lower third of duct.
17	24	F.	L.	Not noted	None assigned	None	Stillicidium; blennorrhœa of sac; occlusion of inner extremity of canaliculus; bony stricture of duct.
18	About 50.	F.	L.	3 or 4 years	None assigned	Collyria	Stillicidium; blennorrhœa of sac; conjunctivitis; several strictures in duct.
19	Not noted.	F.	R.	Not noted	None assigned	Small probes used, just preceding writer's treatment.	Partially dilated strictures in duct.
20	33	F.	R.	Over 18 months.	Nasal catarrh; family tendency (a sister and niece have had similar affection).	None	Acute inflammation of the sac, supervening upon chronic blennorrhœa; stillicidium; close and general constriction of duct.
21	33	F.	R.	Not noted	Nasal catarrh	Previously treated with probes, with only partial success.	Incomplete stricture of duct.
22	16	M.	L.	Not noted	Naso-pharyngeal catarrh.	Astringent collyria	Stillicidium; conjunctival hyperæmia; close stricture at upper extremity of duct.
23	16	M.	R.	Not noted	Naso-pharyngeal catarrh.	Astringent collyria.	Stillicidium; conjunctival hyperæmia; incomplete bony stricture in upper part of duct.
24	About 35.	F.	L.	Some years	Nasal catarrh	None	Stillicidium; blennorrhœa of sac; incomplete occlusion of duct.
25	About 35.	F.	R.	Not noted	Nasal catarrh	None	Stillicidium; blennorrhœa of sac; incomplete bony stricture near upper end of duct.
26	42	F.	L.	Not noted	Nasal catarrh	None	Stillicidium; slight blennorrhœa of sac; several strictures (not very close) in duct.
27	42	F.	R.	Not noted	Nasal catarrh	None	Stillicidium; slight blennorrhœa of sac; bony strictures in lower part of duct.
28	32	F.	R.	12 years	Struma and typhus fever.	Astringent collyria	Chronic blepharitis and conjunctivitis; no stillicidium; tolerably close bony stricture in lower third of duct.
29	About 45.	F.	L.	Not noted	None assigned	None	Stillicidium; blennorrhœa of sac; strictures in duct.
30	24	F.	R.	12 years	Nasal catarrh	None	Stillicidium; acute inflammation of sac; strictures in duct.
31	26	F.	L.	About 1 year	Nasal catarrh	None	Stillicidium; blennorrhœa of sac; several close strictures of duct.
32	55	M.	L.	Not noted	Nasal catarrh	Probes of comparatively small size used, with little benefit.	Stillicidium; inflammation of sac; extensive periosteal and bony strictures of duct.
33	55	M.	R.	Not noted	Nasal catarrh	Probes of comparatively small size used, with little benefit.	Stillicidium; inflammation of sac; extensive periosteal and bony strictures of duct.
34	31	F.	L.	3 years	Not apparent	None	Stillicidium; blennorrhœa of sac; strictures of duct; conjunctivitis and blepharitis.

Size of probe first introduced.	Largest probe introduced.	Condition at last report.			Length of interval between last introduction of probe and last report.	Remarks.
		Sac.	Duct.	Stillicidium.		
7	16	Healthy	Pervious to tears.	Absent	14 months.	
4	16	Healthy	Pervious to air and tears.	Absent	10½ years.	
4	16	Healthy	Pervious to air and tears.	Absent	7½ years	This case yielded very slowly to treatment, and the stillicidium persisted for some time after the largest probe had been introduced.
5	16	Healthy	Pervious to air and tears.	Absent	13 months.	
2	15	Healthy	Pervious to air and tears.	Absent	3 months	Six years afterward heard through a friend that eye had continued well.
5	16	Healthy	Pervious to tears.	Absent	12 months.	
5	16	Healthy	Pervious to tears and air.	Absent	7 years	Is now under treatment for stricture of L. duct, the R. duct being still pervious and healthy.
5	16	Healthy	Pervious to air...	Still present ...	8 months.	
3	12	Healthy	Pervious to tears.	Absent	2½ months.	
3	16	Healthy	Pervious to tears and air.	Absent	2 months.	
5	15	Healthy	Pervious to tears.	Absent	15 months.	
5	14	Healthy	Pervious to tears.	Absent	15 months.	
6	16	Healthy	Pervious to air...	Not mentioned, probably absent.	2 years and 8 months.	
6	16	Healthy	Pervious to air...	Not mentioned, probably absent.	2 years and 8 months.	
3	15	Healthy	Pervious to tears and air.	Absent	4 years.	
6	15	Healthy	Pervious to tears and air.	Absent	2½ months.	
3	16	Healthy	Pervious to tears and air.	Absent	19 months.	
7	16	Healthy	Pervious to tears.	Absent	5½ years.	
8	13	Healthy	Pervious to tears and air.	Absent	3 months.	
2	16	Healthy	Pervious to tears.	Absent	3 years.	
7	16	Healthy	Pervious to tears and air.	Absent	11 months.	
6	13	Healthy	Pervious to tears and air.	Absent	7 months.	
6	13	Healthy	Pervious to tears and air.	Absent	7 months.	
5	16	Slight blennorrhœa of sac.	Pervious to tears and air.	Absent	16 months.	
6	14	Healthy	Pervious to tears and air.	Absent	16 months.	
5	16	Healthy	Pervious to tears.	Absent	14½ months.	
6	16	Healthy	Pervious to tears and air.	Absent	14½ months.	
3	15	Healthy	Pervious to tears and air.	Absent	6½ months.	
6	15	Healthy	Pervious to tears and air.	Slight at times.	4 months.	
5	16	Healthy	Pervious to tears and air.	Absent	13½ months.	
6	15	Healthy	Pervious to tears and air.	Absent	5 months.	
7	16	Healthy	Pervious to tears and air.	Absent	5 weeks.	
7	16	Healthy	Pervious to tears and air.	Absent	5 weeks.	
6	16	Healthy	Pervious to tears and air.	Absent	3 months.	

probes is impracticable, the best substitute would be a very large style, 3½ or 4 mm. in diameter, made, because of the superior lightness of this metal, of aluminium.

It only remains to be said that the writer has been so well satisfied with the results which he has obtained in the treatment of nasal-duct strictures by the thorough dilatation plan which he pursues that he has never been tempted to make trial of the treatment by division recommended by Stilling. He can scarcely persuade himself, however, that permanent benefit would often result from this operation, unless it were supplemented by systematic and thorough dilatation. The operations of destruction of the lachrymal sac and extirpation of the lachrymal gland, which have been referred to as measures recommended in intractable cases of obstructive lachrymal disease, are also procedures which he has never resorted to. There may be cases, perhaps, in which it is proper to employ these extreme measures, but he has not encountered them, and he believes they are of very rare occurrence. *Samuel Theobald.*

[1] Transactions of the Medical Society of the State of New York for the year 1876, p. 150.

LACTIC ACID. Of the isomeric bodies known chemically by the generic name of *lactic acid*, the common acid, called technically *isolactic* acid, is the one used in medicine. This body is a product of a certain form of fermentation of sugar, such as notably finds its conditions present in the case of milk. Hence the name and the common source of this acid. Lactic acid is officinal in the U. S. Pharmacopœia under the title *Acidum Lacticum*, Lactic Acid, such officinal article being "a liquid composed of seventy-five per cent. of absolute lactic acid and twenty-five per cent. of water" (U. S. Ph.). The same is "a nearly colorless, syrupy liquid, odorless, having a very acid taste and an acid reaction. Sp. gr. 1.212. It is freely miscible with water, alcohol, and ether, but nearly insoluble in chloroform. It is not vaporized by a heat below 160° C. (320° F.); at higher temperatures it emits inflammable vapors, then chars, and is finally entirely volatilized, or leaves but a trace of residue" (U. S. Ph.). Lactic acid should be kept in glass-stoppered bottles, and it is very hygroscopic (Squibb). According to Squibb, the American market is supplied entirely by two or three German makers, and the samples procurable almost never quite equal the strength prescribed by the Pharmacopœia.

Lactic acid is sharply sour, but is non-corrosive and non-poisonous. Its distinguishing properties, from the medicinal point of view, are that it dissolves to a considerable extent freshly precipitated calcic phosphate, and hence is useful to prepare the so-called *syrup of lactophosphate of calcium;* and that it dissolves false membranes, and so may be employed locally in diphtheria and croup. In the latter application the acid may be used by spraying or gargling, in admixture with water, of a strength of from four to twenty per cent. Like many other things, lactic acid has been also claimed by some to have considerable efficacy in diminishing the excretion of sugar in diabetes, while others have found it of no benefit. Lactic acid, lastly, may be used for the making of acid draughts to be given in dyspepsia or in fever, but has probably no advantage over other acids for the purpose. Lactic acid may be administered in teaspoonful quantities or more, well diluted with sweetened water.

Edward Curtis.

LACTUCARIUM, U. S. Ph.; Ph. G.; Codex Med. Lettuce Opium (not official in Great Britain, although its source, *Lactuca virosa*, is). A solid, opium-like product obtained from several species of lettuce, but especially from *Lactuca virosa* Linn.; Order, Compositæ. This is a coarse, narcotic-smelling, and bitter-tasting biennial herb, with an upright, prickly, paniculately branching stem a metre or more in height, and long, spreading, ovate or oblong, sinuate-dentate, pointed, and prickly leaves; the lower narrowed and petiole-like at the base, the upper sessile. Flower-heads small, about like those of garden lettuce; corollas yellow, achenia black. It is an inhabitant of rocky places and open woods in Middle and Southern Europe. Cultivated in the valley of the Moselle as a source of German Lactucarium, and in Scotland. The herb itself in flower is the *Lactuca* of the British Pharmacopœia. *L. altissima* Bieb, of the Caucasus, is a gigantic species cultivated in France for the production of a French variety of Lactucarium. *L. scariola* Linn., another prickly European species, is also said to yield a portion of the drug, as well as *L. sativa* Linn., the common salad or garden lettuce. The American species, *L. canadensis* Linn., has also been experimented with; it yields a Lactucarium of but little bitterness and inferior quality.

Lactucarium, in its present form, was introduced by Dr. Coxe, of Philadelphia, who collected it from garden lettuce at the end of the last century. Lettuce itself, as a medicine, is of much older date, and garden lettuce, as a salad, has been cultivated for several hundred years.

Collection.—After the plants have sent up flowering stems they are cut off about a foot from the top, when the "milk" flows out freely; this is wiped off with the finger and conveyed to a little cup; the operation being continued with successive stems until the cup is sufficiently filled. As first exuded it is liquid and pure white, but it soon sets upon exposure, and turns yellow and then brown. When it has coagulated it is emptied from the collecting vessel and dried by gentle heat. The form of Lactucarium varies with the details of its collection. French samples are in small circular cakes, the English (Scotch) is in broken fragments, and the German, which comprises most of that imported here, is evidently quarters of a plano-convex cake cut up before it is quite hard. It is, however, brittle, and often much broken.

Description.—Lactucarium is a brittle, structureless solid, of a gray or dull red-brown color, whitish or yellowish within, as shown by fresh fracture, of a waxy lustre, heavy narcotic odor, and disagreeable bitter taste. It is a composite substance, and not wholly soluble in any one menstruum. Alcohol and ether dissolve portions of it; with water it forms a turbid mixture.

Composition.—The most abundant ingredient is *lactucerin*, of which it nearly half consists; a wax-like substance, common to other milky juices. *Lactucin* is, however, its active principle. This crystallizes in pearly scales; is soluble in boiling water, cold alcohol, and acetic acid, but not in ether, and is very bitter. Yield, 0.3 per cent. *Lactucic acid* and *Lactupicrin* are other constituents. Besides these, *Lactucarium* contains vegetable tissue, caoutchouc, gum, cellular tissue, and a host of common vegetable substances.

Action and Use.—Common lettuce is well known to be slightly soporific; its effects are occasionally quite marked. The various extracts of lettuce are also more or less so. Lactucarium has so far shown itself to be an uncertain medicine, often of no value, but when good, an efficient and pleasant hypnotic; its power of overcoming pain is slight when compared with opium—in fact, almost none—but simple discomfort or moderate distress is occasionally relieved by it. In cardiac asthma and restlessness it is frequently useful, and it may be tried in numerous cases where opium is indicated but not well borne. It is free from the subsequent constipation and headache of opium.

Administration.—The uncertain quality of this drug makes its dose a tentative one, but half a gram or a gram (0.5 Gm. to 1 Gm.=grs. viij. ad xv.) should show some effect. It may be given in powder or pill, or the fluid extract (*Extractum Lactucarii Fluidum*) in the same or a larger dose. From the extract a syrup (*Syrupus Lactucarii*, U. S. Ph., strength, $\frac{5}{100}$) is made; a useful vehicle and adjuvant for opium or other hypnotics.

Allied Plants.—See Chamomile.

Allied Drugs.—See Opium. *W. P. Bolles.*

LADANUM, Labdanum. A resin collected in Greece and the Grecian Islands from several species of Rock Rose (*Cistus creticus* Linn., *C. ladaniferus* Linn., *C. cyprius* Lam., etc.; Order, *Cistaceæ*), whose stems and branches abound in a sticky exudation. Two methods, both coarse and dirty, are in vogue for collecting it: The first is to whip or rake the bushes by an instrument having a

number of leather thongs at the end, to which the resin sticks, and from which it is scraped off; the second, and more common, has been in use for many centuries, viz., to comb and press it out from the beards and wool of goats and sheep which pasture among it. It is then melted and manipulated, and often adulterated with other resins, or mixed with sand, etc., perhaps as much to give it solidity as for falsification. Common Ladanum is imported in snake- or worm-like coils; it is a dark-gray or greenish-gray brittle solid, of resinous odor and a bitter balsamic taste. It consists of from twenty to eighty per cent. of *resin*, a small amount of *oil, gum*, and other vegetable products, and the rest of dirt, sand, or other foreign admixture.

Action and Use.—The same as those of other resins. As a medicine it is obsolete; plasters, fumigations, etc., sometimes contain it.

Allied Plants.—The *Cistaceæ* are generally showy flowers, but have no further economic value.

Allied Drugs.—Olibanum, Myrrh, etc.

W. P. Bolles.

LADIES' SLIPPER (*Cypripedium*, U. S. Ph.; Moccasin Plant), *C. pubescens* Willd., order, *Orchidaceæ*, the larger yellow ladies' slipper, is a perennial herb arising from a horizontal rhizoma by a pubescent, leafy, few-flowered stem half a metre or more in height. Leaves also pubescent, broadly oval, acute, parallel-nerved; flowers two or three, the most conspicuous part of which is the large inflated, pouch-like lip, one and a half to two inches (25 to 50 mm.) long, from which it and others in the genus derive their name. Rather common in moist woods. *C. parviflorum* Salish, the smaller yellow ladies' slipper, is about half as large a plant, with flowers in the same proportionate size. Both the above species are recognized as the sources of the drug of that name.

The rhizoma, with its adhering rootlets, is collected. It is "horizontal, bent, four inches (10 ctm.) or less long, about one-eighth of an inch (3 mm.) thick; on the upper side beset with numerous circular, cup-shaped scars; closely covered below with simple, wiry rootlets, varying from four to twenty inches in length (10 to 50 ctm.); brittle, dark brown or orange-brown; fracture short, white; odor faint, but heavy; taste sweetish, bitter, and somewhat pungent."

It contains a *volatile oil*, a *volatile acid, tannic* and *gallic acids, resins, gum, starch*, etc. These ingredients make cypripedium a gently stimulant and soothing aromatic of the hop and valerian kind. It is really a comparatively inactive medicine.

Allied Plants.—The genus is a large and very showy one, many varieties being among the most beautiful of orchidaceous plants. The other American species have probably qualities similar to the above—*i.e.*, aromatic, stimulant, soporific. For the order, see Vanilla.

Allied Drugs.—Hops, Valerian, Chamomile, etc.

W. P. Bolles.

LA FAYETTE WELL. *Location and Post-office*, La Fayette, Tippecanoe County, Ind.

Access.—By the Wabash, the Cincinnati, Indianapolis, St. Louis & Chicago, and the Louisville, New Albany & Chicago Railroads.

Analysis (C. M. Wetherell, M.D.).—One pint contains:

	Grains.
Carbonate of magnesia	3.590
Carbonate of lime	1.044
Chloride of sodium	40.590
Chloride of magnesium	3.707
Chloride of calcium	0.465
Sulphate of lime	7.042
Iodide of magnesium	trace
Alumina and oxide of iron	0.062
Silica	0.058
Total	56.558
Gases.	Cub. in.
Carbonic acid	1.52
Sulphuretted hydrogen	0.24
Nitrogen	0.61

Temperature of water, 55° F.

A well-known and popular saline-sulphur water.

G. B. F.

LAKEWOOD. The village of Lakewood, formerly known as Bricksburg, and situated in Brick Township, Ocean County, N. J., has of late years acquired a reputation, chiefly among New York physicians, as a desirable health-resort during the winter season and the early part of the spring season. Reference to the large geological map of New Jersey, accompanying the report of the State Geologist for the year 1881, shows the village to be situated forty-four miles south by west from New York City, nine miles back from the Atlantic coast-line on Squan Beach, five miles back from the mainland shore of Barnegat Bay, and standing upon a tongue of sandy "pine-land" soil which runs back from the latter to a point some two and a half miles beyond Lakewood, has at Lakewood a breadth of a mile and a half, and is inserted, wedge-fashion, between two portions of an extensive "oak-land" district. Both the "pine-land" and the "oak-land" soils are sandy; the "pine-land" being especially so. The geological map just referred to shows us a very large extent of country, triangular in shape, which reaches from the Atlantic coast at Long Branch (twenty miles northeast of Lakewood) almost to the very shores of Delaware Bay, having an extreme length of about ninety miles and an extreme breadth of about forty-five miles. The apex of the triangle is at Long Branch; its base rests upon the marsh-land strip of Delaware Bay described on page 752 of vol. i. of this Handbook, in the article entitled Cape May. This area is made up exclusively of "oak-lands" and of "pine-lands," in the proportion of about two parts of the former to one part of the latter. The greater portion of the "pine-land" or "pine-barren" soil is to be found in the northern half of this great triangle; so that for this half the relative proportions of "oak-land" and of "pine-land" soils are exactly the reverse of those just stated—that is, the very sandy "pine-lands" are, throughout this northern half, twice as great in area as are the less sandy "oak-lands." It has already been stated that the village of Lakewood is built upon pure "pine-barren" soil, but the "oak-land" predominates over the "pine-land" in the immediately surrounding country. Nevertheless, by far the most extensive region of unbroken "pine-barren" country to be found in the State, comprising an area which may be roughly estimated at no less than four hundred square miles, lies to the southward of Lakewood, and at a distance from the village of less than twenty miles; while the intervening "oak-land" region is intersected by tongues of "pine-land" similar to the one upon which Lakewood itself stands, but of decidedly greater area than this one. Other strips of "pine-land" country are dovetailed into the "oak-land" region to the northward. From this account of the geology of the New Jersey southern interior it must be evident to the reader that the soil, for many miles about Lakewood, is of an exceptionally sandy and dry nature.

Its distance back from the coast excludes Lakewood from the category of seaside stations; for, in Professor Smock's appendix to the "Report of the State Geologist of New Jersey (1881)," we read that "the influence of the ocean's waters is felt very decidedly to a distance of four to eight miles from the line of beach or outer coast-line, from Sandy Hook to Cape May," and that the climatic limit of the Atlantic coast-belt in Monmouth County "is thought to be four or five miles; in Ocean County" (the county in which Lakewood is situated) "it follows closely the line of clearings or settlements, not going beyond the line of woods or into the forest-belt. It is here from four to seven miles wide."

The abundance of pine-trees growing about Lakewood is not by any means to be lost sight of in estimating its climatic peculiarities and advantages; the beneficial effects produced by the balsamic exhalations of these trees are well known, and have already been referred to in the articles describing Aiken, Arcachon, etc. Furthermore, it should be borne in mind that while walking or driving through the pine-woods the invalid or convalescent enjoys a very considerable degree of protection from cold winds. The taking of meteorological observations at Lakewood appears to have been hitherto neglected;

hence, to describe its climatic peculiarities with accuracy is impossible. To the dryness of its sandy soil the difference between the climate of Lakewood and that of the immediate neighborhood of New York is chiefly to be ascribed.

The following extracts from a letter will convey to the reader additional information of a practical character. The letter from which they are taken was very kindly written by Mr. C. H. Kimball, the president of the Lakewood Hotel Association, in reply to a letter of inquiry which I sent him on January 8, 1884: "Our temperature is from seven to twelve degrees warmer than New York from 9 A.M. to 2 P.M. Our nights are usually a little colder than those in New York. . . . During the latter part of December and early part of January we usually have a little snow, but rarely more than two or three days' sleighing. At all other times driving, riding, and walking are excellent through our pine- and oak-forests, of which we have seventeen thousand acres. We have an abundant supply of pure water, and our drainage is considered perfect. From our hotel to a brick cesspool, six hundred feet away, there is a fall of thirteen feet. From this point the liquid portion of our drainage passes through a six-inch pipe about seven hundred feet, with a fall of thirteen feet, into a rapid stream flowing to the ocean; the balance is taken out several times each week and carted several miles away." The hotel of which Mr. Kimball speaks is the Laurel House, having accommodations for about three hundred guests, provided with extensive glass-covered piazzas, and with open wood-fires in most of its rooms; according to all accounts a most comfortable and well-kept house. Up to the present time (October, 1886), so far as the writer is aware, this Laurel House is the only hotel existing at Lakewood; to all intents and purposes the Laurel House is Lakewood; hence it becomes necessary to say more about it than we should do did we follow our usual custom with respect to the mention of special hotels in describing a health-resort. There are several boarding-houses at Lakewood; of their merits the present writer knows nothing save that Mr. Kimball, at the close of one of his letters, refers to them, or to certain of them, as being "quite nice." "There are four or five quite nice boarding-houses in Lakewood . . . ," he says; "two of them have rooms for twenty or more guests each, the others for a less number."

Finally, we come to the consideration of the pathological conditions which are likely to be benefited by a resort to Lakewood. Mild cases of throat and lung troubles are often benefited by a visit thither, and a trip to Lakewood is frequently found serviceable to persons convalescent from other forms of disease, to the overworked, and to those who require little more than mere rest and change of air to restore them to a condition of full health. Mr. Kimball writes me that cases of asthma and of rheumatism are "quickly relieved" there, and that persons suffering from common colds, from nervous prostration, and insomnia "are cured or greatly relieved." "Lakewood," he says, "is really an 'out-door cure,' and we recommend it to those *only* who are able to drive, ride, and walk in the open air. Physicians are earnestly entreated not to send us *very sick* people, for whom we can do nothing, and whose presence saddens many who require cheerful surroundings."

In another letter from Mr. Kimball he states distinctly that the stockholders of the Lakewood Hotel Association and Land Company "do not desire the place to be considered a sanatorium." In suitable cases a stay at the Laurel House is probably not the less, but rather the more, beneficial on this very account.

Good and really comfortable hotel accommodations and easy accessibility are Lakewood's strong points. The place is but two hours' distant by rail from New York City. For invalids requiring a decidedly milder climate than that of New York, resort must be had to places lying much further south, or to California, or some of the celebrated resorts of Southern Europe, to Egypt, or it may be (where dryness and powerful insolation without much heat are indicated) to Colorado, to Davos, or to the Engadine.

As a "change-of-air" resort and place of handy recuperation, Lakewood has nevertheless been found most useful in very many cases. It appears to the writer by no means unlikely that similar resorts may, at no very distant day, be established in the extensive pine-belts lying somewhat further to the south in New Jersey, about on the line of latitude of Barnegat Inlet. Such places would be but little further distant from New York City, and would be a trifle less distant from Philadelphia, and an abundance of good market provisions would therefore still be secured; while, if the New Jersey geological map is to be trusted in the matter, they would lie in the midst of a tract of "pine-lands" very much less broken by "oak-land" tracts than is the country about Lakewood. *Huntington Richards.*

LA MALOU is a thermal station in the south of France, in the department of l'Hérault, having an elevation of only about 600 feet above the sea. The climate is pleasant, and treatment may be carried out during the entire year, although custom has limited the season to the six months from the first of May to the first of November. There are twelve springs here, which are grouped among three establishments, known respectively as La Malou-le-Bas, La Malou-du-Centre, and La Malou-le-Haut. There are five springs at the first-named establishment, viz., La Source Ancienne or Grande Source, Nouvelle Source, Petite Source, Source Cardinal, and Source de la Roche-Rouge. The springs at La Malou-du-Centre are known as La Source de Capus, Source des Bains de Capus, and Source Bourges. At La Malou-le-Haut are L'Ancienne Source, La Nouvelle Source, Le Petit-Vichy or Source de la Veyrasse, and La Source de la Mine.

The following is the composition of the most important of these springs, as given by Rotureau in Dechambre's "Dictionnaire Encyclopédique." The quantity of solid constituents is calculated in grammes per litre.

	La Source Ancienne de La Malou-le-Bas. Temp. 94° F.	La Source Bourges de La Malou-du-Centre. Temp. 61° to 82° F.	La Source Nouvelle de La Malou-le-Haut. Temp. 95° F.
Sodium bicarbonate	0.7711	0.4507	0.3653
Potassium bicarbonate	0.1242	0.1560	......
Calcium bicarbonate	0.4528	0.6261	0.4000
Magnesium bicarbonate	0.1863	0.1951	0.0667
Ferrous bicarbonate	0.0251	0.0224	0.0221
Manganous bicarbonate	......	......	0.0060
Lithium and strontium bicarbonate	......	trace	......
Sodium chloride	0.0187	0.0166	0.0085
Silica	0.0638	0.0280	0.0180
Alumina	0.0202	trace	0.0050
Sulphates	trace	0.0425	0.0728
Phosphates	......	trace	0.0027
Sodium arseniate	......	0.0004	......
Organic matters, etc	Undetermined	trace	0.0599
Total solids	1.6722	1.5378	1.0270

The waters are used internally and externally, and douche- and gas-baths are also employed.

As might be supposed from the number of springs, differing from each other more or less in composition, persons suffering from a great variety of diseases are often relieved by a course of treatment at La Malou. Chronic rheumatism in all its manifestations, locomotor ataxia, and various forms of paralysis are often signally benefited by the waters. La Malou is frequented also by sufferers from various neuroses, hysteria, chorea, epilepsy, neuralgia; from intestinal and gastric dyspepsia, hepatic congestion, albuminuria, and diabetes; from chronic metritis, leucorrhœa, and other affections of the female generative organs; from the results of lead and mercurial poisoning, and from the later manifestations of syphilis. The duration of a course at La Malou is about three weeks, and many visit the spa twice during the season, once in May or June, and the second time in September or October. The accommodations for visitors are good. *T. L. S.*

LAMINARIA, Ph. G. (Sea tangle), *Laminaria Cloustoni* (*L. digitata* Lam.); order, *Fucoidæ*, *Algæ*, is a large, foliaceous, olive seaweed, which from a branching and stout foot ("root") sends up a long, terete, strong stem, surmounted by a flat, leaf-like, lanceolate, oval or more

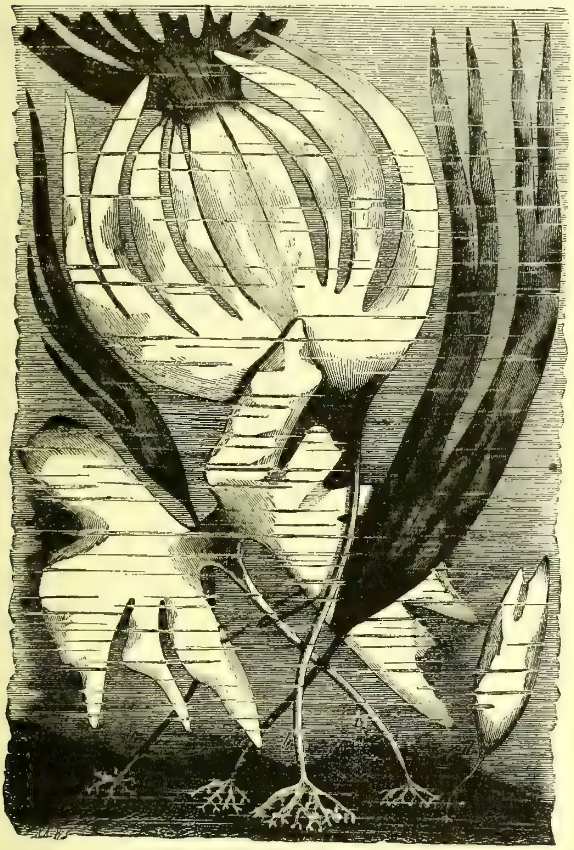

FIG. 1995.—Forms of Laminaria. (Lüerssen.)

or less divided and crispy-margined thallus. It attains a great size, often measuring six or eight metres long, and one or more in breadth. Laminaria is not used in medicine, but its cylindrical, and when dry, hornlike stipes are cut and filed into suitable shapes for tents to dilate the os uteri and sinuses, which they do by their capacity of swelling exceedingly when soaked in watery

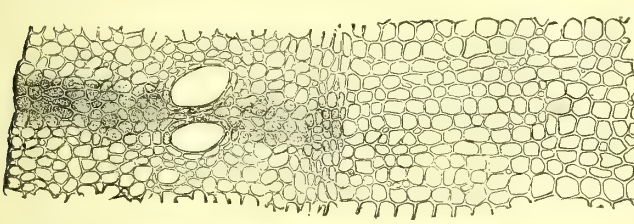

FIG. 1996.—Laminaria, Section as Expanded of Fresh Stem. (Lüerssen.)

fluids. Laminaria tents are generally cut in cylinders from three to eight millimetres ($\frac{1}{4}$ to $\frac{1}{3}$ inch) in diameter and from twenty-five to fifty (1 to 2 inches) in length; they are filed and sand-papered smooth, and the ends are carefully rounded. A hole made in one extremity holds the loop of silk for removing it. Its swelling capacity is developed in three or four hours, and often enlarges the tent to two or three times its original diameter. It was introduced into medical use but a few years ago, as a substitute for the sponge-tents, which had in a number of instances already shown how apt they were to hold or develop infectious material, and cause chills, septicæmia, and even death. Laminaria, in consequence of its close texture, presents no apertures in which such material could be permanently held, and practice has shown it to be much safer.

ALLIED PLANTS.—IRISH MOSS, GIGARTINA (AGAR-AGAR), etc.

SIMILAR APPLIANCES.—The sponge-tents just referred to were made by compressing and rolling fine sponges into narrow cylinders of similar dimensions to the above, which, as they became moistened, resumed their original shape. They were sometimes "medicated" or "disinfected," often dipped in cocoa butter. *W. P. Bolles.*

LAMIUM ALBUM (*Ortie blanche ou Lamer*, Codex Med.). The leaves and flowers of this plant are at present but rarely used, and have really no advantage over other *Labiates*, *Composites*, and *Scrophulariæ*. They are reported to be astringent, diuretic, hæmostatic; for the order see PEPPERMINT. *W. P. B.*

LA MOTTE-LES-BAINS is a little hamlet in the department of l'Isère, France, lying in a narrow valley at an elevation of about 1,500 feet above the level of the sea. It is a very pretty spot, and visitors whose health permits of climbing find many beautiful walks up the mountains in the neighborhood. The climate is somewhat trying, there being often considerable variation in temperature between the day and the night. There are two principal springs, having a temperature of from 136° to 149° F. The following is the composition of the water according to the analyses of MM. Bally and Henry. Each litre contains:

	Source du Puits. Grammes.	Source de la Dame. Grammes.
Sodium chloride	3.80	3.56
Magnesium chloride	0.14	0.12
Potassium chloride	0.06	0.05
Calcium sulphate	1.65	1.40
Magnesium sulphate	0.12	0.10
Sodium sulphate	0.77	0.67
Bromides	0.02	trace
Aluminum silicate	0.02	0.05
Calcium carbonate	0.80	0.64
Magnesium carbonate	0.80	
Ferrous carbonate	0.02	0.01
Manganese	trace	
Total solids	8.20	6.60

Later analyses are said to show the presence of very minute quantities of iodine and arsenic. The waters are taken internally and used for baths—water, spray, douche, and vapor. When a sudorific effect is desired the water is drank hot, but when the object is to promote diuresis it is taken cold. The waters are used for the properties just mentioned, and also in chlorosis, anæmia, scrofulous affections, rheumatism, and tubercular bone and joint diseases, though they are said not to be beneficial in pulmonary phthisis. *T. L. S.*

LANDECK. A thermal station in Prussian Silesia, in the valley of the Biela River, in the Glatz Mountains, at an elevation of about 1,300 feet above the sea. There are five principal springs, two of which, the Mariannenquelle and the Wiesenquelle, furnish water used for drinking; the others, the Georgenquelle, Marienquelle, and Friedrichsquelle, being employed only for bathing. The following is the composition of the Wiesenquelle. Each litre contains:

	Grammes.
Sodium sulphide	0.0007
Sodium chloride	0.0072
Sodium carbonate	0.0726
Sodium sulphate	0.0822
Potassium chloride	0.0030
Calcium carbonate	0.0074
Magnesium carbonate	0.0007
Silicic acid	0.0425
Total solid constituents	0.2173

The temperature of the different springs varies from 71° F. to 84° F.

The season at Landeck lasts from May 15th to October 15th. The guests are chiefly sufferers from digestive troubles, neuralgia, nervous disorders, and diseases of the female sexual organs. The waters are often drank mixed with milk or whey, and mud and vapor baths are employed in addition to the usual mode of external administration of the water. The climate is rather cold, though the air is milder than in other less well protected mountain regions. *T. L. S.*

LANGENBRÜCKEN is a Bavarian spa, lying between the cities of Heidelberg and Bruchsal, pleasantly situated in a well-sheltered spot, at an elevation of about 400 feet above the sea. The climate is very mild and pleasant, the north and east winds being cut off. There are upward of fourteen sulphur springs, of which only one, the Waldquelle, is used for drinking as well as bathing purposes; and of the others, which are employed only externally, the Kurbrunnen is the chief. Both springs furnish cold saline-sulphur waters, whose composition seems not to have been determined with certainty, as the analyses made by different persons, at different times, agree in almost no particular. The gases are sulphuretted hydrogen and carbonic acid. The waters are used in the treatment of diseases of the respiratory organs, skin affections, chronic rheumatic troubles, and congestive disorders of the abdominal organs. *T. L. S.*

LANOLIN. Under the title of *lanolin*, Oscar Liebreich has proposed, to serve as a basis for ointments, the peculiar body that results from the mixture of a *cholesterin* fat with water. The cholesterin fats are peculiar, in comparison with ordinary glycerin fats, in not decomposing, in "taking up" and holding in intimate blending an equal quantity of water, in mixing also with glycerin, and in possessing a high diffusion-power. By reason of the latter power, lanolin used as an inunction ointment rapidly impresses the system with any absorbable active drug substance that may be incorporated with it. For use it has been recommended to add to lanolin from one-eighth to one-fourth part of some ordinary oil, such as castor-oil, in order to reduce stickness (Walter Smith).

Edward Curtis.

LARCH BARK (*Laricis Cortex*, Br. Ph.). The bark of the trunk and branches of the European Larch, *Larix europœa* D.C. (*L. decidua* Mill), order, *Coniferæ*, an abundant timber plant of the mountain regions of Middle and Southern Europe, and a rather commonly cultivated ornamental tree both in Europe and here. Its light and delicate branches and tufted deciduous leaves make it easily distinguishable from other conifers.

The bark is in flattish pieces or quills of varying lengths and sizes. The outer surface is dark red or rosy, and somewhat uneven; inner surface nearly smooth, and yellowish-white or pinkish-red, according to its age; fracture close, except the liber, which is somewhat fibrous, and the fractured surfaces, except internally, of a deep carmine-red color. Odor slightly balsamic and terebinthinous, taste astringent.

Larch bark, which should be gathered in the spring, has very little, in a medical way, to distinguish it from other coniferous barks: *volatile oil, resin*, a peculiar *tannin*, and *larixinic acid*. The turpentine and tannin make larch and other fir-barks astringent and stimulating to the renal and bronchial mucous membranes. It is used to a slight and diminishing extent in bronchitis, vesical and urethral catarrh, as well as in purpura and other hæmorrhages. A tincture (two and a half ounces to the pint) is an eligible form. Dose, one or two cubic centimetres (♏ xv. ad xxx.), several times a day.

Allied Plants.—The American Larch (Tamarack, Hackmatack), *Larix Americana* Michaux, is a smaller and less ornamental tree than the above, but in most respects resembles it very closely. The genus is a small one, of less than a dozen species; for the order see Turpentine.

Allied Drugs.—A thickish liquid oleo-resin, Venetian turpentine, is collected in the Tyrol from the trunks of larch trees by deep incision or boring—a slightly opalescent liquid of a turpentine-like odor and taste. It is a very slow-drying liquid, of more agreeable odor and taste than most of the other turpentines. Our Canada balsam approaches it most nearly. A sort of manna, consisting of a peculiar, sweet principle, *melezitose*, exudes from the stems and leaves of the larch in midsummer. It is, like manna, a mild laxative, but is very little used at present. Besides the ordinary terebinthinous substances Larch bark may be compared with Grindelia, Terebene, Juniper tops, etc. *W. P. Bolles.*

LARD (*Adeps*, U. S. Ph.; *Adeps præparatus*, Br. Ph.; *Adeps suillus*, Ph. G.; *Axonge, Saindou*, Codex Med.), the fat of the common hog, *Sus serofa* Linn., order *Pachydermata*, usually obtained from the enormous collection of fatty tissue situated in the abdomen, at each side of the backbone, and enclosing the kidneys. This tissue, which goes by the name of "leaf lard," is washed, chopped, cleaned from connective bands and trabeculæ, and then, with a little water, exposed to the temperature of boiling water and maintained there until the connective tissue is softened and the fat has run out; it is then strained, and the heat continued until the water is nearly removed and the melted fat is clear and homogeneous, when it is poured out and cooled. If a very fine product is desired, it should be filtered in a hot filtering apparatus.

Commercial lard is so universally impure, either being mixed with water or salt, or having a portion of its liquid oil removed, that it is in general unfit for medicinal use, and the apothecary will do well to always prepare his own. Ordinary lard rather rapidly becomes rancid and irritating, but if perfectly pure and free from water it will keep, closed in a cool place, for a very long time. For pharmaceutical purposes it is scented with benzoin, a little of the balsam being tied in a bag and suspended in the melted lard for two hours. Thus treated, it is almost entirely permanent, besides having an agreeable odor.

Composition.—*Olein, palmitin*, and *stearin* are the principal constituents of lard, their relative proportions (upon which its consistency depends) varying considerably. It ordinarily melts at about 95° F.

Action and Use.—Lard is an article of food, and is emulsified, like other fats, when taken into the stomach and intestines, without any particular physiological action. As an external dressing it is protective and bland in a high degree, qualities which have given it its popularity as a basis of ointments and cerates. Those of the U. S. Pharmacopœia follow: *A. Benzoinatus*, just mentioned, *Ceratum, Ceratum Cantharidis, Ceratum Extracti Cantharidis, C. Resinæ, Unguentum, Ung. Hydrargyri, Ung. Mezerei, Ung. Iodi*, etc.

Allied Substances.—The fat of a number of domesticated animals and birds is collected and saved for household use and extemporaneous medicines.

W. P. Bolles.

LARYNGECTOMY: Resection or Extirpation of the Larynx, with Artificial Substitutes. The history of this operation, like that of numerous other so-called modern operations, shows that it was conceived of some time before being put into actual execution; that an occasional experiment served to demonstrate gradually the possibility of its success, and that, finally, a careful experimental study of its technique led to its trial upon the human subject. In 1829, Albers made some experiments upon dogs to learn, if possible, the exact part played by the larynx in the act of respiration. He opened the trachea and part of the thyroid, and in two dogs removed the entire larynx; the first of these two died of hæmorrhage, the second lived nine days and died of starvation. Albers seems to have drawn no special inferences as to the feasibility of thus operating upon man. Von Langenbeck, in 1854, made public mention of the fact that he was prepared to make trial of extirpation upon a patient in his clinic, and he even gave a general description of what he intended to do, but the patient declined operative help. Foulis states that in 1856 Köberle spoke of the propriety of partial and total operations of

this nature; and that in 1866 Watson, of Edinburgh, operated upon and lost a patient. The same plan seems to have suggested itself to Hueter, in 1870, who saw an otherwise healthy patient die of cancer of the larynx. His idea was to make a preliminary tracheotomy, and then, after extirpating, to sew the mucous membrane of the pharynx to the skin, in order to make a permanent fistula for purposes of feeding.

But the greatest credit should be ascribed to Czerny, now of Heidelberg, who, in 1870, undertook a systematic investigation of the subject. He was the first to completely demonstrate that not only was it possible to remove the entire larynx from dogs, but that the operation was practicable on man; and he even laid down rules for its performance. He, moreover, showed that when a T-shaped tube was introduced properly, a certain capability of speech might be expected. Such tubes he constructed for some of his dogs, and these tubes were the rude and simple precursors of the elegant models of to-day.

Three years later, Billroth found opportunity, in his Vienna clinic, to make the first attempt upon a living patient. This patient had already undergone a laryngotomy for cancer, which had returned in four weeks and involved all the interior of the larynx. The operation was a brilliant success, and the patient in due time was supplied with an artificial substitute by Gussenbauer, who has displayed conspicuous ingenuity in his mechanical devices for this purpose. The fact that the patient died a year later from cancer of the cervical glands, in no wise detracts from the success of the operation as such. The practicability of this extreme measure having received this brilliant demonstration, other surgeons were not slow to resort to it; and Billroth was quickly followed by Heine, Maas, Schmidt, Schönborn, and numerous others, until now, at present writing (1886), it has been performed in the neighborhood of a hundred times.

Two features in particular have contributed to make the operation a success, aside from the increasing confidence with which surgeons attack all parts of the human frame, and these are hæmostatic forceps and antiseptic gauze. The former permit a most extensive dissection, in extremely vascular regions, with a minimum loss of blood, and the latter very largely does away with the disastrous passage into the stomach and lungs of decomposing discharges. Before the use of such gauze, perhaps the greatest danger to the patient was that of septic pneumonia (*Schluckpneumonie*), from the entrance into the trachea of offensive pus; at present this can be guarded against with reasonable assurance, as will appear below.

INDICATIONS.—The principal indication for this extremely radical operation is obviously the presence of a malignant tumor incapable of thorough removal by other methods, or which, after previous milder operative attacks, shows a disposition to return. Besides the presence of such tumors, the larynx has been removed on account of destruction of its identity from cicatricial stenosis, for lupus, for intractable perichondritis followed by necrosis; and one may, at least, imagine a case of primary tuberculosis of the larynx in which, if the diagnosis could be made early enough, resection would be justifiable. Indeed, in one case a tuberculous larynx was removed, having been considered to be cancerous; the patient recovered from the operation to die months later of phthisis.

Of course those general principles which obtain concerning the earliest possible removal of malignant growths elsewhere, apply with equal force here, and the rule should always be, "the earlier the better." Extreme exhaustion would, in all cases, be a contra-indication; so would be the hæmorrhagic diathesis and the dissemination of the growth beyond the laryngeal confines, although in several cases more than the larynx has been removed. Thus Langenbeck, in one case, did not hesitate to remove along with it a number of enlarged submaxillary glands, the hyoid bone, and base of the tongue, along with a part of the pharynx and of the œsophagus; he was compelled to tie both external carotids, as well as both linguals, external maxillaries, and superior thyroids. The patient made an excellent recovery, but died some months later from a return of the disease.

Indeed, one may say that the proportionate gravity of this always grave operation depends in largest measure upon the general condition of the patient. Nevertheless, its results have been so conspicuously successful in otherwise absolutely hopeless cases, that one need never hesitate to advise it when the general condition outside of the larynx is favorable.

THE OPERATION.—The larynx may be removed in whole or in part; in other words, the resection may be complete or partial. We shall give in this place rather a general idea of the former, feeling that anyone contemplating its actual performance would desire to refer to the special literature of the subject.

It has happened in many cases (the writer's, for example) that the exigencies of the condition present have called for a tracheotomy, which has thus been made a preliminary to the more radical extirpation. Thus the question has been raised whether preliminary tracheotomy is not always advisable. Of course, if it have been already made, the question is at once settled, but when the matter can be taken under advisement the writer would be adverse to it, and on these grounds: when undertaken a few days previously, it leaves a certain amount of disturbance and adhesive inflammation, which may complicate subsequent dissection; whereas, if left till the extirpation, it can just as well be merged into and become a part of the latter. The surgeon must, however, be prepared to perform it instantly in case of impending suffocation.

The preliminary skin incision should be a long one, from well up toward the chin down even to the sternum. By this long incision one may be spared the necessity for making others at right angles; it is also in the line of safety, and healing takes place much more satisfactorily. From a height above the hyoid bone to a level below the larynx this incision should be deepened, until the entire respiratory tract is exposed, and the deep fascia covering the same divided. Now, the cutting edge should be replaced by the handle of the scalpel, or, better still, by a reasonably sharp periosteum elevator, by means of which all the lateral attachments of the laryngeal muscles are separated. Any small spouting vessel must be caught in the hæmostatic forceps; any one of sufficient size to call for it must be ligated twice and divided between the ligatures. The isthmus of the thyroid must also be treated in this way. By this process the larynx is freed anteriorly and laterally. To free it and the upper rings of the trachea, if any are to be removed, from the œsophagus, is perhaps the most difficult part of the operation. This must be done with extreme care, and preferably with the finger-nails. It must be remembered that the anterior wall of the œsophagus commences at the level of the cricoid cartilage.

After the larynx has thus been loosened from all lateral and posterior attachments, the thyro-hyoid membrane exposed, and the hæmorrhage all checked, the operator is ready to begin its removal. There has been considerable discussion as to whether it is better to do this from above or from below. The writer's preference, based upon a single experience, is for the latter. It is perhaps a little the more abrupt, but it provides for the proper care of the trachea at once, and the operator may proceed to complete his work with less haste. The height at which division shall be made being first decided on, whether just below the cricoid, or between some of the upper tracheal rings, as circumstances may dictate, the section is quickly made. The portion above being already loose, may be quickly lifted out of the way, and a tracheal cannula, arranged to suit the operator, may be rapidly inserted; through this, for the balance of the operation, the anæsthetic is administered. This having been so cared for as to prevent entrance of blood into the trachea, complete removal is now effected. The matter of removal of the epiglottis, if not already settled upon, must now be quickly decided. If diseased, it must of course be removed; but when it is healthy one may easily waver in opinion. Here again the writer advises its removal, since experience caused him to regret leaving it. It has many times been found a detriment rather than an advantage.

The thyro-hyoid membrane is now divided, also the folds connecting the epiglottis with parts above, as well as any remaining connections, and the diseased mass is lifted out.

Now is the time for careful examination of surrounding tissues and extirpation of any that are diseased. Thus part of the hyoid, base of tongue, lateral pharyngeal wall, or œsophagus, or the thyroid, cervical or other enlarged gland, if diseased, may be conveniently dissected out without much difficulty. With all this, hæmorrhage is not likely to be severe, and so long as blood is kept out of the trachea no great difficulty is met with.

For the purpose of keeping the trachea clear various measures have been suggested. Trendelenburg's tampon tracheal cannula, has been used, but is not unlikely to disappoint one, and to give out when most wanted. It consists (Fig. 1997) of a soft rubber tampon drawn over a metal cannula; by a small rubber balloon, the former is inflated after introduction so as to completely fill the trachea; the cannula is connected by a rubber tube of large calibre with a perforated funnel, covered with flannel or filled with a sponge upon which the anæsthetic may be administered. But an ordinary large trachea-tube may be wrapped with a strip of sponge so as to fill the trachea, or even may be so packed around with sponge, after introduction, as to sufficiently protect the lungs from entrance of blood.

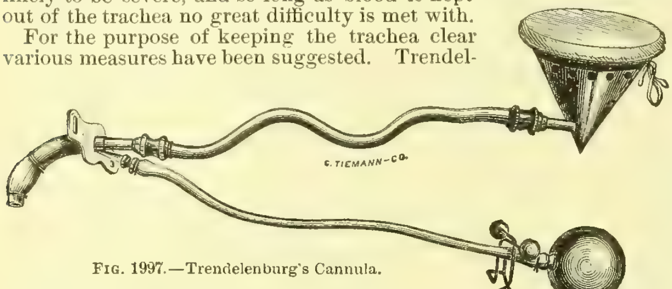

FIG. 1997.—Trendelenburg's Cannula.

After the completion of the excision a formidable large wound is left, whose most conspicuous features are the large pharyngeal opening, the upper gaping end of the œsophagus, and the divided trachea. The cavity being so large, the temptation may be a strong one to bring its edges somewhat together. Yet common experience has demonstrated that it is much safer to let it close naturally, as it rapidly will. It is only necessary to prevent the trachea from retracting, as it naturally tends to do, by suturing it to the margins of the wound; a silk or silkworm-gut suture on either side suffices for this.

The wound is then dressed by removing the cannula, which has been packed about with sponge or otherwise protected, clearing the trachea of any contents, replacing a tube and carefully packing around it with gauze, so that no secretion can pass it, and then packing the balance of the wound nearly full with the same gauze (for formula for this gauze see article in vol. i., Antiseptics in Surgery). Access must be left to the œsophageal opening, which may be lightly plugged with a strip of gauze, one end of which is left hanging out so that it can be readily removed without disturbance of the other dressing. Iodoform gauze is usually used for this purpose, but the writer heartily commends the substitution of oxide of zinc, which is equally effective, and by which all danger of poisoning is eliminated. It is prepared in the same way.

AFTER-CARE.—The requisite after-care is much the same, so far as surroundings are concerned, as in a case of tracheotomy. The air of the room should be kept moist, and at a temperature not much below 80° F. The gauze must be kept well packed around the cannula, so that neither saliva nor secretions from the wound may enter the trachea. This must be changed as good judgment may dictate, and the tube will need to be occasionally removed for cleaning. Obviously, the patient must be fed artificially for weeks. The anterior lip of the severed œsophagus will probably hang forward over the tracheal tube, and will serve as a guide for the easy introduction of a flexible feeding-tube, through which, by means of a funnel, milk, raw eggs, and other fluid food may be introduced. Feeding should be practised every four to six hours, according to the demands of the case. As the wound fills up by granulation the œsophageal tube will, after two or three weeks, have to be passed by the mouth. Whatever medication may be indicated may be administered with the food. The upper end of the œsophagus should be kept lightly plugged with gauze, except at the time of feeding.

As cicatrization follows the granulating process, preparations should be made for the introduction of some artificial substitute for the larynx. The common tracheal tube must be replaced by the tracheal portion of the apparatus to be worn, and its pharyngeal opening (*vide* below) may be protected by gauze when not in use. In the writer's case the patient was wearing this in three weeks; a week later the pharyngeal portion was put in place and worn, the man breathing once more through his nose. In seven weeks he was able to swallow soft solids without much difficulty. Of course the corresponding periods will vary within wide limits in different cases.

THE ARTIFICIAL LARYNX.—This most ingenious instrument owes its present perfection more to the genius of Gussenbauer, of Prague, than to any other individual, though it has been variously modified or adapted to special cases by different surgeons.

The latest model of the Gussenbauer apparatus, as the writer had it from him in 1882, is shown below in Fig. 1998.

It consists of a tracheal tube of large size (A) with lobster-tailed rings at its lower end permitting a slight motion, corresponding to the natural flexibility of the trachea. Through its front plate, and through an opening on its upper curvature, passes a second or pharyngeal tube (B), also made flexible (or not, according to the case), with an opening on its lower curved surface, so placed that a stream of air may play freely through both tubes, even though the external outlet be closed. The upper end of the pharyngeal tube lodges behind and below the epiglottis, if this have been left *in situ*, or behind and below the base of the tongue, as the case may be. Around it the œsophagus granulates and closes, so that after the healing process is complete the only passage from the pharynx into the larynx is by way of the metal tube. In order that fluids and solids may not pass through this, an obturator (C) is provided, which is passed through the external opening and up through the tube, so that its rounded upper end plugs the upper end of the pharyngeal open-

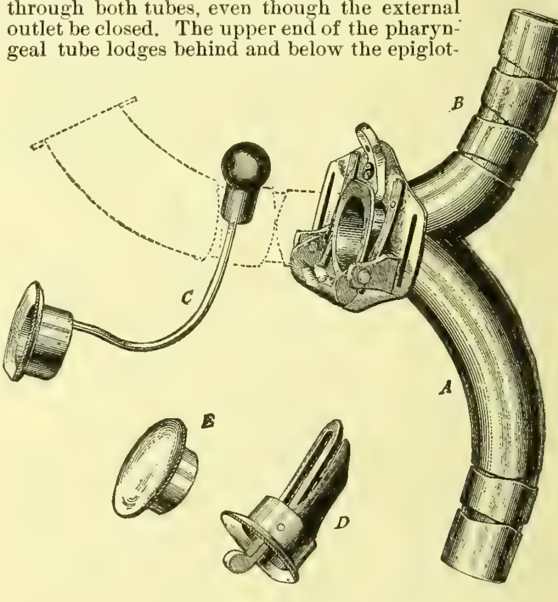

FIG. 1998.—Gussenbauer's Artificial Larynx.

ing, thus preventing passage of anything into the trachea. But since this would also shut off air, the obturator is attached below, not to a solid plug, but to a ring, as seen, which fits accurately into the external opening of the instrument, through which the patient breathes so long as this plug is worn. Except at meal-times the simple stopper (E) is worn, so that the patient breathes through the nose and mouth. After a time, by an instinctive education of the pharyngeal and buccal muscles, the upper end of the tube is protected during the process of deglutition, and patients wearing these instruments learn to swallow readily without the assistance of the obturator.

The feature of greatest interest about this apparatus is the vocal part. It will be remembered that the vocal cords have nothing to do with articulation, which is all performed above the larynx ; they only furnish tone or sound. Possibility of articulation, then, not being interfered with, we have only to find a substitute for the vibrating cords. In the simple mechanism shown at D we

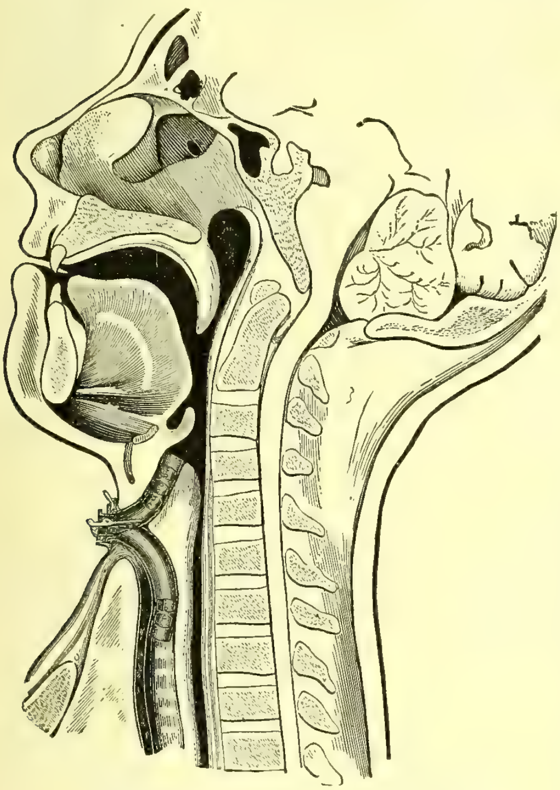

FIG. 1999.—Gussenbauer's Artificial Larynx in Position.

have such a substitute—namely a metallic reed, like a melodeon reed, playing freely in a movable slotted bar, and fitted inside of a stopper. This movable bar carrying the reed has an external lever, by means of which the wearer is enabled, with a touch of his finger, to throw it into or out of the air-current, and thus, as it were, to voluntarily open or close his glottis. Placing this part of the instrument *in situ*, and throwing the reed into the air-current, the metal strip vibrates as it does in the jew's harp, and the sound thus produced is converted, by the articulating parts above, into something more than a whisper—*into distinct speech*. To be sure the voice is now a monotone, but it is nevertheless a true spoken voice.

In Fig. 1999 is given an idea of the apparatus in position (modified from Schüller)

Fig. 2000 represents a modification of the above, devised by Irvine, of Glasgow, and used by Foulis in one of his cases. In this the pharyngeal tube is first introduced, and is made to carry the tracheal tube which passes through it. Besides this the interior of the pharyngeal tube is grooved, and the piece carrying the reed is made to slide in these grooves. These have been made either of hard rubber or of metal.

As a further example of what may be done for special cases, the reader may refer to Fig. 2001, which represents an instrument constructed for a case of Lange's. The plate B was intended to be a substitute for the anterior wall of the œsophagus which had been cut away ; A is the artificial epiglottis, and D the chamber containing the removable apparatus. The parts at A and E are much like one of the earlier forms of apparatus devised by Bruns.

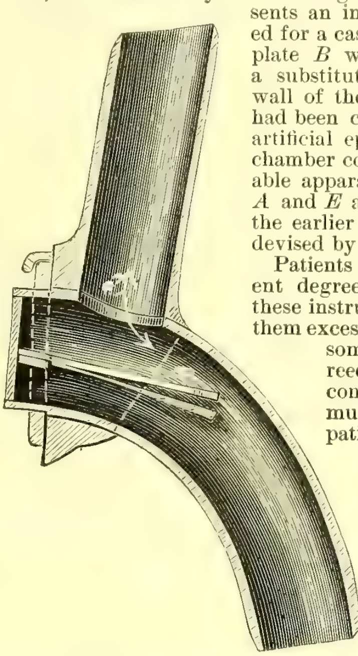

FIG. 2000.—Irvine's Modification of Gussenbauer's Apparatus.

Patients display very different degrees of toleration of these instruments. Some find them excessively inconvenient, some cannot use the reed, others wear them continually without much discomfort. A patient of Gussenbauer's was known to the writer, who wore his apparatus without apparent inconvenience, who was almost continuously in the saddle as a riding-master, and who still kept up his reputation as the best rider in Bohemia.

RESULTS.—The operation has been performed now (1886) about one hundred times, mostly by German and Italian surgeons. In considering results obtained, it seems to the writer fair to claim as a recovery every patient who has lived more than two months after the operation—in other words, who has survived it ; so far as the success of the operative procedure is concerned, it matters very little whether the patient has remained perfectly well, or has died later of metastatic trouble. Looked at in this light, about one-third of the cases have been successful; and this proportion seems large enough to amply justify the attempt, in selected cases, to prevent or delay the fatal termination, otherwise speedily inevitable.

Of these thirty odd successful cases, some have lived for several years, others only for several months, but all much longer than would have otherwise been possible.

Those interested in the work of American surgeons in this field are referred to the *Annals of Surgery* for January, 1886.

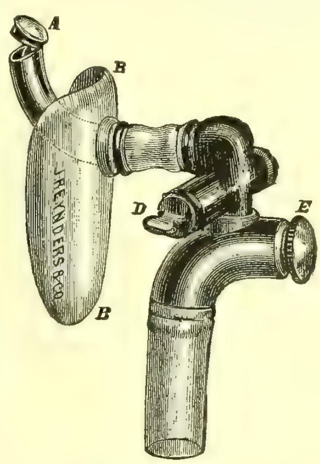

FIG. 2001.—Lange's Artificial Larynx.

PARTIAL OR UNILATERAL LARYNGECTOMY.—Inasmuch as laryngeal cancers are more often confined to one side, at least at first, it may be possibly indicated to remove the affected half. Thus, of one hundred and nineteen cases of cancer of the larynx, including the epiglottis, in sixty-nine the disease was unilateral. That partial resection is feasible some of the earlier cases abundantly

proved. Thus, in Billroth's third case he removed only a lateral half, and still the patient was thereafter able to phonate without mechanical aid. Hahn has advised, as the method of operating in such cases, that by an angular incision the larynx be first exposed, and then split open for examination. If only one-half be involved, then it may alone be removed; if, however, the disease have advanced beyond the median limit, then the complete operation may still be made. In other words, he recommends an exploratory laryngotomy, to be followed by whatever may be indicated. After the operation a cannula is introduced and packed in the manner above described. If only half the organ have been removed, the patient will probably be able to make himself easily understood without artificial aid.

This partial operation has been successful in about three-fifths of the total number of cases—some twenty odd in number—in which it has been practised. As we gain in ability to recognize the earliest stages of laryngeal cancer, and with increasing confidence in operative attacks, the number of partial laryngectomies will grow relatively larger. *Roswell Park.*

LARYNGOSCOPE (λαρυγξ - σκοπεῖν). An instrument used for demonstrating the interior of the larynx and the neighboring parts.

Although the remains of specula, somewhat resembling the laryngoscopic mirrors now in use, have recently been found at Pompeii, the art, if known at all to the ancients, became lost, and has only been successfully revived within the present century. In 1743 M. Levret, a distinguished French physician, contrived a small re-

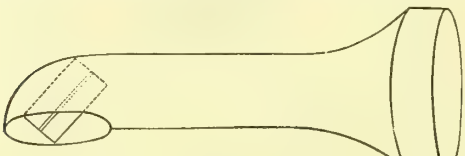

Fig. 2002.—Bozzini's Laryngoscope.

flecting mirror to aid in the detection and removal of polypoid growths of the nostrils, throat, ears, and other parts. In 1804 Dr. Bozzini, of Frankfort-on-the-Main, invented an apparatus for examining the various canals of the body, which consisted of a hollow tube (Fig. 2002), furnised with a looking-glass at one end and a lantern at the other. In the centre of the lantern were two round holes, opposite each other. To the one an eye-piece was fixed; to the other the speculum. The flame of the candle used for illuminating was situated just below the level of these apertures. Later, more or less successful attempts to demonstrate the interior of the larynx were made by Babington, Bennati, Baumès, Liston, Avery, and others. Avery invented an instrument very similar in principle to the modern laryngoscope, but did not place his invention on record until some time after the one now in use had been described. Dr. G. Troop Maxwell, of Middletown, Del., is credited with having devised a laryngoscope and developed its use independently of the knowledge of its discovery abroad; while the remarkable additions to the then existing knowledge of the diagnosis

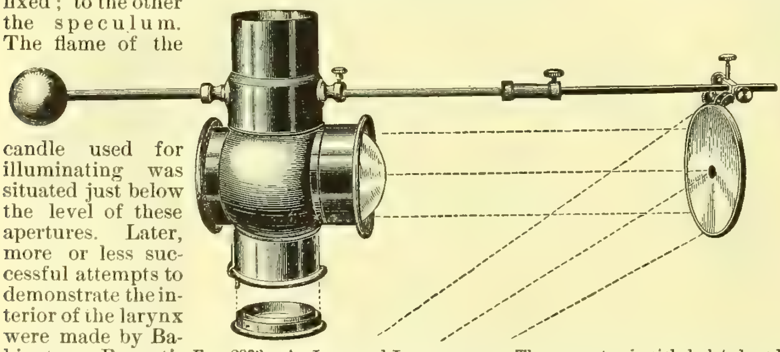

Fig. 2003.—An Improved Laryngoscope. The apparatus is nickel-plated, and has the merit of being convenient and inexpensive. The separate parts are shown in Figs. 2004 and 2005.

and treatment of diseases of the pharynx and larynx, made long before the introduction of the laryngoscope, by Dr. Horace Green of New York, constitute one of the most brilliant chapters in the history of medicine in this country.

To Signor Manuel Garcia belongs the credit of having first demonstrated a practical means by which the interior of the larynx might be studied. Having practised the method during 1854, he presented, in 1855, a paper to the Royal Society of London, entitled "Physiological Observations on the Human Voice." In this he described the respiratory and phonatory action of the vocal bands, and made some important explanations as to the production of sound in the larynx, and the formation of the so-called chest and head notes. His method consisted in the introduction into the pharynx of a small, round mirror, such as was used by dentists, only having a longer handle. Upon this he reflected the direct rays of the sun into the larynx, receiving the image of the latter upon the mirror. For the performance of auto-laryngoscopy, which he also invented, he advised that the rays of the sun be reflected from a second mirror into the pharynx. In the mirror thus used as a reflector he also saw the autoscopic image.

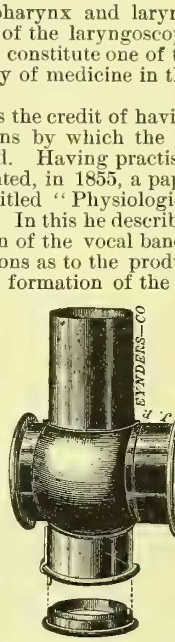

Fig. 2004.—Represents the Condenser, a modification of the Mackenzie model. It is furnished with a reflector behind the light, and can readily be adjusted either to an ordinary Argand gas-burner or to a student's lamp.

The merit of Garcia's discovery was not appreciated in England; but becoming known to Türck, of Vienna, it was shortly afterward communicated by him to Czermak, of Pesth, who devised laryngeal mirrors of different sizes, adapted the concave reflecting head-mirror for use with artificial light, and thus created the art of laryngoscopy. Little real change from Czermak's methods has since been made, and almost as he left it, so it is known and practised to-day.

Although the one absolutely necessary part of the instrument is the laryngeal mirror, still the process of its successful employment is greatly assisted by means of, first, the use of artificial light, and second, some instrument for the proper condensation and reflection of the light. So important are these two factors that they have become regarded as essential, and the word "laryngoscope" is generally understood as including all three.

The laryngeal mirror is a small speculum, sometimes formerly made of polished steel, now universally made of glass. The latter is generally mounted in a plate of German silver, which completely covers and protects its back, and by which, around the edge, it is firmly grasped and retained. The diameter of the mirrors used varies from a half to one and a quarter inch. They should be as thin as possible, and the encroachment of the metal rim upon the diameter of the reflecting surface should be reduced to a minimum. In this country, mirrors are numbered, beginning with the smallest diameter and ascending to the largest, thus: No. 1 represents the rhinoscopic mirror, No. 5 that ordinarily used in examinations of the larynx. For all ordinary purposes the above sizes, Nos. 1 and 5, will be sufficient. The older authors describe throat mirrors of both square and oval shapes. The former are entirely obsolete, while the latter, although occasionally of some service in cases where the pharyngeal space is narrowed by enlargement of the tonsils, are rarely useful. The shank of the mirror should be of slightly flexible wire, about five inches in length and one-tenth of an inch in diameter. It should

be firmly united to the metallic back of the mirror, and the work finished so carefully that no angles and corners shall be left to interfere with the absolute cleansing of the instrument. The shank should be soldered to the mirror at an angle of about one hundred and twenty degrees. The handle should be five and one-half inches long, and a

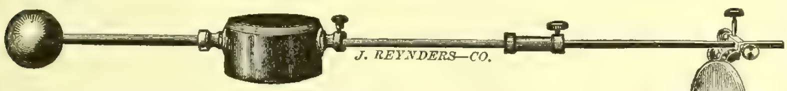

FIG. 2005.—Tobold Attachment to the above.

little more than a quarter of an inch through its greatest diameter. It should be shaped as shown in Fig. 2007, and perforated throughout its long axis, so that the shank of the mirror may be set at any length, or removed altogether, and its place taken by a laryngeal mirror of any size, a laryngeal probe or brush, a palate retractor, a nasal or laryngeal applicator, or any other similar instrument for which such a handle becomes necessary. The end of the handle must be furnished with a metal band, which carries a screw for holding the shank of the mirror firmly in place. When the latter is well made, it will be found to give entire satisfaction, but if badly constructed it will not hold the mirror with sufficient firmness, and is liable to get out of order. The writer has a set of these handles, which, although in constant use for more than ten years, are still in perfect condition. The peculiar shape of the opposite end of the handle is not for ornament, but to enable the instrument to be adjusted more accurately to the space between the thumb and forefinger, in which it rests.

THE LIGHT.—This may be either sunlight or artificial. The latter is greatly to be preferred, and may be furnished by lamp, gas, or electricity. There is a great variety of illuminators in use, of which the best one, for general purposes, is the so-called Mackenzie condenser, attached to a movable bracket over an ordinary Argand gas-light. A modification of this, lately made in Philadelphia, and adapted either for the head-mirror or the

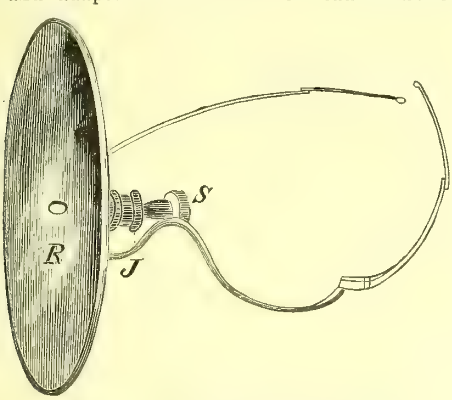

FIG. 2006.—Forehead Mirror, with Spectacle-Frame.

Tobold adjustment, is by far the most attractive, economical, and convenient condenser yet devised (Fig. 2004). The Sass apparatus, an improvement upon the Tobold illuminator, is much more expensive, but at the same time more powerful than the Mackenzie, and, like the Tobold, possesses the advantage of enabling the operator to use the concave mirror either attached to the forehead or to the illuminator itself. For direct illumination Morell Mackenzie strongly recommends the oxyhydrogen lime-light, and says that for class-room demonstration it is superior to any light in use.

Of the almost innumerable electric illuminators which have been offered of late to the profession, both in this country and abroad, none, thus far, has seemed worthy of entire confidence, the main difficulty being in the unreliability of the electric current. It is not too much to expect, however, that at some date in the near future a perfect and thoroughly trustworthy electrical apparatus will be invented, which will far surpass in power and convenience any illuminator heretofore employed.

The light may be used by the method of direct illumination, as practised in France, or it may be reflected into the patient's throat by means of a large concave mirror, fastened to the illuminator after the manner of Tobold, or worn upon the forehead. The head-mirror should be from three to four and a half inches in diameter, and should be perforated in the centre with an opening, either round or oval, of about three-eighths of an inch in diameter. It is fastened to the forehead by means of a head-band or a spectacle-frame (Fig. 2006). The mirror should have a focal distance of about fourteen inches, and it should be worn, not over the forehead or below it, as recommended by some, but to one side, and with the perforation opposite the operator's eye. It should be of light weight, and backed with silver rather than with amalgam.

In performing laryngoscopy the following suggestions will be found of practical value. It is supposed that the operator will use artificial reflected light. The patient, seated directly opposite the operator, should be in an erect position, with the chin at about a right angle to the vertical axis of the body, and the muscles of the neck

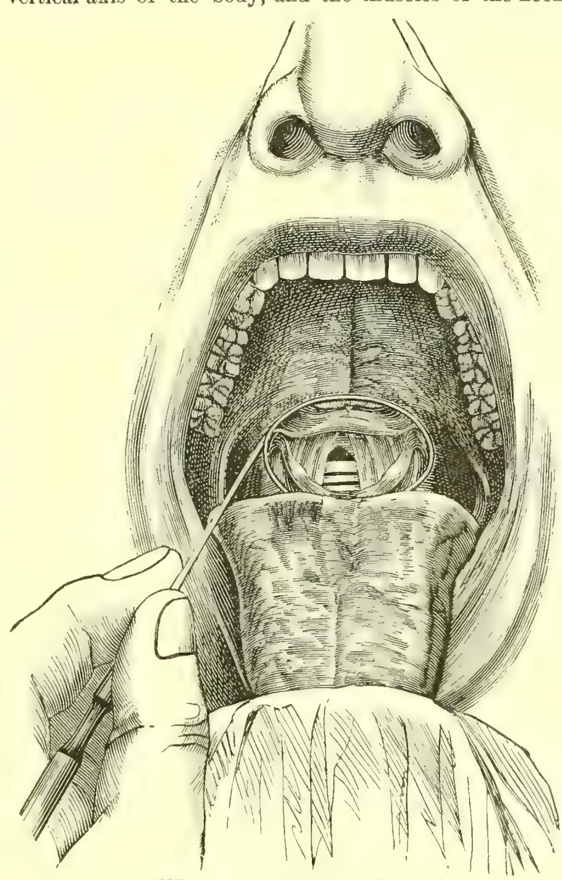

FIG. 2007.—The Laryngeal Mirror in Position.

and throat relaxed. The light should be at about the level of the patient's ear, and a little behind it. The mouth of the patient being open, the light is reflected from the head-mirror, properly adjusted upon the forehead of the operator, into the patient's pharynx, and the proper focal distance obtained by advancing or withdrawing the head-mirror until the point of strongest illumination is reached.

The examination of the pharynx is facilitated by de-

pressing the patient's tongue. To accomplish the latter with comfort and success, place the blade of the depressor upon the highest part of the dorsum of the tongue and press gently but firmly downward, taking care that the position of the depressor be not altered. It should be remembered that the circumvallate papillæ and the base of the tongue are particularly sensitive, and that if the depressor be thrust too far backward, and thus allowed to irritate them, the patient is almost certain to gag. Even should some resistance be encountered, the tongue will soon sink into the floor of the mouth, and the buccal cavity, pharynx, tonsils, soft palate, etc., will come into full view. Having inspected the pharynx, withdraw the tongue depressor and proceed to the examination of the larynx. To this end direct the patient to protrude the tongue, and, encircling its tip with a napkin, draw the tongue gently forward with the thumb and forefinger, rolling it slightly over the middle finger, so as to protect the frænum linguæ, and resting the ring and little fingers upon the patient's chin to insure steadiness. Forcible dragging of the tongue forward and downward is unnecessary and objectionable, and should never be permitted. The next step is the introduction of the mirror. Preliminary to this, the mirror should be warmed until its temperature reaches 100° Fahrenheit. To do this hold the mirror over the flame of the illuminator for a few seconds, watching carefully for the collection and dispersion of the film of moisture which collects upon the glass, and upon the disappearance of which the temperature will be found to be nearly at the desired point. It is, of course, the *mirror* which is to be warmed, and not its metallic framework. Never introduce the mirror without having first tried its temperature upon the ball of the thumb, as, if introduced too cold, it immediately clouds; if too hot, it is intolerable, so that in either case the examination will fail. The mirror warmed and the tongue protruded, the proceeding is completed in two movements; first, the mirror, held after the manner of a pen, between the thumb, index and middle fingers, is introduced with the surface of the glass parallel with the plane of the dorsum of the tongue, and as far back as the uvula; and secondly, the uvula being reached, the mirror is passed under it, and it and the soft palate are pushed gently upward and backward until the lower border of the mirror almost touches the posterior wall of the pharynx. The hand of the operator is then carried outward, until the shank of the mirror rests in the angle of the patient's mouth, and, in order to secure a maximum of steadiness, the ring and little fingers may be rested upon the side of the patient's chin. Should the pharynx be irritable or the uvula long, direct the patient to phonate the vowel sound "E," when the soft palate will be raised, and the mirror may easily be slipped into place. Now, again directing the patient to phonate a high-pitched "E," the larynx will be raised, the epiglottis thrown widely open, and the vocal bands approximated and brought into plain view (Fig. 2007).

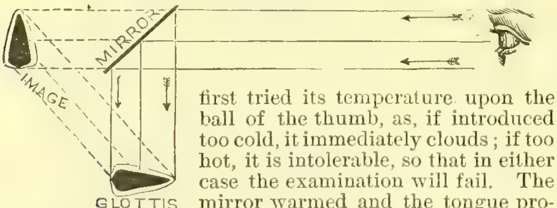

FIG. 2008.—Shows the Principle of Reflection of the Laryngeal Image.

Sometimes, instead of drawing the tongue forward, the vocal bands may be demonstrated to better advantage by simply depressing the tongue with a spatula, the rest of the procedure being carried out as above described. In difficult cases it is well to try both methods. Although the former is the one universally recommended, the latter is, in exceptional instances, easier for both operator and patient

In the examination of the larynx certain difficulties may be encountered by the beginner. The first of these will be, of course, want of dexterity on the part of the physician himself. It must be conceded that dexterity in the use of any instrument of precision can only be acquired by diligent, careful, and long-continued practice. It is a mistake, therefore, to believe that an expert laryngoscopist can be made as the result of a few hours of instruction. The hand, the eye, and the judgment must be well trained before the learner can be regarded as sufficiently qualified to undertake the diagnosis and treatment of pathological conditions. To accomplish this much discipline is necessary. The requisite skill once attained, however, will amply repay the time and trouble spent in its acquirement. Next in importance to skill, if not actually synonymous with it, is absolute gentleness in the use of the instruments, and in the handling of the patient. Anything approaching to roughness, haste, or indecision will compromise the success of the examiner, and, in very many cases, especially during a first examination, induce distrust and prejudice. Upon the importance of the above too great emphasis cannot be laid.

One of the first difficulties to be encountered will be the management of the head-mirror. The use of this should be mastered before any attempt to examine the larynx is made. Again, should the laryngeal mirror, after having been introduced, fail to bring the larynx into view, it is better to withdraw and reintroduce it rather than irritate the pharynx, and cause the patient to retch by moving the mirror from place to place. Several short rapid glances at the larynx will often convey more to the observer's eye than a single long demonstration. And, since in some cases a glance is all that can be obtained, the physician should educate himself to the most rapid and comprehensive appreciation of the laryngeal picture possible.

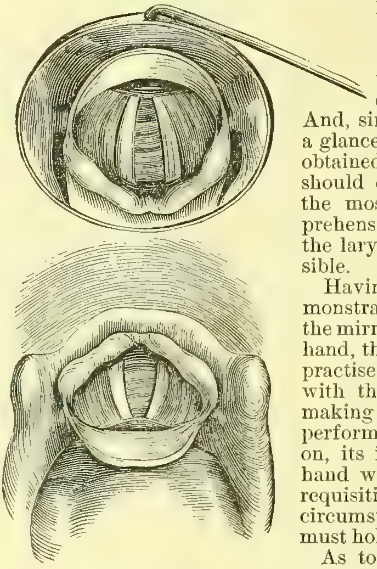
FIG. 2009.—The Larynx and its Reflected Image.

Having learned to demonstrate the larynx with the mirror held in the right hand, the beginner should practise demonstrating it with the left hand, as in making applications to, or performing operations upon, its interior the right hand will be called into requisition. Under these circumstances the patient must hold his own tongue.

As to the apparent reversal of the laryngeal image in the mirror, no difficulty can arise if the observer will call to mind the anatomical outline of the larynx, and remember that the epiglottis, being the most anterior, will appear at the top of the picture, while the arytenoid prominences, being posterior and nearer to the mirror, will appear at the bottom. The right side of the larynx will, of course, be on the right side of the patient, and this side of the larynx will be reflected from that side of the mirror which is directed toward the patient's right (Fig. 2009).

Difficulties in the way of an examination may be found which relate to the patient. These may be faucial irritability, peculiar action of the tongue, an elongated uvula, hypertrophied tonsils, or a pendent condition of the epiglottis.

Faucial irritability may usually be overcome by care in the management of the tongue and in the introduction of the mirror. If the suggestions as to gentleness given above are observed, it will seldom be met with. Should it actually exist, it can almost invariably be overcome by directing the patient to practise, several times daily, touching the pharynx with some blunt instrument. A number of drugs have been recommended by various writers as producing more or less anæsthesia of the pharynx. They are practically useless, and sometimes harmful, and in the case of the application of morphine in solution, fatal nar-

cosis has resulted. An excellent method, recommended by Morell Mackenzie, is the continuous sucking of cracked ice for fifteen or twenty minutes. By far the best means yet proposed is the application of a solution of cocaine. This, however, cannot be tolerated in certain cases.

Intractability of the tongue may usually be overcome by the use of the tongue depressor, as mentioned above. Elongation of the uvula will seldom interfere if the patient be directed to phonate a vowel sound as the mirror is introduced, while in case of hypertrophy of the tonsils a small mirror, or one of oval shape, may be used. Removal of the redundancy of these organs will greatly facilitate future examinations.

An overhanging epiglottis may sometimes be drawn upward and forward by means of a laryngeal probe covered with English-woven catheter material. The larynx may also be seen by introducing the mirror lower in the fauces and holding it more perpendicularly. The plan recommended by some German laryngologists, of passing a thread with a curved needle through the epiglottis, which is then drawn forward, need be mentioned only to be condemned. *D. Bryson Delavan.*

LARYNX, ANATOMY AND PHYSIOLOGY OF THE.

The larynx, or vocal organ, is situated at the upper end of the trachea and opens, above and posteriorly, into the pharynx. It is a modified portion of the air-passages.

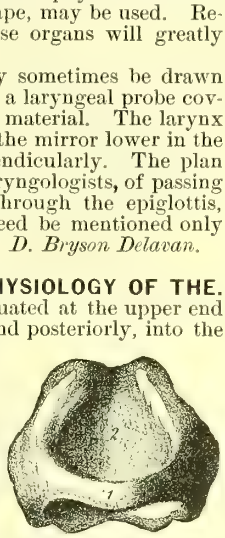

Fig. 2010.—Anterior View of the Cricoid Cartilage. 1, The anterior arch; 2, the posterior arch. (From Luschka.)

By virtue of its anatomical and physiological arrangements it subserves two purposes. First, it is the seat of the origination of vocal sounds. Second, by the action of its muscular apparatus, the air-passages are protected against the ingress of food during the act of deglutition. Its "respiratory function," so called, is rather the result of the conditions arising from the presence of the vocal mechanism than of primary physiological importance. In other words, the air could pass back and forth as readily in respiration, in the absence of a larynx, as where one is present.

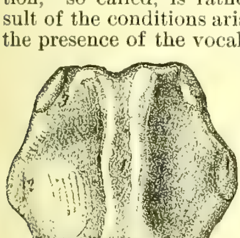

Fig. 2011.—Posterior View of the Cricoid Cartilage. 1, The median ridge, to which is attached the suspensory ligament of the œsophagus; on either side of the ridge are the depressions for the origins of the posterior crico-arytenoid muscles; 2, articular facet for the inferior cornu of the thyroid cartilage; 3, facet for the articulation with the arytenoid. (Luschka.)

The cartilaginous framework of the larynx is made up of several distinct pieces, so arranged as to accommodate its shape to its function. The inferior or *cricoid cartilage* (see Figs. 2010, 2011 and 2012) is a ring, differing from those of the trachea in being complete, so that the posterior wall is not yielding. It is narrow in front and broad behind, resembling somewhat a signet-ring, except that the broad posterior portion does not extend below the lower border of the ring proper, but lies entirely above this line. It projects upward a distance equal to about two and a half times the diameter of the anterior arch.

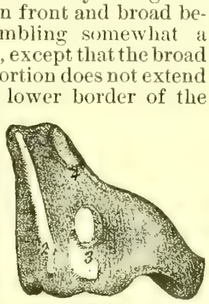

Fig. 2012.—Lateral View (right side) of the Cricoid Cartilage. 3, Articular surface for the inferior cornu of the thyroid; 4, articular surface for the base of the arytenoid. (Luschka.)

The surface of the cricoid is smooth, except that its level is broken by two slight depressions, one on either side of the posterior arch, in which the posterior crico-arytenoid muscles take their origin; and by an elevation between them, which gives attachment to the suspensory ligament of the œsophagus. At the outer aspect of each of the posterior depressions there is a smooth articular facet. These support the corresponding facets on the inner sides of the inferior cornua of the thyroid cartilage, forming the *crico-thyroid articulation.* On the upper surface of the posterior portion of the cricoid cartilages are two articular convex surfaces, looking upward and outward. They articulate with the arytenoid cartilages above. The result of the union is the *crico-arytenoid* joint.

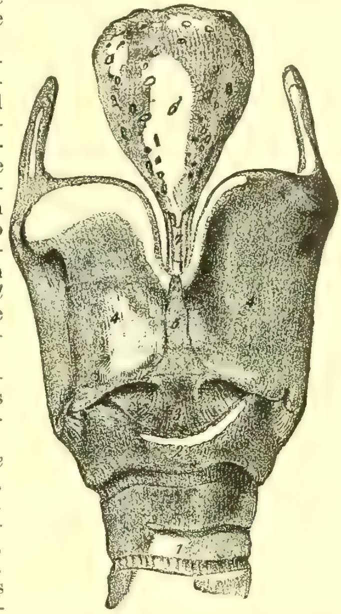

Fig. 2013.—Anterior View of the Cartilages of the Larynx. 1, Upper rings of the trachea; 2, anterior arch of the cricoid; 3, anterior portion of the crico-thyroid membrane (conoid ligament); 4, 4, lateral halves or alæ of the thyroid; 5, median portion of the thyroid; 6, epiglottis; 7, thyro-epiglottic ligament. (Luschka.)

Besides its attachment to the two cartilages above, the cricoid cartilage is bound below, by the general tracheal membrane, to the upper ring of the trachea. Above and in front it is attached to the thyroid by an elastic membrane, known as the *crico-thyroid membrane,* or, more properly, as the *membrana elastica laryngis.* The extensive anatomical relations of this membrane will be noticed farther on.

The *thyroid cartilage* lies above the cricoid, and is supported by it. It is made up of two lateral halves, or wings, the *alæ* of the thyroid. Each lateral half, as will be seen by reference to Figs. 2013 and 2014, is flat, broader behind than in front, and has, projecting upward and downward as continuations of its posterior border, two slender processes, the *superior* and *inferior cornua.* The superior cornu is connected with the greater cornu of the hyoid bone by means of an elastic ligament (Fig. 2016), the thyro-hyoid ligament. This contains, in many subjects, a small, oblong, fibro-cartilaginous mass, known as the *cartilago triticea.* The outer surface of the ala of the thyroid is smooth, and traversed by an oblique line, which, from a point just below the base of the superior cornu, runs downward and forward, marking the limit of attachment of the sterno-thyroid muscle below, and of the thyro-hyoid above. The lateral halves of this cartilage are joined in front at an acute angle, which forms the projecting Adam's apple, or *pomum Adami.* The greater prominence of this point in the neck of the male depends upon the fact that the male larynx is larger than that of the female; and, further, upon the greater fulness of the female neck, because of the superior dimensions of the thyroid gland and the larger amount of subcuta-

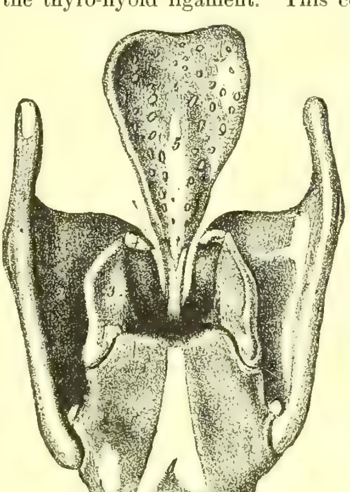

Fig. 2014.—Posterior View of the Cartilages of the Larynx. 1, Broad posterior arch of the cricoid; 2, internal surface of the ala of the thyroid; 3, arytenoid cartilage; 4, corniculum laryngis (cartilage of Santorini); 5, the posterior surface of the epiglottis. (Luschka.)

neous fat in the latter. The inner surfaces of the thyroid are smooth. In the anterior angle there is a slight protuberance, to which are attached the vocal and ventricular bands.

The *arytenoid cartilages* (see Figs. 2014 and 2015), two in number, are of an irregularly conoid form, the inferior surfaces of which are concave, and rest upon the convex facets of the cricoid, so as to form a joint admitting of a rotatory and lateral-sliding movement. From this lower surface three angles project; one inward, toward its fellow of the opposite side; one outward, toward the thyroid, and the third forward, toward the anterior angle of the larynx. The superior angle, or apex of the cone, is turned somewhat inward and backward. The anterior surface of the arytenoid, or that portion between and above the anterior and external angles, is slightly concave, and gives attachment to the thyro-arytenoid muscle, as well as to the ventricular band. The posterior surface is occupied by the arytenoid muscle; while the internal aspect of the cartilage, facing its fellow opposite, is covered by the laryngeal mucous membrane. Attached to the anterior angle is the inferior or true vocal cord, or *vocal band*, as it is more commonly termed by laryngologists. From the fact of its giving attachment to the vocal band, this angle is also called the *vocal process* (see Fig. 2018). The external angle gives attachment, laterally and in front, to the lateral crico-arytenoid, and, posteriorly, to the posterior crico-arytenoid muscle. The superior angle lies in the depths of the submucous tissue of the larynx, and is attached by fibrous tissue to a small, elongated cartilage, called the *corniculum laryngis*, or cartilago Santorinii (Fig. 2014, 4). Above and external to the latter, another small, flattened, cartilaginous cone lies just beneath the mucous membrane of the ary-epiglottic fold.

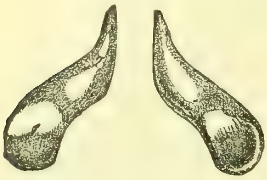

FIG. 2015.—Inferior Surface of the Arytenoids, as seen when the Vocal Bands are Approximated. 1, Articular facet for the cricoid; 2, the anterior angle, or *vocal process*, to which the vocal band is attached. (Luschka.)

These two smaller cartilages have no muscular attachment, but simply serve to support and give permanency of form to the mucous surface of the larynx. The remaining cartilage is the epiglottis. This is shaped somewhat like a leaf, broad above, and tapering to a narrow and somewhat prolonged process at its inferior extremity, which is attached in the retiring angle of the thyroid, just above the insertion of the vocal bands (Figs. 2013 and 2014).

FIG. 2016.—Lateral View (right side) of the Cartilages and Ligaments of the Larynx. 1, Upper ring of the trachea; 2, cricoid; 3, thyroid; 4, the hyoid bone; 5, the thyro-hyoid membrane; 6, the cartilago triticea, embedded in the thyro-hyoid ligament. The crico-thyroid membrane is seen in the interval between the cricoid and thyroid cartilages. (Luschka.)

The cricoid and thyroid cartilages are hyaline in their structure. The arytenoid is hyaline, except at its anterior angle, where the fibres from the vocal band penetrate it and give it, for a short distance behind its extremity, the character of fibro-cartilage. The other cartilages are of the yellow, elastic variety.

The more important ligaments and membranes of the larynx are the following: 1. The *crico-thyroid* membrane (Figs. 2016, 2017, and 2018) is divisible into two parts: The anterior or median portion, the crico-thyroid membrane proper, is composed of elastic tissue mainly, and unites the upper border of the anterior arch of the cricoid with the lower border of the anterior projection of the thyroid. It is the membrane that is felt when the finger is pressed upon the neck just below the *pomum Adami*, and is perforated in the operation of laryngotomy. The lateral portion of this membrane, called more correctly the *elastic membrane of the larynx* (*membrana elastica laryngis*) (Fig. 2017, 6, 7, and 8), is also composed of elastic tissue, but is thinner than the anterior portion. It is attached below to the inner edge of the upper border of the ring of the cricoid. From thence it passes obliquely upward and inward, to be attached anteriorly to the nodular projection in the angle of the thyroid; posteriorly to the anterior angle of the arytenoid. Stretching across the space from one point to the other, it presents a sharp, vibrating edge, which is the vocal band, or true vocal cord. From this sharply folded edge it passes outward again, horizontally, toward the wing of the thyroid, but when it has reached a point about midway between that cartilage and the median line of the larynx, it turns upward and, taking a nearly vertical direction, is spread out below the mucous membrane of the ary-epiglottic fold. It will be seen from this description, and by reference to Fig. 2019, which represents a frontal (vertical-transverse) section of the larynx, that the fellow-membranes approaching one another from opposite sides narrow the cavity of the larynx from below upward, so that, when the vocal bands are approximated, its inferior portion is almost completely cut off. The part of the larynx below this point is known as the inferior or subglottic portion of the larynx. As the membranes again

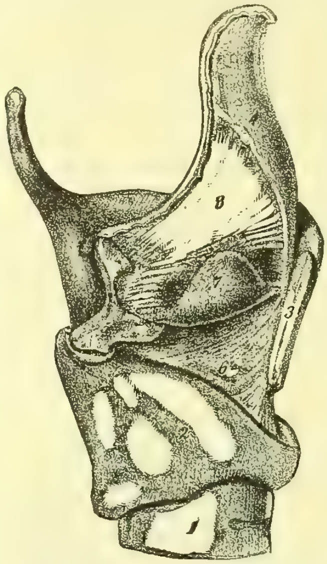

FIG. 2017.—Lateral View of the Larynx, with the Ala of the Thyroid removed, so as to show the *Membrana Elastica Laryngis*. 1, Trachea; 2, cricoid; 3, cut surface of thyroid; 4, epiglottis; 5, arytenoid; 6, the crico-thyroid membrane, arising from the cricoid below, and attached to the anterior angle (*vocal process*) of the arytenoid and the anterior angle of the thyroid; forming, between these points, a sharply cut ligament, the inferior thyro-arytenoid ligament or true vocal cord; 7, indicates the situation of the pouch of the ventricle just above the line of the vocal cord; 8, the superior portion of the elastic membrane (*membrana quadrangularis*), stretching from the arytenoid to the epiglottis. (Luschka.)

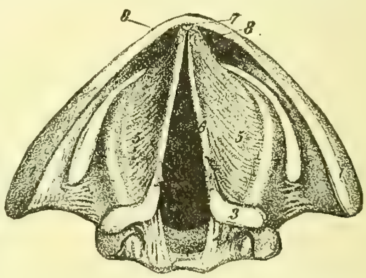

FIG. 2018.—View of the Vocal Bands from above. 3, The arytenoid, to the anterior angle of which the vocal band (6) is attached; 5, crico-thyroid membrane; 7, elevation on the thyroid, to which the vocal bands are attached; 8, 8, sesamoid cartilages in the anterior ends of the vocal bands. (Luschka.)

diverge, their horizontal portions, covered by mucous membrane, form the floor of a middle compartment, the ventricle of the larynx, or ventricle of Morgagni. Again, the secondary ascent of the membrane on either side marks the outer boundary of the upward prolongation, or *pouch of the ventricle.* Between the elastic membrane and the cartilaginous side of the larynx a triangular space is seen, which contains many of the intrinsic laryngeal muscles (see Fig. 2019). 2. The *thyro-hyoid membrane* (Fig. 2016, 5) is a fibro-elastic expansion, stretching from the superior border of the thyroid cartilage to the superior and posterior border of the body and greater cornua of the hyoid bone. By its obliquity it favors the drawing of the thyroid cartilage upward and backward, into the concavity of the hyoid, during the act of deglutition. A synovial bursa is sometimes found in this locality. 3. The *thyro-hyoid ligament* (Fig. 2016, 6) is formed, on either side, by a thickening of the posterior edge of the thyro-hyoid membrane. It unites the extremities of the greater cornu of the hyoid and the superior cornu of the thyroid. For a minute description of the joints and lesser ligaments of the larynx the reader is referred to the works of Merkel, Luschka, and Henle.

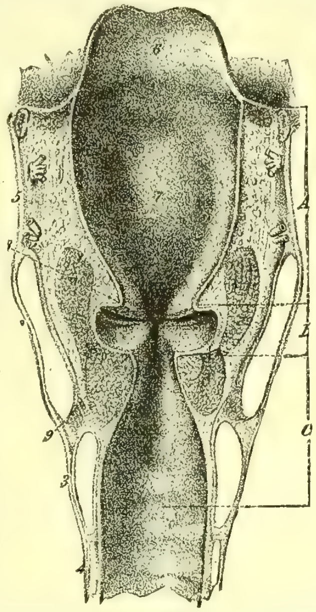

FIG. 2019.—Frontal Section of an Undissected Larynx. The three divisions of the larynx are marked off by the straight dotted lines on the right side of the figure. *A*, The superior compartment, extending from the ary-epiglottic folds to the superior vocal cords (ventricular bands); *B*, the cavity of the ventricle, bounded above by the superior vocal cord, below by the inferior or true vocal cord, and externally by the elastic membrane of the larynx; *C*, the inferior or subglottic compartment, extending from the true vocal cord to the inferior border of the cricoid cartilage; 8, edge of the superior vocal cord; 9, edge of the inferior vocal cord. Below the true vocal cord is seen the *thyro-arytenoideus* muscle.

The *muscles* of the larynx are so arranged as to accomplish the double object of producing vocal sounds and closing the entrance to the trachea during deglutition. Those which serve the latter purpose are, as has been pointed out by Henle, so disposed as to make a sphincter at the entrance to the larynx. Besides those which are easily dissected, and receive names in the anatomical text-books, there are numerous bundles of fibres running in various directions, and more or less inconstant in their presence. The great variety in these accessory fibres, and, indeed, in the more distinct internal muscles of the larynx, probably has much to do with the differences in voices.

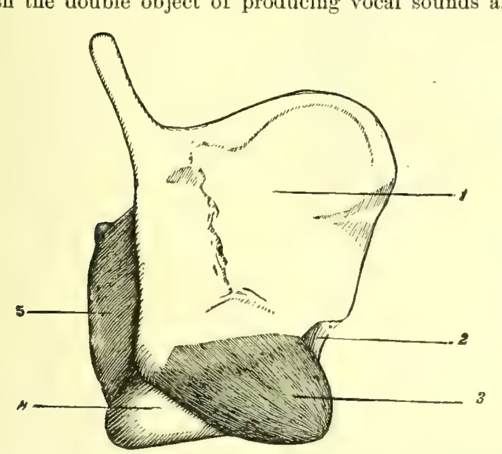

FIG. 2020.—Lateral View of the Larynx, showing the Crico-thyroid and Posterior Crico-arytenoid Muscles. (Drawn by Dr. A. H. P. Leuf.) 1, Thyroid; 2, crico-thyroid membrane (conoid ligament); 3, crico-thyroid muscle; 4, posterior portion of the cricoid cartilage; 5, lateral view of the posterior crico-arytenoid muscle.

The muscles which we shall describe are the crico-thyroid; crico-arytenoid, lateral and posterior; thyro-arytenoid, internal and external; thyro-epiglottideus; arytenoideus; aryteno-epiglottideus.

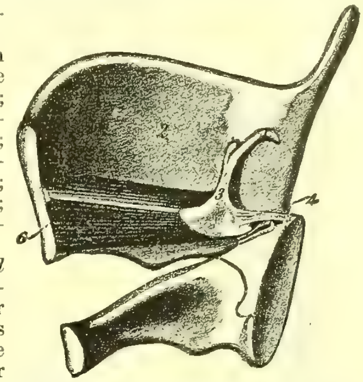

FIG. 2021.—Internal View of the Laryngeal Cartilages, with Everything Removed except the Edge of the Vocal Band, and the Thyro-arytenoideus Muscle. 3, Arytenoid cartilage; 6, vocal band. It will be seen that, if the thyroid be rotated downward on its inferior cornu (indicated by the dotted line), the vocal band will be put upon the stretch. (Luschka.)

The *crico-thyroid* (see Fig. 2020), situated on the exterior of the larynx, takes its origin from the upper lateral border of the cricoid cartilage. The anterior fibres, called by Henle, *crico-thyroideus rectus*, pass almost directly upward, to the lower border of the thyroid. The mass of fibres arising farther back from the side of the cricoid, *crico-thyroideus obliquus*, take a very oblique direction, upward and backward, to the inferior margin of the thyroid, some extending as far backward as the inferior cornu. The action of this muscle is to draw the thyroid cartilage forward, and, at the same time, to depress its anterior portion, rotating it upon the articulation between its inferior cornu and the cricoid. A glance at Fig. 2021 will make it evident that, as the axis of rotation lies below the level of the posterior end of the vocal band, this motion will increase the distance between its anterior and posterior attachments, and tighten the cord. The crico-thyroideus is, then, a tensor of the vocal bands, and an important factor in phonation.

This statement corresponds with the descriptions given in most of the standard anatomical text-books. It is held, however, by some, and notably by Dr. Franklin H. Hooper, of Boston ("Transactions of the American Laryngological Association," 1883, p. 118), that, instead of drawing the thyroid downward, this muscle draws the cricoid upward. The effect upon the vocal bands is the same. The acceptance of Dr. Hooper's views need not involve any change in the anatomical nomenclature.

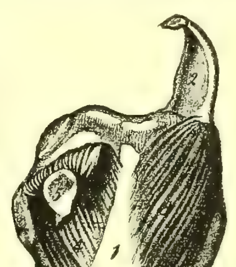

FIG. 2022.—Cricoid Cartilage, Posterior View, with the Right Arytenoid *in Situ*, the Left Removed. 3, Right *crico-arytenoideus posticus*. 4, Left. Its point of attachment to the external angle of the arytenoid is turned back, showing the inferior surface of that portion of the cartilage (5). (Luschka.)

The *posterior crico-arytenoid* muscle (see Fig. 2022), arises from the depression on the broad posterior portion of the cricoid cartilage. Its fibres converge to the outer angle (*processus muscularis*) of the arytenoid. The lateral crico-arytenoid muscle (Fig. 2023) arises from the upper lateral border of the cricoid, internal to the origin of the crico-thyroid. Its fibres, also, converge to their insertion into the external angle of the arytenoid cartilage. These two muscles, one of which arises anteriorly and laterally, the other posteriorly, but with the same point of insertion, are physiological opponents. While the posterior crico-

arytenoideus draws the external angle of the arytenoid cartilage backward, rotating it so as to carry the anterior angle outward and open the glottis; the lateral crico-arytenoideus does exactly the reverse, draws the external angle forward, rotating the anterior angle inward and closing the glottis.

FIG. 2023.—Right Lateral View of a Dissected Larynx. The Ala of the Thyroid is Removed. 1, Cricoid; 2, thyroid; 3, arytenoid; 4, epiglottis; 5, hyoid bone; 6, posterior crico-arytenoid muscle; 7, aryteno-epiglottideus muscle; 8, the lateral crico-arytenoideus; 9, thyro-arytenoideus. The other fibres, seen running in various directions, are inconstant in their distribution. (After Luschka.)

The accompanying diagrams (Figs. 2024 and 2025), drawn by Dr. A. H. P. Leuf, illustrate the action of these muscles, and of the arytenoideus, on the glottis.

The posterior crico-arytenoid muscle is one of the most important in the body. Its function is to keep the chink of the glottis open during the act of inspiration, so that it must contract from sixteen to twenty times a minute during the life of the individual. Dr. Franklin H. Hooper found, as a result of an elaborate series of experiments in the physiological laboratory of the Harvard Medical School,[1] that when animals were killed by the administration of chloroform, the *crico-arytenoideus posticus* was the last of the laryngeal muscles to lose its vital irritability. This action, as stated above, is not of primary importance, but is rendered necessary by the phonatory mobility of the vocal bands.

The *thyro-arytenoid* muscles (Figs. 2021 and 2023) take their origin from the internal surface of the thyroid carti-

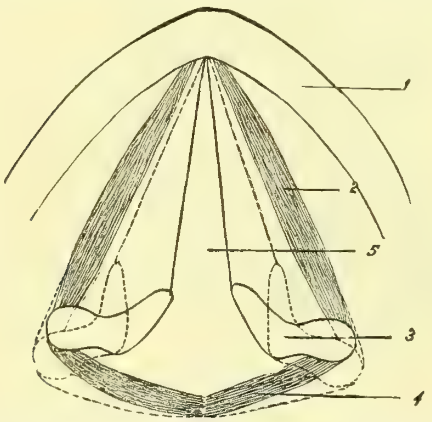

FIG. 2024.—Diagram to Show the Movements of the Arytenoid Cartilages and their Effect upon the Glottis. 1, Section of thyroid; 2, thyro-arytenoideus externus and lateral crico-arytenoideus; 3, arytenoid cartilages; 4, arytenoideus muscle; 5, chink of the glottis. The dotted lines show the position of the cartilages and vocal bands when the glottis is opened (action of the posterior crico-arytenoids). The uninterrupted lines show their position when the lateral crico-arytenoids contract and approximate the vocal processes. This action affects the anterior portion of the glottis only.

lage, just outside the anterior attachment of the vocal band. The thyro-arytenoideus internus lies in the angle made by the folding outward of the elastic membrane of the larynx, at the level of the vocal band (see Fig. 2019). It lies under the floor of the ventricle, and its inner edge is closely connected with the vocal cord, to the fibres of which many of its own fibres are attached, so that in dissecting it out we are obliged to divide many fibres which take their origin from, or are inserted into, the fibrous tissue of the cord. Its posterior extremity is inserted into the anterior angle and surface of the aryte-

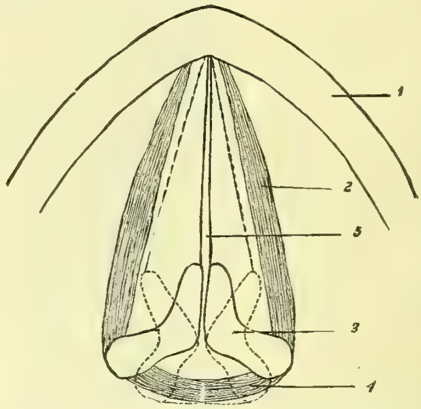

FIG. 2025.—Diagram designed to Show the Mechanism of the Closure of the entire Rima Glottidis. The numbers are the same as in Fig. 2024. The difference between the two figures is that in Fig. 2025 the arytenoideus has contracted, drawn the arytenoids together, and closed the posterior portion of the glottis.

noid cartilage, just external to the attachment of the vocal cord. This muscle is the direct opponent of the crico-thyroid; whereas the latter, by its contraction, so tilts the thyroid cartilage as to increase the distance between the anterior and posterior extremities of the vocal band, the internal thyro-arytenoid approximates these points, shortens the band, and relaxes it.* The external thyro-arytenoid is inserted farther out upon the anterior surface of the arytenoid cartilage, and, by its contraction, helps the lateral crico-arytenoid muscle in closing the glottis. It may be that this muscle varies its action sometimes, and assists in the shortening of the cords. Or it may combine with the crico-arytenoideus lateralis and the internal thyro-arytenoideus, so as to assist, both in shortening and adduction.

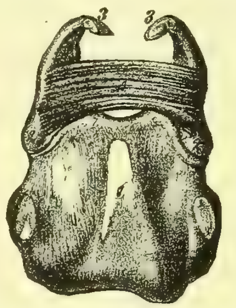

FIG. 2026.—Posterior View of the Cricoid and Arytenoid Cartilages, showing the Attachment of the Arytenoideus Muscle. 1, Cricoid; 2, arytenoid; 3, corniculum laryngis; 4, arytenoideus muscle. (Luschka.)

The *thyro-epiglottideus* (Fig. 2023) is a band of fibres passing upward from the internal surface of the thyroid cartilage, just outside of the attachment of the thyro-arytenoidei. They spread out in that portion of the elastic membrane which extends upward from the ventricle into the ary-epiglottic fold (*membrana quadrangularis*), and are attached to the side of the epiglottic cartilage.

The action of this muscle is to draw the epiglottis downward in deglutition, or in the contraction by which the larynx is closed against the accidental introduction of foreign bodies, and in vomiting.

The *arytenoideus* (see Fig. 2026) is a strong bundle of transverse muscular fibres attached at either end to the posterior surface of the arytenoid cartilage. Its action is to draw the cartilages toward one another and close the posterior portion of the glottis.

The *aryteno-epiglottideus* muscle consists of a few com-

* This is the apparent action of the muscle when it contracts as a whole, but there is good reason to believe that, by the contraction of certain of its bundles, it regulates the tension of the vocal bands in phonation. This will be more fully explained in the article on Voice and Speech.

paratively slender bundles, which, taking their origin from the external angle (*processus muscularis*) of the arytenoid cartilage, pass obliquely upward across the arytenoideus muscle to the opposite side of the larynx, where they are traced upward into the ary-epiglottic fold, and as far forward as the epiglottis (see Figs. 2023 and 2028). A few bundles may be inserted into the *corniculum laryngis*, and others pass downward and forward along the outer side of the pouch of the ventricle, to be inserted into the thyroid cartilage near its anterior angle. These latter fibres, which, by their contraction, are thought to compress the ventricle and expel its contents, were called by Hilton the *compressor sacculi laryngis*. The action of this muscle is to draw together the ary-epiglottic folds and arytenoid cartilages, and, in conjunction with the arytenoideus and thyro-epiglottideus, to close the entrance to the larynx.

Henle groups the fibres described here under the names aryteno-epiglottideus and thyro-epiglottideus, under the general name *thyro-ary-epiglotticus*. They vary considerably in different subjects.

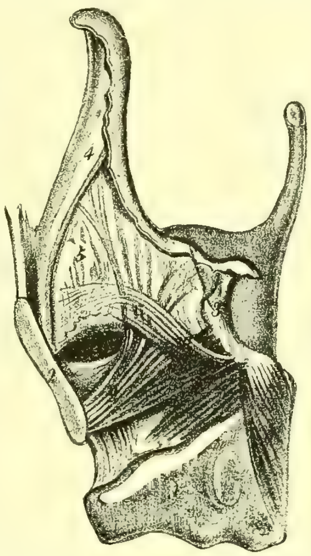

FIG. 2027.—Lateral View of the Laryngeal Muscles. 1, Cricoid; 2, thyroid; 3, arytenoid; 4, epiglottis; 5, elastic membrane of the larynx; 6, posterior crico-arytenoid; 7, lateral crico-arytenoid; 8, thyro-arytenoid; 9, thyro-epiglottideus; 10, fine fibres spreading out in the elastic membrane (*ary-membranosus*). (Luschka.)

All the muscles of the larynx, with the exception of the *crico-thyroid*, are supplied by the inferior laryngeal branch of the pneumogastric nerve. The cricoid-thyroid is supplied by its superior branch.

The *mucous membrane* of the larynx is loosely attached, except on the epiglottis and true vocal cords.

The folds which extend from the sides of the epiglottis backward to the arytenoid cartilages are called the *ary-epiglottic* folds (see Figs. 2019 and 2028). At their posterior extremities are seen two eminences, which indicate the site of the cartilages of Santorini. Their movements of abduction and approximation, seen in a laryngoscopic examination, correspond to the lateral sliding movements of the arytenoids. Just in front of, and external to these, two other eminences are seen, formed by the cartilages of Wrisberg. In the vicinity of the cartilages, and in the inter-arytenoid space, are collections of racemose mucous glands.

Two other shorter and thicker folds pass outward from the sides of the epiglottis to the pharyngeal wall (Fig. 2028). They are the pharyngo-epiglottic folds. In them, according to Henle, fibres of the *palato-pharyngeus* muscles sometimes pass downward and interlace with fibres from the aryteno-epiglottidei. Three other folds of the mucous membrane connect the epiglottis to the tongue. They form the glosso-epiglottic ligaments (Fig. 2028).

Below the ary-epiglottic folds the mucous membrane, as it covers the muscles of the larynx, approaches the median line, and finally becomes firmly attached, by means of the fibrous tissue in the submucous layer, to the anterior angle of the thyroid cartilage in front, and to the anterior edge of the arytenoid behind. Between these points it stretches as a crescentic band, the *ventricular band*, or false vocal cord. The best idea of the mode of its formation can be derived from the study of the frontal section of the larynx, shown in Fig. 2019. Below the ventricular band, the mucous membrane is turned in, and lines the cavity of the ventricle. In this situation the mucous glands are very large and numerous, serving to keep the membrane moist in this narrow part of the larynx, where the friction of the air, especially during phonation, is very great. On the surface of the true vocal cord, the mucous membrane is very thin, consisting mainly of epithelium and basement membrane, with very little submucosa. It is closely adherent, and does not become œdematous in submucous laryngitis and in anasarcous conditions, as the other parts do. The mucous glands of the epiglottis lie in the little depressions and holes by which it is marked. Many of the larger ones are in the connective tissue anterior to the epiglottis. Their ducts penetrate the cartilage. On either side of the

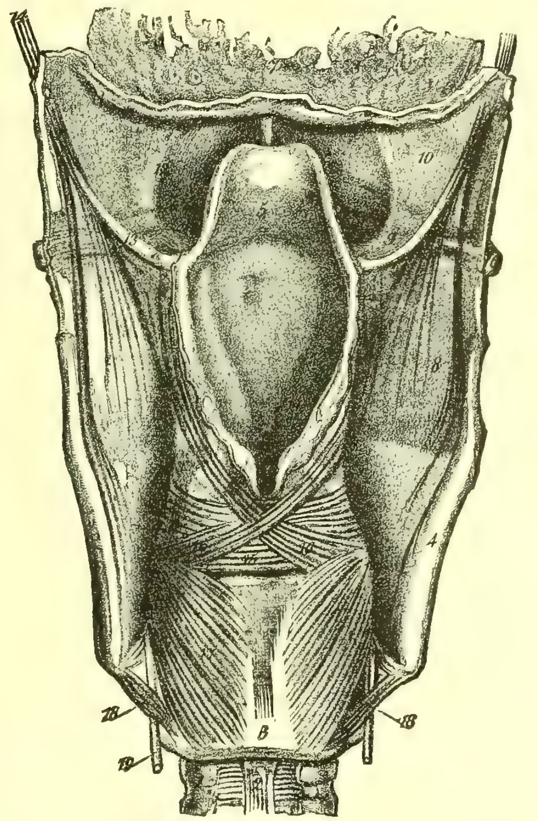

FIG. 2028.—Posterior View of the Larynx. The pharynx and mucous membrane are removed. 1, Trachea; 2, posterior crico-tracheal ligament; 3, cricoid; 4, posterior border of the thyroid; 5, epiglottis; 6, great cornu of the hyoid bone; 7, root of the tongue; 8, thyro-hyoid; 9, hyo-epiglottic membrane; 10, hyo-glossal membrane; 11, middle glosso-epiglottic ligament; 12, lateral glosso-epiglottic ligament; 13, pharyngo-epiglottic fold; 14, stylo-laryngeus muscle; 15, arytenoideus muscle; 16, 16, crossing bundles of the aryteno-epiglottideus (*constrictor vestibuli laryngis*); 17, posterior crico-arytenoideus muscle; 18, 18, a few slender bundles, crico-thyroideus, posticus, or kerato-cricoideus of Merkel; 19, inferior laryngeal nerve. The ary-epiglottic folds are seen reaching from the sides of the epiglottis to the arytenoid eminences, and bounding the superior orifice of the larynx, the *vestibulum laryngis*. (Luschka.)

entrance to the larynx, the mucous membrane dips down between the arytenoid cartilages and ary-epiglottic folds, and the alæ of the thyroid, forming a sulcus or cavity, the sinus pyriformis (Fig. 2028).

The laryngeal mucous membrane is covered by pavement epithelium, from the entrance downward, as far as the middle of the epiglottis and the ventricular bands (superior vocal cords). Below this it is covered by cylindrical ciliated epithelium, except in the inter-arytenoid space, where the pavement epithelium of the pharynx dips over into the larynx; and on the true vocal cords, where it is also of the squamous variety.

The vocal bands deserve a separate notice on account of their great physiological importance. They consist of

bands of elastic tissue, formed by the thickened inner borders of the crico-thyroid membranes, and are attached posteriorly to the vocal processes of the arytenoid cartilage, and anteriorly to the ridge or nodule in the angle of the thyroid. This nodule is made up of connective tissue, and has, arising from its outer sides, some of the fibres of the internal thyro-arytenoid muscles. In the substance of the vocal band, near its anterior extremity, is a small elastic cartilaginous nodule, the sesamoid cartilage (see Fig. 2029). It is not always present.

At its posterior extremity the fibres of the vocal cord penetrate the vocal process of the arytenoid, giving to this part the character of fibro-cartilage. The physiological action of the vocal bands in singing and speaking will be fully described in the article on the Voice and Speech.

The larynx derives its vascular supply from the lingual and superior thyroid arteries. Its lymphatics are very numerous, and the submucous network exceedingly close. They communicate with the submaxillary and anterior cervical glands.

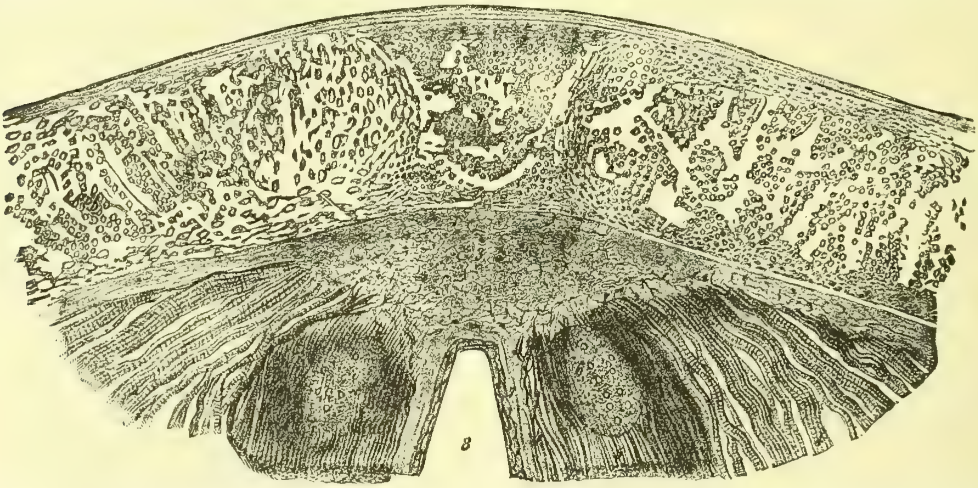

Fig. 2029.—Transverse Section of the Thyroid Cartilage at the Level of the Attachment of the Vocal Bands, and Origin of the Internal Thyro-arytenoideus Muscle. (Magnified 20 diameters.) 1. Median lamina of the thyroid ; owing to the difference in structure between this and the lateral plates, 2, as seen in the arrangement of the cartilage-cells, it separates from them after maceration, and the cartilage falls into three parts ; 3, fibro-cartilaginous nodule ; 4, internal thyro-arytenoideus muscle ; 5, elastic tissue of the vocal band ; 6, cartilaginous nodule in the substance of the vocal band ; 7, mucous membrane of the vocal band ; 8, anterior extremity of the rima glottidis. (Luschka.)

The mucous membrane of the larynx is supplied with sensory filaments from the superior laryngeal branch of the pneumogastric nerve.

The physiology of vocalization will receive separate and more thorough treatment in the article on Voice and Speech.

Benjamin F. Westbrook.

LARYNX, BENIGN TUMORS OF. History.—Pre-laryngoscopic records furnish but few instances in which intra-laryngeal neoplasms were discovered and successfully removed during the life of the patient ; a few cases, in which a tumor, either located high up in the larynx or attached by a long pedicle, so that the tongue being depressed, they came into view in the mouth and were thence removed, are known to us. The majority, then, were first discovered upon the post-mortem table, the rational signs to which they had given rise during the lifetime of the patient having usually remained unrecognized or unappreciated. When Middeldorpf, in 1854, collected the histories of all the cases then on record, 64 in number, it was shown that in 9 of them only had any attempt been made to remove the neoplasm. To Kaderik, in 1750, is ascribed the credit of the first operation *per vias naturales.* Seventeen years later Lieutard details the histories of two undoubted cases. Brauers, in 1833, attempted to remove a laryngeal polypus by thyrotomy ; and Regnoli, in 1836, succeeded, after a preliminary tracheotomy, in extirpating a growth through the mouth and throat. Ryland follows, with a description of laryngeal tumors in his classical work ; and after a long interval Ehrmann's celebrated treatise appeared, in 1850, including 31 cases. To these, in 1851, Rokitansky added 10, and, as Morgagni and Lieutard had done in earlier times, contributed much to the then existing anatomical and pathological knowledge of the subject. Green, in 1852, with 39 cases ; Buck, in 1853, with 49 ; and, finally, Middeldorpf, in 1854, with 64, quickly followed, and brought the then existing experience down to the date (1858) of the introduction of the laryngoscopic mirror into practice. The subject, from this time onward, assumes an entirely new phase ; its historical interest ceases, while the practical increases. The rapid development of special knowledge, the immense increase in the number of laryngeal growths discovered—an increase which renders all attempts at a correct computation to-day impossible—and, finally, the impetus given to intra-laryngeal surgery by the success of Bruns in removing a fibroma of the larynx by the natural passages, with the aid of the mirror, in 1861, have all been the natural outcome of the discovery of this diagnostic and therapeutic means.

Frequency.—Notwithstanding the fact that laryngeal growths have been proved to occur with greater frequency than was formerly supposed, they constitute but a small proportion of the chronic diseases of the larynx—not more, it is estimated, than two and a half per cent.

Etiology.—The etiology of neoplasms of the larynx is most uncertain and undecided. Chronic catarrh of the mucous membrane is regarded by all authors as the most fruitful cause ; but it is difficult to understand why, if this be true, the proportion of laryngeal growths met with in practice is not much greater, chronic catarrh being the commonest form of laryngeal disease. In all probability it is the result rather than the cause in cases of intra-laryngeal tumor.

Equally problematical is the influence of the exanthemata as a factor in the subsequent production of laryngeal neoplasms through the chronic inflammation of the larynx which they excite.

Mechanical irritation of the membrane of the vocal cords and larynx from overuse, prolonged use, and strain of the voice, as with clergymen, public speakers, etc., has been ascribed as a cause ; but, as a matter of fact, tumors of the larynx are not seen in this class of persons with any more frequency (with the exception of singers) than in others. The experience of all laryngologists has taught them, in short, that growths may form with apparently absolute healthy surroundings, and that continued irritation, even extreme old-standing chronic inflammation, may be present without leading to the development of

any new-formations. Tubercular disease and syphilis do not predispose to the development of true laryngeal neoplasms. Epithelial thickenings and granulation tumors may form about the margin of ulcers, especially in the posterior commissure of the larynx, but these cannot be confounded with true neoplasms.

A "polypoid diathesis" is considered by the French school as a predisposing cause, one that evinces itself by the development on other regions of the body, such as the hands, feet, eyelids, etc., of papillomata.

Heredity as a cause rests upon insufficient data to be regarded as proved.

A number of observers—relying mainly upon the character of the voice—hold to the possibility of the congenital origin of intra-laryngeal tumors.

The influence of sex is of importance. Men, more exposed by occupation, etc., than women, are more apt to be affected. Age also has its predisposing influence. The period from twenty to fifty is the most favorable for the development of neoplasms. After fifty their occurrence is very rare. More commonly are they seen in the form of papillomata in early childhood.

SYMPTOMS.—The symptoms which indicate the presence of a tumor in the larynx vary very greatly, but usually the ones that alone are of importance are those concerning, first, alterations in the voice; second, and more rarely, interference with respiration. Other symptoms usually ascribed to the presence of a tumor in the larynx, such as pain, cough, interference with deglutition, etc., are practically rarely met with.

Phonation is more or less interfered with in all cases, always when the growth is located upon the vocal cords. Here its site, mode of attachment, and size play important *rôles*. It can readily be understood that a tumor on the edge of the vocal cord will create more disturbance in vocalization than one located on its upper surface, for instance; or a growth of a given size will interfere more with the accurate approximation of the vocal cords, and hence with the voice, if located just in the anterior commissure than if it be in the posterior one. A growth below the vocal cords creates less vocal disturbance than one above, a pedunculated growth less than a sessile one, and, naturally, a smaller less than a larger one.

Interference with normal phonation, it will thus be seen, depends more upon the seat of the tumor than upon its size. In harmony with these differences in location and size will the voice be altered in various ways, between the extremes of mere change in tone or quality and a hoarse whisper or even absolute aphonia.

In benign tumors of the larynx dyspnœa is rarely encountered. A growth can only cause mechanical obstruction when large, and, aside from papillomata, they never attain a size sufficient to produce it. In adults even the latter seldom cause much interference. In children with small larynges dyspnœa is not infrequently encountered. In the latter, also, and occasionally with adults, even a small growth, pedunculated or not, may cause sudden attacks of dyspnœa, by provoking laryngeal spasm, in consequence of local irritation. In such cases the temporary stridor and dyspnœa may be considerable, but the spasm very seldom leads to a fatal issue.

Both mechanical dyspnœa and spasm of the glottis are naturally more apt to occur in such cases as above indicated when the tumor is located in or near the glottic aperture.

A growth that is located high up in the larynx, in the region of or upon the epiglottis, may, if it be large, interfere slightly—never, in the case of benign growths, seriously—with the act of deglutition; practically such cases are rarely, if ever, met with. Constitutional symptoms are not, as a rule, of any moment, except in the case of young children with large papillomata interfering seriously with respiration, and thus producing the train of symptoms associated with non-aëration of the blood.

PATHOLOGY.—Although a number of varieties of benign tumors of the larynx are described by various authorities, in reality but few forms are encountered in practice, and no good purpose can be subserved by enumerating and describing neoplasms which very seldom occur, about the true pathological nature of which there is room for difference of opinion, or of which isolated examples alone exist in literature.

Papillomata, fibromata, and cystic growths are the forms most commonly met with, and are those which will here be considered.

Lipomatous, myxomatous, adenomatous, and angiomatous growths, as well as ecchondroses, may, on account of their great rarity, and in some instances questionable authenticity, be practically dismissed from all consideration, as far as the general practitioner is concerned. In order of frequency, papillomata assume the first rank, not only in adults, but especially in children; they vary greatly in size, from a millet-seed to a walnut. Their most common situation is on the anterior two-thirds of the vocal cords, on the ventricular bands more rarely, and they are uncommonly seen in the posterior commissure or upper portions of the larynx. On the epiglottis they are never forthcoming. Clinically, three varieties of papillomatous tumor are met with: The first class consists of numerous small, light-red tumors, of uneven surface and broad base, generally thinly scattered, and never of great size. After removal, their recurrence is unusual. The second variety is the whitish-grey, papillary, warty tumor, seated upon a broad base, and springing usually from the vocal cords. It recurs very slowly after removal, if at all. The last form, and the most intractable as regards recurrence, as well as the most dangerous on account of possible epitheliomatous degeneration taking place, is the large reddish tumor, single or multiple, resembling the cauliflower or mulberry growth, growing rapidly, and invading all parts of the lower laryngeal cavity.

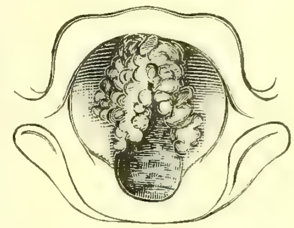

FIG. 2030.—Papilloma. (From an original drawing.)

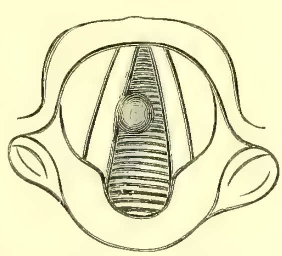

FIG. 2031.—Hard Fibroid. (From an original drawing.)

Histologically, papillomata are simply collections of enlarged papillæ, composed of connective tissue, plentifully supplied with capillary vessels, and covered by epithelium.

Fibromata, the second class of growth in order of frequency, are usually round or oval, red in color, hard or soft in consistency, and may, but rarely, be pedunculated if of the hard variety. The surface is smooth, and they always occur singly in the larynx, upon the vocal cords, and grow very slowly. After their removal there is no tendency to recurrence.

Histologically, the hard fibroid tumor is made up of interlacing bundles of white elastic tissue, and generally covered by several epithelial layers. The soft fibromata are largely made up of more or less perfectly developed fibro-cellular tissue, diffused through the meshes of which is a quantity of serum-like fluid. Both have an epithelial covering. The vascular supply of either is but slight.

Cystic growths in the larynx never, or very rarely, attain a large size. On the lingual face of the epiglottis, their favorite seat, they not infrequently are seen having the size of a pea, in a few instances that of a hazel-nut. Their color is yellowish or white. They have dense walls, and are filled with a thick, white, semi-

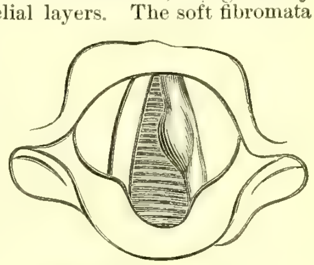

FIG. 2032.—Soft Fibroid. (From an original drawing.)

fluid material, when located upon the epiglottis. If upon the vocal cords, they are always seen upon the free edges, and they have thinner, more delicate walls, while their contents are more fluid and transparent. Spontaneous rupture of the little sac is not unusual in the latter locality. Cystic growths, thoroughly laid open and their contents emptied, show no tendency to recurrence.

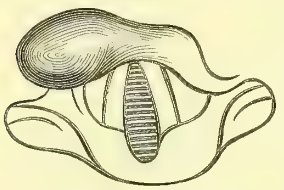

Fig. 2033.—Cyst of Epiglottis. (From an original drawing.)

Histologically, they belong to the class of retention-cysts.

Diagnosis. — There can be but little room for doubt as to the pathological nature of an intra-laryngeal neoplasm of the varieties here enumerated if the laryngoscopic mirror be used.

The reddish, warty papilloma cannot readily be confounded with the small, hard or soft, bright red, and smooth fibroid ; nor the latter with the white or yellow, round, smooth cyst (see accompanying illustrations). The rarer forms of laryngeal growths that have been alluded to are so infrequent, and their appearances vary so greatly, that room for doubt must always exist, even to the expert eye, as to their true nature, should they be seen ; but even so, they cannot be confounded with the typical and unvarying features of the neoplasms above described. The same is true of the irregular and but slightly elevated condylomata seen in laryngeal syphilis. Gummata are evidently deposits in the mucous membrane or submucous tissues, not outgrowths on the former. The thickening of laryngeal phthisis has none of the circumscribed definition of a laryngeal tumor, while the rapid growth, dense infiltration of surrounding tissues, ulceration, and displacement of parts by a malignant tumor serve to distinguish it in its later stages from the benign forms of growth, even did corroborative clinical and physical evidence fail to assist in elucidating a problem here sometimes in the earlier stages of the cancerous growth confessedly difficult.

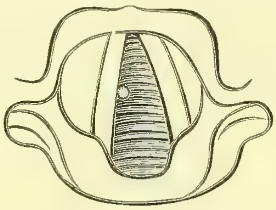

Fig. 2034.—Cyst of Vocal Cord. (From an original drawing.)

Prognosis.—In the benign forms of laryngeal tumor the prognosis in adults as regards life is rarely a matter for serious consideration. The growth can be, in the great majority of instances, removed *per vias naturales* without danger, and even, with the use of cocaine, with but little discomfort to the patient. This rule is a general one, and there are but few exceptions to it.

In children the prognosis, as regards life, is less favorable, the diagnosis is not so easily made, and any manipulations within the larynx which presuppose the co-operation of the patient are much more difficult of execution than in the adult. Moreover, the larynx is small and much more quickly occluded by the tumor, which is usually a papilloma, and often of rapid growth ; the tendency to laryngeal spasm and to acute inflammation is also greater in the young larynx. For these reasons, then, if the tumor is to be removed, the extra-laryngeal methods of operating must usually be chosen, and the additional risks attendant upon any serious surgical operation must thus be incurred, factors which militate seriously against the life of the little patient.

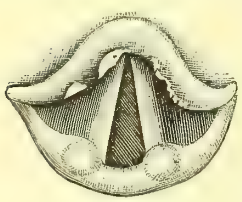

Fig. 2035.—Condylomata of the Larynx. (Mackenzie.)

The prognosis as regards restoration of voice depends largely upon the character, situation, size, and number of the laryngeal tumors, and especially upon the question of whether they can be extirpated through the mouth or not. If in the adult the growth be single, small, and pedunculated, and located so as to be easily reached by instruments introduced through the mouth, the chances are decidedly in favor of full restoration of voice following their extirpation ; but if, on the other hand, the growths are multiple, sessile, and not clearly defined, still more if they be unfavorably situated, as in the anterior parts of the larynx, below the vocal cords, etc., the difficulty of their thorough removal is greatly increased, and the chances of voice-restoration correspondingly decreased. The question of the recurrence of the growth must always, also, be borne in mind in deciding that of prognosis.

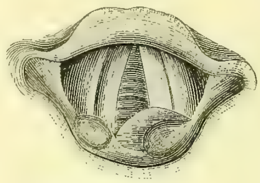

Fig. 2036.—Gumma of the Larynx. (Mackenzie.)

In young children, as has been stated, the extra-laryngeal method of operating must usually of necessity be chosen. Thyrotomy, requiring a division of the vocal cords at their anterior commissure, lessens the chances of restoration of the normal voice, but does not by any means preclude it either in children or in adults. Palliative treatment, in cases of benign laryngeal growth, is so rarely called for, and is in itself so unscientific, that it requires no consideration ; a radical treatment, in the light of our present knowledge, is universally demanded.

Treatment.—There are but few exceptions to the rule, that, an intra-laryngeal neoplasm having been proven by means of the laryngoscopic inspection to exist, it should be carefully and thoroughly removed at once. The exceptions concern small growths on the epiglottis and ventricular bands, which occasion no inconvenience and which have been proven, by repeated examinations, to remain quiescent as regards their growth. Thus small warty tumors, after attaining a certain size in these localities, undergo not infrequently no further development. Small fibromata upon the vocal cords are sometimes seen, which occasion little or no interference with phonation. They grow very slowly, and are commonly arrested in their development. To interfere, therefore, in such cases, simply because a growth exists, is uncalled for.

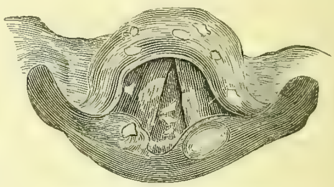

Fig. 2037.—Laryngeal Phthisis, showing Great Thickening, with Scattered Ulcers. (Mackenzie.)

The general rule, however, as above stated, holds good for the following reasons : Interference with phonation usually requires that the growth be removed. A small growth is often much more easily removed than a large one, and the chances of removing it, without serious injury to the delicate structures by which it is surrounded, or upon which it is seated, if sessile, are better the smaller the tumor. A tumor of benign type, occurring in an elderly person, may at a later period develop evidences of malignancy, and, finally, sudden and dangerous dyspnœa may occur (at a time when skilled assistance is not available) in consequence of a sudden increase in the size of the tumor, which quickly assumes renewed and increased activity of growth, or from some intercurrent affection, such as acute laryngitis, œdema, or spasm of the glottis. The removal of the laryngeal tumor having been decided

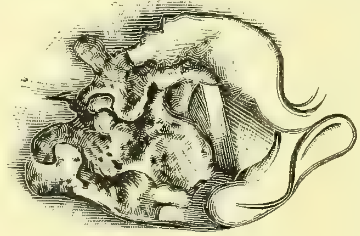

Fig. 2038.—Epithelial Cancer. (From an original drawing.)

upon, the means and method require consideration. Practically, there is but little difference of opinion. The laryngeal forceps (Mackenzie-Gottstein) are commonly employed by the majority of operators, and certainly subserve the best purpose in the largest number of cases. Well warmed, they are introduced by the trained hand, under the guidance afforded by the laryngoscopic mirror and artificial illumination, into the larynx, which has been thoroughly anæsthetized by the use of a solution of cocaine. The growth being seized, it is torn, in whole or piecemeal, or crushed, from its base, and removed within the blades of the forceps. Several sittings may be necessary to effect the removal of a large growth. Complete, thorough extirpation should always be aimed at, and effected if possible.

Under certain circumstances, as has been stated, *i.e.*, in small children, such an operation is impracticable, and the larynx must be opened from without, to permit of the thorough removal of the neoplasm. The latter course is also necessary in cases where the growth in adults is located below the vocal cords, and is thus inaccessible by the mouth; and again, in cases where it is of great size and springs from many points within the laryngeal cavity, besides being firmly attached with a broad base to the underlying tissues, and cannot thus be removed by the natural passages without great laceration and damage to the laryngeal structures.

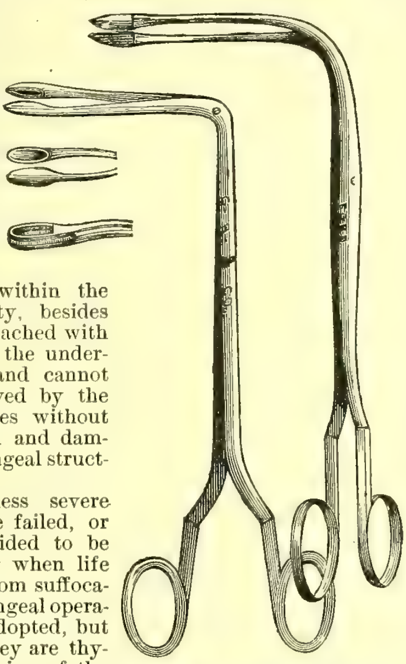

Fig. 2039.—Laryngeal Cutting Forceps. (Mackenzie.)

When the less severe operations have failed, or have been decided to be inapplicable, or when life is in danger from suffocation, extra-laryngeal operations may be adopted, but then only. They are thyrotomy, or division of the thyroid cartilage alone; complete laryngotomy, or division of the thyro-hyoid membrane and thyroid and cricoid cartilages, even the upper rings of the trachea; sub-hyoidean pharyngotomy, *i.e.*, transverse section of the thyro-hyoid membrane; and, finally, section of the middle crico-thyroid ligament. Of these, the ones commonly employed are the first two, the choice between which will depend upon the size and particular location within the larynx of the growth to be removed, and the amount of space required for manipulation. Sub-hyoidean pharyngotomy affords only limited space, and is rarely indicated. Mesochondric laryngotomy, the last procedure alluded to, may be employed for the removal of small tumors located below the vocal cords, and sometimes subserves a good purpose.

The details of the surgical steps involved in these procedures will be found in the works on General Surgery.

NOTE.—Drawings Nos. 2030, 2031, 2032, 2033, 2034, and 2038 are original, and taken from life sketches by the author.

George M. Lefferts.

LARYNX, BURNS, SCALDS, AND INJURIES OF. Severe acute inflammation of the larynx, involving the submucous areolar tissue, may follow the swallowing of very hot liquids, and of corrosive poisons, the inhalation of flame or of highly heated air, or the impaction of a foreign body.

The pathological condition commonly met with in the first three accidents above named is, practically, acute laryngeal œdema; and, although from the youth of the patient, the hyperæsthesia of the parts, or the urgency of the symptoms, a laryngoscopic examination will often be impracticable, the congestion of the fauces, on the other hand, the rapidly increasing dyspnœa, and occasionally the tumefied margin of the epiglottis visible above the tongue, will plainly indicate the nature and seat of the difficulty. Mackenzie suggests that the tumefaction which follows the impaction of a foreign body partakes of the character of venous obstruction, since its occurrence is too rapid to be accounted for by inflammatory action.

The prognosis in these cases is very serious, and great promptness of action may be required. The sucking of cracked ice, the administration of a non-depressant emetic, and thorough scarification of the œdematous tissue as described under the title Glottis, Œdema of the, are highly recommended. Of course, in case of the impaction of a foreign body the offending object must be removed. Too much stress cannot be laid upon the necessity for energetic treatment, and when the symptoms are urgent, immediate recourse should be had to tracheotomy, or better still, to intubation of the larynx after the method of O'Dwyer (see Larynx, Intubation of).

Laryngitis from corrosive poisoning is frequently followed by extensive sloughing, and eventually by cicatricial contraction which may require more or less important surgical treatment for its relief (see Larynx, Stenosis of).

D. Bryson Delavan.

LARYNX, CARCINOMA OF. By this term is understood a carcinomatous affection, originating in, and most frequently limited to, the larynx, causing hoarseness, dyspnœa, odynphagia, dysphagia, ulceration and necrosis of tissue, lancinating pains in the ears, orbit, and head, hæmorrhages, and, finally, death from apnœa or exhaustion. This description applies with equal exactitude to the epithelial and encephaloid varieties of carcinoma, which differ microscopically, but possess, with the exception of differences to be hereafter mentioned, essentially the same clinical history, progress, duration, and termination.

Krishaber divides primary cancers of the larynx into intrinsic and extrinsic, the former division including growths of the vocal and ventricular bands, ventricles, etc.; the latter those of the epiglottis, ary-epiglottic folds, and interarytenoid region. This division, in my opinion, has an important clinical foundation, and will be adopted throughout this article.

Intrinsic cancers have, as early symptoms, dysphonia or dyspnœa, while the extrinsic variety, on the other hand, is marked by dysphagia and odynphagia.

ETIOLOGY.—The influence of heredity as a cause of cancerous disease of the larynx is not positively established, and those instances tending to strengthen a belief in an hereditary predisposition are few. The abuse of tobacco and strong alcoholic liquors, prolonged residence in humid cold climates, as well as the respiration of gases or vapors of an irritating nature, all undoubtedly predispose to the development of carcinoma of the larynx, especially in those who make violent use of the voice.

Traumatism is regarded by Blanc and Démarquay as an occasional cause, and Fauvel cites a case due to an external wound of the neck.

Oft-repeated attempts at extraction of benign intra-laryngeal growths by means of forceps, etc., are by a few writers held to occasionally terminate in the conversion of an otherwise benign tumor into one of a malignant nature.

The writer, in a considerable experience with benign tumors of the larynx, has never observed any but the happiest results follow their extraction *per vias naturales*, and is inclined to believe that the malignancy claimed to result from evulsion in reality existed *ab initio*.

HISTORICAL.—Prior to the invention and general employment of the laryngoscope, carcinoma of the larynx,

as a primary disease, was considered extremely rare, and only what were improperly denominated secondary carcinomata claimed attention from medical authors.

The laryngoscope has not only aided in the early recognition of this disease, but has enabled the physician to more closely observe its development and progress day by day.

The detection of approaching stenosis, the results of medical and surgical treatment, and, finally, the determination of the time when a tracheotomy should be done, are a few of the advantages derived from an intelligent use of this instrument. Delavan's case well illustrates the force of the above remarks. (See bibliography at end of article.)

In 1837 an instructive case of primary cancer of the larynx was reported by Trousseau. Louis and Barth each report a case, the date of the latter's being 1854.

A number of so-called secondary carcinomata, extending from the œsophagus, tongue, tonsils, or pharynx, to the larynx, were reported at an early date, but Fauvel considers these to be "cancers of vicinity," and not, properly speaking, consecutive (or secondary), and remarks that "cancer which takes its origin at a distance from the vocal organ, and which in time may be developed in other regions, always respects the larynx."

In the past ten years numbers of primary laryngeal carcinomata have been reported, and have generally received a conscientious and satisfactory histological examination.

Recently the case of General U. S. Grant has served to direct universal attention to cancer of the throat. His was an epithelioma of the squamous variety, and attacked primarily the pillars of the fauces, base of the tongue and palate of the right side. The inestimable value of the microscope and laryngoscope as instruments of diagnosis, and the utility of cocaine as a therapeutic agent, were demonstrated to the public mind during the progress of this case.

FREQUENCY.—Primary carcinoma of the larynx is not a rare disease, as some writers have stated, and an examination of the literature of the subject will demonstrate the truth of this assertion.

In early days the records of malignant laryngeal growths were unaccompanied by satisfactory histological data, and hence several systematic writers have been forced to exclude numerous imperfect cases from their writings, thus seemingly reducing the aggregate.

Butlin, for example, in his monograph has collected only fifty authentic cases, having found it essential for purposes of analysis to admit only tumors examined with the microscope. It is a settled fact that males are more liable to cancer of the larynx than females, and of Butlin's fifty cases forty occurred in males. Whether this greater liability in the male is due to habits, exposure, and occupation is unknown; but Fauvel suggests that the larynx is more liable to malignant growths in men than in women, because these diseases find in the latter a soil prepared for them in the mamma and uterus.

Profession or occupation does not appear to exercise a marked influence in causing this disease, although alcoholic liquors and shouting may invite its development in those having a predisposition.

The following table from Butlin shows the ages of his fifty collected cases:

3 years	1
28 to 30 "	4
31 " 40 "	6
41 " 50 "	8
51 " 60 "	15
61 " 70 "	10
71 " 76 "	2
Uncertain	4
Total	50

SEAT.—The site of the cancer is variable, and it becomes difficult after it has encroached upon other parts to positively determine the point primarily invaded.

The entire larynx is occasionally covered by the growth, or the epiglottis may be so swollen as to obscure the interior of the larynx.

Ziemssen claims that the vocal bands or ventricles of Morgagni are the elective points from which these tumors originate. In Fauvel's 37 cases 26 were of the left side, and of these 16 were of the ventricular band. M. Mackenzie in 53 cases of primary laryngeal cancer met with 18 on the left, and 17 on the right side—15 of the right and 13 of the left ventricular band—thus giving 56.7 to 43.3 as the relative frequency with which the two ventricular bands are attacked.

From the above it is apparent that the middle and upper portions of the larynx are the favorite starting-points for cancer of this organ, the ary-epiglottic folds and epiglottis being finally involved by a spreading of the growth.

Fauvel has seen the epiglottis invaded primarily only once in thirty-seven cases, M. Mackenzie six times in fifty-three cases, and Ziemssen mentions it thirteen times in ninety-six collected cases.

Various theories have been advanced to explain why cancer of the larynx should, in the large majority of instances, involve the left side, but they are, in the estimation of the writer, unsatisfactory. M. Mackenzie has observed that in his fifty-three cases the various portions of the larynx were attacked with the relative frequency below mentioned:

Right ventricular band	15
Left ventricular band	13
Left vocal cord	3
Left vocal cord and subglottic region	2
Right vocal cord	2
Anterior commissure of the vocal bands	2
Epiglottis	6
Posterior surface of cricoid cartilage	1
Whole larynx	9
	53

PATHOLOGICAL ANATOMY.—Carcinoma assumes two leading types in the larynx, the epithelial and the encephaloid or medullary. The histological characters of these two varieties, when found in the larynx, are identical with those distinguishing like growths in other organs. Carcinoma, as is well known, embraces four principal varieties, viz., epithelioma, medullary or encephaloid, scirrhus, and colloid; the two former will alone receive consideration in this article. A great deal of the uncertainty existing in reference to the histogenesis of carcinoma is attributable to the complex character of its anatomical structure (see article on Carcinoma, Pathological Anatomy of).

By far the most common form of tumor is the epithelioma, forty-five of Mackenzie's fifty-three cases of cancer being of this nature and only six encephaloid. In sixty-eight cases collected by Ziemssen, fifty-seven were epitheliomatous and nine encephaloid. Seventeen of Schroetter's twenty cases were epitheliomata. In Fauvel's experience, however, the relative frequency of the two forms was almost identical.

SYMPTOMS.—The symptoms presented by primary carcinoma of the larynx may be divided, for convenience of discussion, into those of a *functional*, a *laryngoscopic*, and a *general nature*. These symptoms, except as regards the laryngoscopic appearances, are the same whether the disease be of the epithelial or the encephaloid variety. Functional symptoms may proceed from the organs of phonation, respiration, or deglutition, and their severity is in direct proportion to the malignancy of the disease and the extent of laryngeal tissue attacked. The very first noticeable symptom in the vast majority of cases of carcinomata is a huskiness or enfeeblement of the voice, at first transient, but later permanent in character. A prodromal hoarseness may exist for from one to five years prior to the appearance of the disease. When the ventricular or vocal bands are affected (intrinsic cancer) the voice rapidly becomes hoarse; but involvement of the epiglottis, posterior laryngeal wall, or œsophagus (extrinsic cancer), may result in no alteration of voice, although causing more or less odynphagia and pain of a darting, cutting character.

The *voice* is never entirely lost, as it is in tuberculosis of the larynx, and the patient can make himself heard by violent effort, even in the advanced stage of the disease. The patient generally attributes his huskiness to a simple

catarrhal inflammation, and does not concern himself greatly until after several months, or even a year, when the voice has become harsh and progressively weaker. He then seeks medical advice.

Hoarseness in the earlier stages of laryngeal carcinoma is often due to implication of the inferior or recurrent laryngeal nerve; but when the ulcerative process has commenced depends upon an alteration of structure, or the presence of buds and vegetations within the vocal organ. When these vegetations are expelled spontaneously, extracted by the forceps, or destroyed by chemical caustics, the voice may be partially regained, only to be again impaired by the unceasing progress of the disease. Fauvel states that rest to the larynx, following a tracheotomy, lessens congestion and tumefaction of the parts, and frequently in ten days the voice is so improved as to lead the patient into a deceptive hope of recovery.

Gradual and progressive *embarrassment of respiration* supervenes early in the course of this disease, and assumes all degrees of gravity from slight dyspnœa to fatal asphyxia. Respiratory disturbances vary much, but depend in a great measure upon the amount of carcinomatous mass obstructing the glottic orifice, the degree of subglottic œdema, the existence of arytenoid ankylosis; perichondritis, the paralysis of intra-laryngeal muscles, etc. The patient first becomes conscious of dyspnœa upon making slight physical exertion: running, going up the steps briskly, lifting, etc. Later a rough laryngeal sound, of a harsh piping character, known as "cornage," is developed, and is considered by Fauvel as characteristic. Suffocative spasm and cyanosis frequently occur at this period of the disease, and the life of the patient is thus threatened. The attacks are usually nocturnal, and in many cases they have been followed by sudden death. Enlarged cervical or bronchial glands may cause asphyxia by direct pressure on the trachea or recurrent nerve; in the latter instance a paralysis of the intrinsic muscles results.

In speaking of impaired vocalization, resulting from obstruction of the glottic orifice by cancerous masses, it was mentioned that the expulsion or extraction of such masses was often followed by improvement of voice. In like manner, respiration is rendered temporarily less distressing when dependent upon similar obstructions.

The exact period at which *interference with deglutition* takes place depends greatly upon the location or seat of the carcinoma, as well as upon the rapidity of ulcerative changes. When the epiglottis, ary-epiglottic folds, or the arytenoid region are the seat of disease (extrinsic cancer) deglutition is soon affected, either as odynphagia or dysphagia; but when the primary seat of disease involves a ventricular band (intrinsic cancer), these symptoms are postponed. The odynphagia and dysphagia are well-nigh constant accompaniments of carcinoma of the larynx, and increase *pari passu* with the disease, until finally the patient can only with the greatest care swallow liquids or mucilaginous substances without causing violent cough and suffocative spasm. Inability to swallow, either from mechanical obstruction or pain, occasionally terminates in the escape of food into the air-passages, a dangerous and sometimes fatal accident. The pain extends to the ears, orbits, jaws, and entire head, and is of a shooting, cutting character. Pressure over the larynx is usually painful, even in the earlier period of the disease, and copious salivation is quite a frequent symptom. The saliva is rarely swallowed, and escapes from the corners of the patient's mouth.

In patients who have been tracheotomized there is a marked amelioration of the symptoms above noted, as referable to phonation, respiration, and deglutition. The voice is improved, suffocative attacks prevented, and swallowing becomes easier, especially if there was previous mechanical obstruction from arytenoid engorgement.* Tracheotomy is urged by Fauvel as a method of relief.

Laryngoscopic Symptoms.—The first signs of cancerous disease of the larynx are by no means pronounced, and consist of simple hyperæmia and hypertrophy; symptoms alike common to catarrhal, syphilitic, or tubercular laryngitis in their incipiency. Later the tumor gradually forms; at first it is of a dirty, reddish-brown color, with a smooth, broad base, which steadily increases in dimensions until just prior to ulceration, when the entire mass may assume a purple hue. Ulceration is always preceded by infiltration, and the disfigurement of the larynx early in the course of this disease may be enormous, furnishing a strong point for its differentiation from syphilis. The mucosa in the vicinity of the tumor is of a deep red hue, but becomes studded with vegetations and anæmic as the disease advances. The cancer may be single or multiple, is of variable size, and is frequently bathed in a purulent secretion or ichorous muco-pus. The general symptoms now become marked, and at this period a clear diagnosis becomes possible. In the encephaloid variety of the disease the tumor appears in single nodules and ulcerates early. As soon as ulceration is established, a process of sprouting commences, and, as Fauvel has well pointed out, the vegetations issue from the ulcerated surface, and do not attack the surrounding mucous membrane, which remains more or less intact for some time, being but slowly eaten away by the spreading of the primary ulcer. On the other hand, in epithelioma, as soon as an ulcer has formed, a series of vegetations spring up about its margins, and these new growths, by ulcerating in their turn, rapidly increase the original loss of substance. The exact color of the vegetations, in both the epithelioma and encephaloid, is difficult to determine, as their surface is unequal, suppurating, bleeding, or covered with grayish mucus or blood-clots.

Hard œdema is apt to occur, and the surface adjacent to the ulcers becomes red and glazed in aspect. As different parts of the larynx are invaded, new tumors form and undergo ulceration.

Curious as it appears, only one side of the larynx is generally attacked, and, as before stated, preferably the left.

The papillary vegetations in the encephaloid cancer become fungous, cause stenosis, and require the performance of tracheotomy oftener than the vegetations of epitheliomata. In short, in a well-defined case of carcinoma of the larynx the appearance may be that of one sloughing mass, whose parts are absolutely unrecognizable, and Blanc has well said, "At a comparatively early epoch of the malady the alterations of the larynx take forms so diverse that not only does one cancerous larynx not resemble others, but even the same larynx, examined at different periods, will often present widely different aspects."

General Symptoms.—*Pain.*—Dull in the earlier stages, later sharp, cutting, constant in character. During the ulcerative period these pains assume an excruciating severity, and are reflected from the larynx to the ears, orbits, forehead, and jaws. The pain developed by digital pressure over the larynx is rarely of a serious nature, and is attributable to tumefaction and tenderness of the cervical and sub-maxillary glands. As before stated, when the œsophagus is concerned in the destructive process, pain is an early, constant, and grave symptom.

Cough.—This is by no means a common symptom, although the sensation of irritation and fulness about the larynx may cause expulsive attempts at cough.

Expectoration.—The sputum in advanced cases is purulent, occasionally fetid, and mixed with blood as well as disintegrated portions of the cancerous mass. Especially is this the case in epithelioma, and as a very small piece will suffice to determine the exact histological nature of the tumor, an examination in this direction should always be made.

Salivation.—The secretion of saliva is greatly augmented with the progress of cancer, and, owing to painful deglutition or dysphagia, this fluid flows from the mouth night and day, often reaching several quarts during a period of twenty-four hours. Sleep is obtained with difficulty, and the bed-linen is usually saturated with the salivary secretion.

Odor.—The breath becomes foul with the commence-

ment of ulceration, but the patient is unconscious of the odor, from its constant presence blunting olfactory sensibility.

Hæmorrhage.—A frequent and pathognomonic symptom, varying in degree from slight tinging of the expectoration with blood to a copious and more or less constant flow. The sputum is occasionally mixed with large black coagula, showing signs of a protracted stay in the larynx (ventricles of Morgagni) prior to expulsion. Discharges of pure blood are not accompanied by clots, as the frequent cough excited by the flow prevents their formation. In tracheotomatized patients blood may escape through the cannula.

Lymphatics.—The external condition of the neck seldom affords any positive evidence as regards laryngeal cancer. Occasionally, as the disease advances (after from ten to twelve months), the sub-maxillary and cervical glands are enlarged and the thyroid cartilage may be pressed outward, so that, as Isambert has well said, the cartilage feels much like a "crustacean carapace." The connection between the lymphatics of the larynx and the glandular system is not so intimate as in the pharynx, and hence we notice involvement of the glands more in the so-called extrinsic than in the intrinsic laryngeal cancer. The lymphatics of the larynx are, according to Sappey and Luschka, abundant; but they are peculiarly arranged and form a network of their own without anastomosing with the lymphatics of neighboring parts. Enlarged peritracheal and peribronchial glands may, by direct pressure upon the trachea, cause stenosis and diminished respiratory murmur.

General State of the Patient.—The subject shows evidence of a malignant cachexia aggravated by the particular location of the cancer and the degree of its interference with vital functions. The usual victims of cancerous disease of the larynx are those in robust health, and their functions remain normal until ulceration, pain, dyspnœa, dysphagia, and gastric disturbances begin, when emaciation rapidly appears. The patient now has a pale yellow, or "waxy" complexion, which is well marked in those upon whom tracheotomy has been performed and in whom an earlier death from asphyxia has thereby been averted. It must be here stated, however, that in very rare instances of primary intrinsic carcinoma of the larynx the development of the cachectic facies does not occur until toward the end of the disease.

Diagnosis.—Prior to ulceration, cancer may be confounded with hypertrophic inflammation of the larynx, but this disease is usually bilateral, while cancer is nearly always unilateral, limited to the left side, and at first to one cord. A red color is indicative of simple inflammation, whereas a dirty, reddish-brown hue would suggest cancer. In laryngitis the dull pain of cancer is wanting.

Papillomata often invade the entire larynx or any part of it, and simulate epithelioma. Here, also, both sides of the larynx may be covered; there is aphonia, no dysphagia, no lancinating pain, no bleeding, and no lymphatic enlargement or other symptom of malignancy.

Gummatous tumors previous to ulceration might be mistaken for cancer, but the history of the patient, the rarity of such tumors, and the effects of anti-syphilitic medication should solve this question.

Subsequent to ulceration cancer might be taken for tuberculous, scrofulous, or syphilitic disease of the larynx.

Tubercular ulcers generally develop in the posterior portion of the larynx, rarely vegetate, produce caries and necrosis of cartilage, pale œdema, and the discharge of abundant pus. The ulcers are nearly always secondary to pulmonary tuberculosis. Tuberculosis occurs at all ages and in both sexes alike, the hæmorrhage is bronchial, and the pain is not lancinating, as in carcinoma.

Scrofulous ulceration is very rare, and takes place at an age when cancer does not occur, is indolent, free from œdema, granulating, not fungous, and is habitually accompanied by the general manifestations of scrofula.

Syphilitic ulcers are usually found upon the epiglottis or in the anterior portion of the larynx; they have raised edges and indurated borders, around which is a membrane, carmine in color, and not reddish-brown or purple. As there may be salivation, acute pain, glandular enlargement, and dysphagia, the diagnosis should be guarded. Antisyphilitic remedies constitute the test in doubtful cases. Fauvel subjects all his cancerous patients to a mixed treatment for syphilis. The differential diagnosis of cancer, which, as remarked, is difficult at the outset, becomes, after a few weeks' observation of the patient, confirmed, owing to the constant progress of the disease, the absence of all efforts at cicatrization, and the inutility of syphilitic treatment.

Prognosis.—Always fatal, whether the cancer is epithelial or encephaloid. Tracheotomy undoubtedly prolongs life and holds out all the comfort and hope which is claimed for the more radical and heroic operation of laryngectomy.

Whether a laryngectomy in the very incipiency of primary intrinsic carcinoma of the larynx will effect a permanent cure the future can alone determine. The tendency of operators now is to laryngectomatize only commencing cases.

The most favorable results in complete laryngectomy for carcinoma have perhaps been obtained in the following cases especially selected by the writer. Thiersch's and Winiwarter's patients were living three years and six months after operation, while Novaro's, Hahn's, and Gussenbauer's were living two years afterward. Some twenty cases have lived for periods varying from six to fifteen months.

According to Hahn recurrence is no more frequent in half-sections of the larynx than after total extirpation.

Progress, Duration, Termination.—*The progress* does not differ materially for epithelioma or encephaloid cancer of the larynx; the alterations of voice usually precede dysphagia, or they may have an identical cause and be simultaneous. The peculiar "cornage" is coincident with hard œdema and ulceration. In very rare cases of intrinsic cancers of the larynx, the dysphagia may not appear until even after it has been necessary to perform tracheotomy. The pain becomes almost intolerable the moment the arytenoid region is attacked. Submaxillary enlargement always accompanies, and sometimes precedes, ulceration.

The duration of the disease depends upon the form of cancer, and whether or not tracheotomy has been performed.

Fauvel found that seven cases of encephaloid in which tracheotomy was not performed lived three years on an average, while eight cases tracheotomatized lived three years and nine months. Six cases of epithelioma not tracheotomatized averaged one year eleven months, while seven cases tracheotomatized averaged four years. Thus the progress of encephaloid where tracheotomy has not been performed is slower than epithelioma. Where tracheotomy is done in epithelioma life is prolonged two years and one month, and where it is done in encephaloid a prolongation of nine months is obtained. Tracheotomy always extends life and is both useful and necessary. The course of laryngeal carcinoma is, in general, very slow. In twenty-seven cases in which accurate information was given with regard to the duration of the entire disease, Ziemssen found it lasted—

	Patients.
From three to six months	4
Nine months	2
Twelve months	3
Eighteen months	7
Over twenty-four months	2
Over three years	3
Over four years	3
Over six years	1
Over ten years	1
Over fifteen years	1
Total	27

Termination.—Always fatal, by either cachexia, apnœa, or inanition. Sometimes sudden death results from passage of secretions into the bronchial tubes and pulmonary vesicles. Abscesses occasionally form during the disease and may rupture externally in the anterior cervical region, or into the œsophagus. Portions of disinte-

grated cartilage may escape through fistulous openings, or be expectorated during coughing.

TREATMENT.—With the best directed medical and surgical therapeusis we can only expect to prolong life or afford our patient comparative ease during the progress of this painful disease.

Tonics and alteratives should be persistently administered, and the usual systemic management of carcinomatous disease intelligently employed. An important rule, however, always to be borne in mind, is to employ no medication which interferes with the processes of assimilation.

Fauvel subjects all his cases of carcinoma of the larynx to a preliminary antisyphilitic course of medication, experience demonstrating the value of this method. Inunctions over the larynx of the oleates of morphine, cocaine, or mercury, as well as opium, belladonna, and chloral hydrate, when combined with simple ointment, give much comfort in the advanced stages, and render deglutition possible. Hypodermatic injections of morphia or cocaine in the vicinity of the larynx should be employed when necessary to control pain.

Endo-laryngeal treatment consists first in the topical medication of affected parts by means of solutions, sprays, powders, or vapors, and second, in the extraction of portions of the cancerous mass (for the relief of urgent respiratory and vocal embarrassment, resulting from laryngeal stenosis). Solutions are employed principally to lessen pain or for cauterization, the most valuable being: Morphine sulphate, gr. iv.–viij. to f ℥ j. of water; cocaine hydrochlorate, gr. v.–xxv. to f ℥ j. of water; lactic acid, ʒ j.–ij. to f ℥ j. of water; ext. opium aq., gr. x.–xv. to f ℥ j. of water. A solution of iodoform, ʒ ss. to f ℥ j. of ether, acts well when cautiously used, and the writer has obtained excellent results from the oleate of cocaine, of five per cent. strength.

The ordinary chemical caustics consist of chromic acid, nitric acid, acid nitrate of mercury, and mono-chlor-acetic acid, either pure or diluted with water. The above solutions should be accurately applied to the diseased parts of the larynx, by means of a properly curved laryngeal brush or on a sound armed with absorbent cotton.

Sprays.—Antiseptic and detergent sprays of carbolic acid, creasote, potassium permanganate, mercuric chloride, thymic acid, boracic acid, bromine, and solution of chlorinated soda, etc., become indispensable after ulceration is well established and the expectoration has become fetid.

The sprays, cold or warm, should be frequently employed, and aid in preventing early derangement of the digestive functions from the presence of offensive discharges in the air- or food-tracts. Sprays are also most serviceable in disguising the offensive and occasionally unbearable breath noticed in some cancerous patients.

Powders.—These preparations may be employed both as analgesics and antiseptics, and are to be be applied directly to the interior of the larynx by means of one of the various forms of insufflator designed for the purpose. Insufflations consisting of morphine, cocaine hydrochlorate, or iodoform, mixed with starch, sugar-of-milk, or lycopodium, will be found among the most valuable. Among the antiseptic insufflations boracic acid and resorcin may be mentioned.

In spite of the theoretical objections urged against the employment of powders within the larynx, upon the ground of their non-absorption, the fact remains that pain may be assuaged by such preparations.

Vapors.—The inhalation of the vapors of cannabis indica, conium, opium, belladonna, tr. benzoin co., and other anodyne and sedative drugs, will be found to afford great relief to those patients who are capable of active inhalation.

From ♏ xx. to f ʒ ij. of the medicament is to be added to O ss. of water heated to 190° or 200° F. and inhaled from a Mudge or Wolfe bottle, a Mackenzie inhaler, a tin cup, or a tea-pot.

Endo-laryngeal Operation.—Little can be accomplished in the direction of complete removal of an ill-defined malignant growth *per vias naturales*, although a few fortunate results of this nature are on record. The writer ventures to express his doubts as to the possibility of such cures. A precept of first importance for our guidance in resorting to endo-laryngeal interference of a surgical nature, is never to meddle unnecessarily, and then only for the relief of urgent symptoms. That tearing, scraping, and imperfect cauterization of laryngeal carcinomata may occasionally add fuel to the flame, will, I think, be admitted by every experienced laryngologist. The maxim "Never interfere actively without a distinct object," is in every sense appropriate and worthy of consideration here.

When, however, a laryngeal carcinoma ulcerates, and the swollen mass is so voluminous as to prevent phonation or respiration, it is justifiable to destroy the mass by extraction, by chemical caustics, or by the galvano-cautery.

If a previous tracheotomy has been performed and the patient breathes below the obstructed point, evulsion by forceps or the burning out of the vegetating mass with the galvano-cautery is of comparatively easy performance for an expert. When the galvano-cautery knife is employed the cancer is to be deeply incised, and when crumbling, softening, and suppuration supervene, large portions of the tumor can be extracted by the aid of forceps, hæmorrhage rarely occurring. Concentrated solutions of chromic acid, varying in strength according to the sensibility of the patient, may be used to destroy the cancerous mass.

In very rare instances abscesses develop within the larynx in the course of cancer, and can be evacuated by means of the laryngeal bistoury, thus avoiding internal rupture and suffocation or external rupture and fistulous openings.

Surgical treatment proper may be either radical or palliative: the radical measures include extirpation of the larynx, sub-hyoidean pharyngotomy, and thyrotomy; the palliative, tracheotomy, laryngotomy, and laryngo-tracheotomy.

Laryngectomy.—This radical operation has been performed one hundred and six times, fifty odd of which were for carcinomatous disease of the larynx. M. Mackenzie, Burow, Blum, Cohen, Hahn, and Baratoux have prepared excellent tables of partial and complete laryngectomies. The justifiability of and advantage resulting from a laryngectomy may even to-day, twenty years after Watson's case, operated upon in 1866, be regarded as *sub judice*. The weight of evidence, in the writer's estimation, is against its performance in any but the most favorable subjects, and then, at an early period of the carcinomatous disease.

The longevity of patients, who have received only palliative treatment (medical and surgical), as compared with those laryngectomatized, is assuredly favorable to the adoption of palliative measures.

Death resulted within eight days in forty-two per cent. of the reported cases of extirpation of the larynx, usually from shock or pneumonia.

The operation requires from one to three hours, and is, *per se*, an undertaking of great difficulty, although the larynx is prominently situated, and its outlines plainly visible. The complications may be endless and insurmountable.

Sub-hyoidean Pharyngotomy.—This operation should, in the writer's opinion, never be relied upon for the radical cure of primary carcinoma.

Thyrotomy.—The results of this operation have been extremely unsatisfactory, immediate death, inability to complete the operation, or an early recurrence of the cancer appear to have usually followed thyrotomy. Bruns has shown that the functions of the larynx have often been seriously injured by thyrotomy, and this is apparent when we reflect that it is necessary to excise every particle of morbid growth, and apply either chemical caustics or the electric cautery to obtain even a chance of success.

The difficulty attending the positive recognition of primary carcinoma of the larynx in its incipiency has already been adverted to, and generally prevents a resort

to surgical interference at a period when it might be curative.

Tracheotomy.—The trachea should be opened early in the course of primary carcinoma of the larynx, and on the first appearance of serious respiratory disturbance. When dyspnœa and suffocative spasm occur, the postponement of tracheotomy may expose the patient to the danger of sudden death. Under no conditions should a high operation be performed, for the lower the tracheotomy the longer is the duration of life in those cases in which there is a tendency to dissemination of the tumor.

The advantages of the operation are manifold, and Dr. J. Solis-Cohen has truly said: "Of a number of cases of carcinoma of the larynx under my own care, who agreed to submit to exsection of the larynx, should I so determine, and in whom I performed tracheotomy in preference, one lived six months, two lived seven months, one lived thirteen months, and one eighteen months, respectively, after the tracheotomy. Had laryngectomy been practised in these five cases with equal tenure of existence, the result would have been accredited to the radical procedure."

According to Fauvel, whose experience has been extensive, "tracheotomy is the palliative surgical treatment *par excellence* of laryngeal cancer."

This operation, when done early and before the general health and strength of the patient are impaired, permits him to breathe, gives rest to the affected organ, arrests for a time the advance of the disease, and renders palliative operations through the natural passages much easier of performance.

Life is rarely sacrificed after tracheotomy, the shock being insignificant, the danger of pneumonia comparatively small, and sepsis infrequent.

A laryngectomatized patient, according to the most favorable reports, is one whose life is more than a misery, even when able to use an artificial larynx.

Laryngotomy, Laryngo-tracheotomy.—These operations should never be resorted to for the disease under consideration, as the cancerous vegetations will immediately attack the wound and render the retention of a cannula impossible.

Alimentation.—When swallowing becomes impossible, artificial feeding may be resorted to, either by means of an œsophageal tube or by rectal enemata.

Aliments should be introduced at a temperature of 90° to 100° F., and preferably by the stomach.

Beef-tea and brandy, or both, mixed with eggs, and administered not more than thrice daily by the stomach or rectum, constitute a serviceable aliment. Artificial feeding has recently been rendered more complete and less tedious by Delavan's apparatus, a simple, inexpensive, and effective device.

Artificial Vocal Apparatus.—When a partial or complete laryngectomy has been performed vocalization may be aided by the employment of Gussenbauer's apparatus.

Foulis and others have modified and improved Gussenbauer's original instrument (see Laryngectomy).

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Explanation of Plate.

Fig. I.—Encephaloid carcinoma, originating from left ventricle, vocal and ventricular bands. Male patient of fifty-five years. Eleventh month of the disease. Death from exhaustion during twenty-ninth month of disease and one month after tracheotomy. (Writer's case, and analogous to one recorded by Fauvel.)

Fig. II.—Encephaloid carcinoma, forming a large tumor covering the superior laryngeal orifice. (After Fauvel.)

Fig. III.—The same larynx after extraction and destruction of the tumor by the galvano-cautery. The ventricular bands and left arytenoid are much swollen. (After Fauvel.)

Fig. IV.—Encephaloid carcinoma. (After Browne.)

Fig. V.—Encephaloid carcinoma, involving larynx and œsophagus. (After Fauvel.)

Fig. VI.—Encephaloid carcinoma. (After Fauvel.)

Fig. VII.—Epithelial carcinoma, right side of larynx. (Patient examined by writer.)

Fig. VIII.—Round-celled sarcoma of right vocal band. Patient aged forty; male. (Writer's case.)

Fig. IX.—Spindle-celled sarcoma of left ventricular band and arytenoid. (After Poyet.)

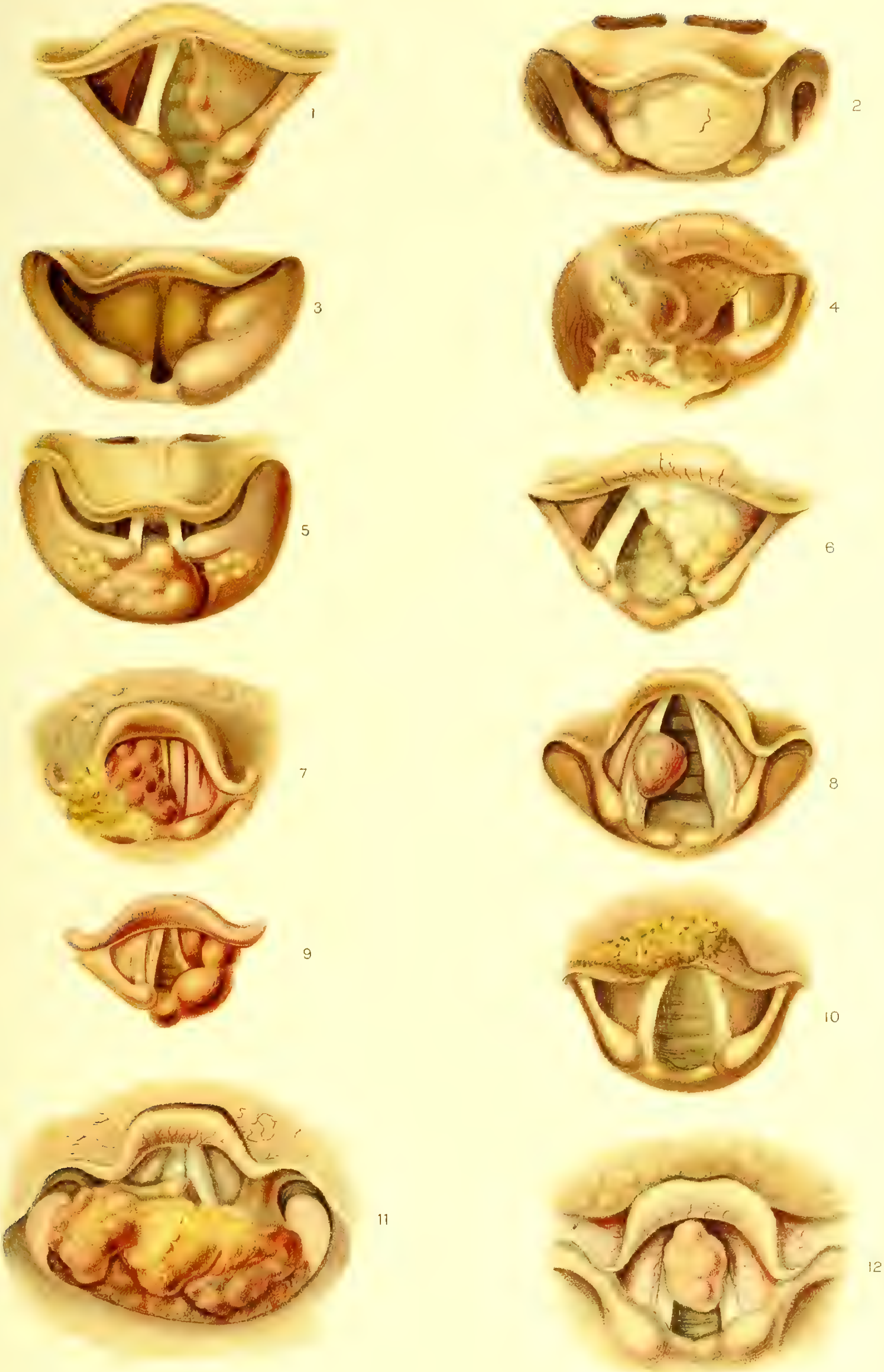
Fig. X.—Round-celled sarcoma, sixteenth month, destroying epiglottis and the adjacent tissues.

Fig. XI.—Encephaloid carcinoma involving posterior laryngeal wall, left arytenoid, ary-epiglottic fold, and œsophageal entrance.

Fig. XII.—Myxo-sarcoma, originating from the anterior commissure of the vocal bands, causing great dysphonia and orthopnœa.

LARYNX, CATARRHAL AFFECTIONS OF THE.

General Observations on the Origin and Etiology of the Simple Inflammatory Affections of the Upper Air-passages.—In view of all that has been said and written concerning inflammatory conditions of the naso-laryngeal tract, it is amazing to find what little ad-



CARCINOMA AND SARCOMA OF THE LARYNX.

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vance has been made toward a more rational conception of the causes that underlie diseases of such prevalence and wide distribution.

It is not the purpose of the present article to treat in an exhaustive manner the conditions under which inflammation of the upper air-passages develops, but simply to offer a few general observations as an introduction and guide to the rational study and treatment of the affection.*

At the outset of our inquiry we should divest the mind of the idea that the pathology of nasal and laryngeal disease is an isolated pathology. The eruption of catarrhal processes in the respiratory tract is governed by the immutable laws that condition the development and course of inflammation in general, and the rational interpretation of nasal and laryngeal affections presupposes, therefore, the application of general pathological principles to the peculiar conditions which the anatomical and physiological functions of the structures involve. Above all, we should remember that peculiarity of structure is not anatomical isolation; we should remember the correlation of organ and organ, the sympathy of tissue and tissue which make up the perfect physiological life of man. In looking upon the subject from the high vantage ground of general pathology and laws of health, we may, therefore, more readily apprehend the rôle which external and internal influences play in the evolution of nasal and laryngeal disease than if we viewed the same from the level of a narrow specialism or from the standpoint of the mere empiric.

I. Inflammation of the upper respiratory tract, either in its entirety or localized in its individual parts, is a disease of the human race which has existed from the remotest period of historic time.

II. The evolution of nasal, pharyngeal, and laryngeal inflammation in a given locality is, in all probability, a part of its geological history, and goes on *pari passu* with its varying meteorological conditions. Hence the geographical limits of the disease have varied with the different epochs of the earth's formation.

The elaboration of the above propositions involves an inquiry into the origin, the predisposing and exciting causes of nasal, naso-pharyngeal, and laryngeal inflammatory affections, and their distribution over the surface of the earth.

Origin.—In the third book of Plato's "Republic" the philosopher tells us that the names of catarrhs were unknown to Homer, and only came into use in the age of Socrates. This assertion of the Grecian sage has been made the groundwork of the thesis that catarrhal diseases are the products of civilized life, and furnishes, among other things, the basis of the Schneiderian argument, that they are born of luxury and ease and of the general degeneracy of mankind.

It is doubtless true that a marked tendency to catarrhal diseases belongs to modern man from the accidents which pertain to his environment, and that as civilization awakens morbid conditions unknown or rarely met with in the savage state, so the disposition to inflammatory troubles of the upper respiratory passages may be encouraged by transmitted vices and the enervating surroundings of modern social life. At the same time it is reasonable to assume that, as the chief causes productive of acute and chronic inflammation of the naso-laryngeal tract have been in operation from the remotest times, the origin of the affection is therefore traceable to the time of the origin of man himself.

The very etymological derivation of the word *coryza* carries us back through the dialects of the Hebrews, Arabians, Chaldeans, and Assyrians to the time when history emerges from fable; the attention paid by the most ancient exponents of medical art, of which we have any record, to inflammatory states of the nose and throat, implies the former frequency of these affections, while the derivation of the terms *angina* and *cynanche*, and the early origin of bronchotomy, point to their recognition of the most dangerous forms of laryngeal disease. The classification and correct clinical history of disease is, moreover, a process of gradual evolution, and, in view of the confusion which reigned among the latter-day nosologists in regard to laryngeal affections, it is not surprising that in the most ancient records of medicine we fail to find that exact anatomical division of catarrhal affections which was the natural outcome of subsequent more advanced anatomical and physiological investigation.*

The remote origin of catarrhal affections is reflected not only in the most ancient records of medical art, but also in the classical writings of the earlier poets, philosophers, and historians.

Chronic affections of the nose and throat were looked upon by the popular satirists as indicative of dissolute habits—as the marks of intemperance and general moral obliquity. Thus Juvenal ridicules the quail-pipe voice forced beyond its natural compass, the foul snout of the debauchee, and draws the following graphic picture of the last stages of the libertine's career:

> "Una senum facies, cum voce trementia membra;
> Et jam leve caput madidique infantia nasi." †

The senseless Phyllis of Perseus,[1] the laughing sot,[2]

> "Guttere sulfureos lente exhalante mephites."

typify, too, the injurious effects of luxurious habits, high living, and excesses in general upon the nasal passages and throat.

The pernicious influence of alcoholic beverages upon the throat seems also to have attracted popular attention, the Romans applying the term *angina vinaria* to the suffocative catarrh caused by the ingestion of large quantities of wine.[3]

The possession of a nasal polypus appears to have been regarded with especial aversion. Thus Martial exclaims that he honors a man with a comely nose, but desires to have nothing to do with the possessor of a polypus:

> "Nasutum volo, nolo polyposum." ‡

It is therefore not unnatural that the lords and ladies of those days should have resorted to many devices for the purpose of concealing their misfortune; but as the more certain modes of disinfection were then unknown, we are not surprised when Horace, in satirizing the deception, informs us that he can detect a polypus or fetid smell, however well concealed.

> "Polypus an gravis hirsutis cubet hircus in alis,
> Quum canis acer, ubi latet sus." [4]

The frequent reference to snoring as a badge of dissolute habits may possibly indicate the frequency of some form of nasal obstruction, which we may, without much violence to logic, assume to be the expression of the hypertrophic form of rhinitis. This was, possibly, for example, the condition of Cicero's neighbor, Marcellus, and that of the Sodomite so frequently alluded to by the satirists, and described more technically by Reiskes.§

In the creature painted by Terence,‖ on the other hand,

* The views contained in this article were first presented in a paper read by the writer at the American Laryngological Association, June 24, 1885. (See N. Y. Med. Journal, September 12 and 19, 1885.)

* Hence we find in the Ayur-Véda, affections of the larynx confounded with those of the palate and pharynx, and among certain of the Hippocratic and Galenic schools the names larynx and pharynx are occasionally employed as convertible terms.

† Sat. x., 197, 198. Farther on (v. 199 et seq.), he describes the effect on the organ of hearing:

> . . . "Aspice partis
> Nunc damnum alterius; nam quæ cantante voluptas,
> Sit licet eximius citharœdus, sitve Seleucus
> Et quibus aurata mos est fulgere lacerna?
> Quid refert, magni sedeat qua parte theatri,
> Qui vix cornicines exaudiet atque
> Concentus? Clamore opus est tubarum ut sentiat
> Quem dicat venisse puer auris quot nunciat horas."

‡ Martial, xii., 37. The term "polyposus" signifies here having a polypus, but it was also used by the ancients to designate those who were affected with ozæna, or stinking smell from the nostrils; while the appellation "ozænosus" was employed, on the other hand, to denote the presence of a polypus. This would seem to indicate a popular confusion of the two affections and their use as convertible terms.

§ "In naribus et in palato vitium, a quo clare non potuerint eloqui, sed ῥέγχειν, stertere et rhonchissare debuerint," quoted by Gruner, Morborum antiquitates, Vratislav., 1774, sect. 1–4, p. 77, from Reiskes, Observat. miscellan., Leid., 1746, def. p. 28.

‖ "Fatuus et insulsus, bardus, stertit noctes et dies,
Neque istum metuas ne amet mulier."
Eunuch, Act V., Sc. 8, v. 49 and 50.

who snored both night and day, and whom no woman loved, the obstruction to respiration may have been seated lower down in the respiratory tract.

The stinking breath, hoarse voice, and snoring respiration of the cunnilingus, fellator and fellatrix, the effeminate, piping tone of the cinædus and irrumator, which excited the special scorn of the early satirical writers, were doubtless the expression of a catarrhal pharyngo-laryngitis acquired in the discharge of their filthy practices.

The influence exerted upon the mental faculties and general health and the incapacity for vigorous intellectual endeavor wrought by catarrhal affections seem also to have been fully recognized by the ancients. The Greeks, for example, had a verb, κορυζάω, which signified to be dull or stupid. Cicero alludes to the heavy feeling or depression following catarrh,[5] and Horace exclaims that the philosopher is the king of kings until his catarrh begins to trouble him:

> "Sapiens uno minor est Iove, dives
> Liber, honoratus, pulcher, rex denique regum,
> Præcipue sanus, nisi cum pituita molesta est."[6]

Etiology.—Catarrhal affections of the upper respiratory tract are met with at all periods of life. They may be ushered in during fœtal life or accompany the degenerative processes of old age. While the loss of elasticity of the mucous membrane at the latter period and its consequent increased vulnerability, and its delicacy and imperfect development in infancy favor, other things being equal, the development of inflammatory processes at these epochs, it is highly probable that age, *per se,* plays a relatively unimportant part in the predisposition to the disease. We cannot, therefore, strictly speaking, confine the tendency to catarrhal disease to any particular stage in the life of the individual. Catarrhal inflammation of the nose and throat, which develops during intra-uterine life, doubtless proceeds from some constitutional vice inherent in the mother, or possibly from some unknown or imperfectly understood placental affection. In this sense we may speak of a nasal or laryngeal catarrh as congenital or inherited.

Inflammatory disorders of the upper respiratory apparatus may be the result of a host of conditions external to the body which arise from man's relation to the outer world, may proceed from agencies within the organism, whose sphere of operation embraces the system as a whole or is limited to its individual parts, or finally, they may be the outcome of defective anatomical and physiological relations—of absence or abrogation of activity in the respiratory structures themselves and in the functions and forces under their control.

The discussion of the causes proceeding from the first source leads naturally to the consideration of the geographical distribution of the affection.

Geographical Distribution. Predisposing and Exciting Causes.—The geographical limits of nasal and post-nasal catarrhs are as yet imperfectly defined, but it is highly probable that they bear a close relationship to the distribution of catarrhal affections of the respiratory organs in general over the surface of the earth. Thus it may be laid down as a rule that catarrhal inflammation of the nasal passages is much more frequently met with in cold than in warm countries, in high than in low latitudes. The observations of travellers and explorers show that the nearer we approach the equator the less prevalent become affections of the respiratory apparatus, while in the temperate zone they are the most common of all diseases, and preponderate in these regions according to the proximity of the individual localities to the polar circle. In the temperate zones of both hemispheres catarrhs are more frequently met with in those places which lie between the isothermal lines of 18° and 4° (Seitz). The prevalence of these affections is related not only to the geographical position of a given country, but also to its elevation above the surface of the sea; the higher above the sea-level the more marked the tendency to catarrh (Hirsch, Seitz), a fact partially explicable by the analogy of natural conditions or meteorological relations between high mountainous regions and those of the frigid zones. In every zone the geographical distribution of the complaint depends, other things being equal, apparently mainly on climatic influences. *In those countries where extremes of temperature follow each other in rapid succession, where the thermo- and baro-metrical fluctuations are most sudden and occur with the greatest frequency, and where the material composition of the atmosphere is continually changing, catarrhal affections of the naso-laryngeal tract are most frequently met with. The appearance of the disease seems to depend not so much upon the degree of heat or cold as upon the rapidity and intensity of the change from the one to the other.* In warm countries coryza and allied affections most frequently prevail during the sudden cooling of the atmosphere by rain-showers, electrical disturbances, or when the heated condition of the atmosphere alternates with dampness and chilliness of the nights. In a similar manner the more or less sudden passage from a dense to a rarefied atmosphere, as in balloon and mountain ascensions, favors the development of nasal congestion and inflammation.

The influence of season in the production of nasal inflammation is simply a part of the greater question of temperature mutations, and will therefore vary with the period of greatest temperature changes in a given year. While spring and autumn furnish perhaps the largest percentage of nasal and laryngeal catarrhs, the coryza which appears in the summer months, when the air is suddenly cooled or altered by electrical and other disturbances, yields to none in the severity of its symptoms and course.

Let us examine more closely those conditions of the atmosphere principally concerned in the production of catarrhal affections.

The relation of coryza and allied affections to certain states of the atmosphere, such as cold and dampness, is a matter of ancient recognition. While, however, their dependence upon "the weather" has always been a fact of universal observation, the nature of the relationship has been the subject of much controversy and the source of much erroneous opinion. That a causal connection does exist between the two seems, in spite of recent views to the contrary, beyond the necessity of argument, for in this portion of the world who can fail to appreciate the direct relation between the evolution of "colds" and allied catarrhal affections and the vagaries of a climate in which, to use the language of the *Spectator,* we lie down in July and rise in December?

It may safely be affirmed that catarrhal affections are more frequently met with (in the State of Maryland, for example) now than formerly, and lazy minds may not hesitate to find the explanation of this fact in the supposition that our forefathers, with their more limited methods of diagnosis, were less acute observers than the modern specialist armed with rhinoscope, laryngoscope, and speculum. It may even be maintained that our ancestors were a sturdier, more virtuous race, and that they were not surrounded by the depressing environment of the present day and generation. Such speculations are, however, wholly gratuitous and inadequate. The simple truth is that the development of these affections in this section of the country has gone on *pari passu* with its changing meteorological conditions—has followed the general law which governs the evolution and territorial distribution of catarrhal diseases. But, if we had no proof of the influence of climatic conditions in this direction, beyond the facts of everyday experience, weighty evidence of their importance as etiological factors is furnished by the geographical distribution of these affections. For, while there is no climate where catarrhal diseases are not encountered in some form or other, there are certain areas of the globe over which they are principally distributed, and in which the more pronounced types of the disorder are confined within certain more or less clearly defined territorial limits.

Additional proof of the power of climatic conditions in this regard is furthermore shown in the development of catarrhal affections from simple change of residence—removal from an equable climate to one in which the atmospheric conditions are constantly changing will often

induce them, and acclimatization is frequently purchased at the price of a nasal or laryngeal catarrh.

It also occasionally happens that change of residence may beget a predisposition to catarrhal affections, which only exhibits itself upon the return of the individual to his native air.

Let us briefly consider the four principal conditions of the atmosphere which, either singly, in combination, or following each other in rapid succession, are especially provocative of catarrhal affections. These are cold, heat, moisture, and air in motion.

Cold.—The influence of cold *per se* in the production of naso-laryngeal inflammation has been grossly overrated. While the pathological effects of low degrees of temperature upon the circulation and upon the general organism should not be overlooked, if we examine the subject closely we shall find that there are many other agencies at work to explain the prevalence of these affections in that portion of the temperate zone that lies along the higher latitudes. Indeed, the effects of cold are often the reverse of prejudicial. A large proportion of patients affected with catarrhal processes experience marked improvement during the steady cold of winter, and not infrequently a nasal inflammation is notably mitigated or completely dispelled by the appearance of frost. Patients often voluntarily seek the open air in cold weather, experience having demonstrated to them the empirical fact that the heated temperature of the dwelling-house creates more nasal and laryngeal irritation than the cold, biting air of the exterior.

The effect of cold, unassociated with moisture or perturbation of the atmosphere, etc., upon the healthy mucous membrane of the nasal passages is that of a gentle stimulant. The membrane becomes more vascular, the glands are excited to increased secretion, and the sum of the result may be expressed as a healthy reaction, which, so far from doing harm, is in many cases actually productive of good.

Persons who suffer from habitual dryness of the nostrils are benefited notably by the local stimulating effects of cold, and other examples may be instanced in which the same rule holds good. The absolute coldness of a climate is, therefore, of itself inadequate to account for the prevalence of catarrhal affections.

Heat.—On the other hand, a very opposite climatic condition may serve to usher in the catarrhal process. The possible part which heat plays in the causation of the latter is invariably overlooked. The frequent immunity from inflammatory disorders of the respiratory tract enjoyed during the summer months, and the generally accepted proposition that they are more or less clearly confined to the higher latitudes, and that their etiology is inseparably connected with the condition, which, in the idiom of loose medical expression, is known as "taking cold," have withdrawn attention from this agent as a possible factor in the production or aggravation of naso-laryngeal inflammation. Upon this subject my experience furnishes the following observations: There are some persons who suffer from catarrhal affections only during the heated term; in others, who suffer throughout the entire year, the affection is simply aggravated by the heat of summer, while the coryza which occurs during the hot sultry days of our summer months often exhibits a degree of severity not met with in the winter and spring.

In many cases heat seems to encourage the production of various reflex phenomena (notably those relating to embarrassment of the respiratory functions), and it is probable that in its depressant effect upon the nervous system and the slowing of the circulation, is to be found the rationale of its action in this direction.

It is, moreover, a great mistake to suppose that catarrhal affections are little known in the warmer climates of the globe. The type of these affections is greatly modified by climate, and the effect of extreme heat is often to materially increase its severity. Hence, some of the worst forms of nasal inflammation are encountered in the regions and seasons of excessive heat. This proposition may, perhaps, be illustrated by reference to the terrible "nakra" of Bengal, which is probably a severe form of nervous coryza, closely allied to the periodic vaso-motor coryza of our country.

But here again the presence of heat alone is insufficient to account for the prevalence of catarrhal disease.

Moisture.—The association of an atmosphere, surcharged with watery vapor, with heat and cold, is especially productive of nasal and throat affections, the combination of the two conditions sufficing to initiate the inflammatory process, when simple heat or cold alone is powerless to produce the same result. The effect of moisture will depend upon the degree of saturation of the atmosphere. The sudden passage from a cold or temperate condition to a heated, sultry state of the atmosphere, is particularly irritative to the respiratory, and especially the nasal mucous membrane. Here the exciting cause acts probably in two ways: viz., by the saturation and consequent engorgement of the membrane and its underlying structures, and by its depressing effect upon the organism, and more especially the nervous system.

Air in Motion.—Finally, draughts, winds blowing either in one direction or constantly shifting their course, and air-currents in general must be regarded as important agents in the determination of catarrhal affections. In the strata of air of different temperature which they bring with them, and in the rapidity of evaporation which they occasion from the cutaneous and respiratory surfaces, we have the important condition of sudden thermo- and baro-metrical change. In moist cold or moist hot air in motion are found the chief exciting causes combined, and it will be found in practice that this combination represents a most prolific source of inflammatory disorders of the naso-laryngeal tract.

It will be seen, therefore, from the above, that, of external agents, it is not so much cold alone, or heat alone, or moisture alone which is responsible for the prevalence of catarrhal affections, but that the latter depends upon the frequency, rapidity, and intensity of the change from one atmospheric condition to another.

Besides the meteorological relations which condition the geographical distribution of these affections, there are others which pertain to the *geological character of the soil*, to the *configuration of the locality*, and to the *emanations which arise from the surface of the earth.* The two former furnish additional proof in favor of the power of climatic conditions in the evolution of naso-pharyngeal inflammation. It is not within the scope of the present paper to enter into an elaborate discussion of this vast and imperfectly understood question, but it may be said, in general, that the temperature of a given locality will depend, to a certain extent, upon the color of the soil and the presence or absence of vegetation. In some countries—as, for example, in Savoy—the peasants spread dark earth upon the land which they desire to cultivate early, which causes the snow to melt fifteen to twenty days earlier than in other localities (Tortual); it is a well-known fact that the temperature is lowered and humidity of the soil encouraged by the presence of forests or large tracts of dense undergrowth. The presence of vegetation exerts, too, a remarkable influence upon the chemical composition of the air, and hence upon the development or dissipation of nasal and other forms of catarrh. The noxious exhalations from certain forms of vegetable life probably act as indirect or predisposing agencies in the spread of catarrhal disease, while the presence of others, by purifying and tempering the atmosphere or filling it with certain odors, seems to secure immunity from the affection. The sulphurous air of volcanic regions has been utilized from time immemorial in the treatment of laryngeal affections, and the singular infrequency with which the latter are encountered in places where the air is laden with resinous and balsamic odors has been familiar from the earliest times. The *configuration* of a country enters as a factor in the localization of catarrh in so far as it conduces to exposure to the variations in temperature which have been mentioned above.

There are also a vast number of injurious influences dependent upon *modes of life, dress, imperfect sanitary*

conditions, etc., which have been brought forward as the alleged causes of localization of catarrhal affections of the respiratory tract, which, although exercising an undoubted irritating effect, are nevertheless purely secondary and accidental, and have led to crude hypothesis and hasty generalization concerning the essential causes of these diseases.

There are a multitude of conditions, which follow as the natural results of imperfect sanitation and professional occupation, which act as predisposing, and often exciting, causes of nasal inflammation. In general it may be said that residence or work in a confined or overheated atmosphere, or in one filled with impure gases or floating particles of organic or metallic matter, conduces to the development of the disease. Thus it is well known that artisans who are subjected to a dusty atmosphere—tobacconists, workers in woollen goods, stonecutters, millers, laborers in chemical works, etc., or in overheated apartments, as, for example, bakers—are thereby rendered more susceptible to catarrhal affections. In addition to the meteorological conditions which prevail in elevated regions, as, for example, the Alps, the finely divided particles of metallic dust suspended in the atmosphere are said to be important factors in determining affections of the respiratory apparatus. The nasal erectile bodies are peculiarly sensitive to the impression produced by certain noxious gases, especially those given off in the combustion of coal, while the furnace heat of the modern dwelling, and the dry, impure air of apartments fed by the majority of coal-burning stoves, and the varying temperatures of the different rooms, create a vulnerability of the mucous membrane which, in our American cities, constitutes a not unimportant etiological factor.

In some parts of our country there is a widespread popular belief that *dust* is the chief factor in the localization of inflammatory disease in the naso-pharynx. As there are some who ascribe all diseases to the peripatetic excursions of a vagrant micrococcus, so there are others who see in dust the source of all our ills. While it is undoubtedly true that dust, when accidentally lodged in the naso-pharynx, may give rise to inflammation, I believe that comparatively few cases originate in that way. In some of the Western States the prevalence of large quantities of dust in the atmosphere is supposed to determine the geographical distribution of the complaint; but even here, in estimating the amount of injury done by dust in this case, we should not forget the important meteorological changes that condition its presence in the atmosphere, nor should we lose sight of the fact that these localities are thousands of feet above the water-level, a condition that subjects them more easily to impressions made by sudden variations in the temperature, and brings them directly under the dominion of the winds that sweep across the continent from sea to sea. Moreover, when an individual is exposed to an atmosphere filled with dust, the greater portion of the inhaled particles is retained within the nostrils. This is due in a great measure, as I have pointed out elsewhere, to the erection of the turbinated corpora cavernosa, which latter serve, in that respect, a certain teleological purpose. That portion which finds its way into the posterior nares is carried into the lower (not the upper) pharynx, not only by the force of the inspiratory stream, but also in obedience to the law of gravitation. When the atmosphere is unusually dense, as in storms of dust, this erection of the corpora cavernosa is often so considerable as to necessitate mouth-breathing, and it is to a large extent in this way that the lower pharynx and larynx become filled with foreign matter. It is also a notorious fact that in the nasal passages themselves the region of olfaction is much less liable to catarrhal inflammation than the respiratory passage. The nasal pharynx is, therefore, infinitely less liable to inflammation from a dusty atmosphere than either the larynx or lower pharyngeal cavities.

*Among the influences which, approaching from the external world, encourage the eruption of naso-laryngeal affections, the chief, and at the same time predisposing, exciting cause, and that which determines the geographical distribution of nasal, naso-pharyngeal, and laryngeal catarrh, is that combination of varying meteorological conditions which are understood when speaking of a changeable climate ; the home of naso-laryngeal catarrh is the land of the greatest and most rapid thermo- and baro-metrical change.**

It follows as a corollary to the above that *the type of the catarrh encountered in a given region or country varies with and is chiefly dependent upon the climatic conditions which have been already given.*

Turning now from the effect of temperature changes and the direct action of local irritation from substances derived from the external world to the agencies which, operating within the organism, determine the localization of catarrhal disease in the nasal passages and throat, we must confess that the ancients exhibited the greatest shrewdness of observation when they referred these affections to defective digestive processes and lowered powers of assimilation. Catarrhal diseases, according to the fathers of medicine, are due to imperfect "coction"—that is to say, imperfect assimilation—and the resulting discharge or secretion was looked upon as aliment which had not undergone the necessary digestive changes, or, in other words, as half-cooked food. While their notions of the etiology of catarrhal affections were in the main crude and curiously influenced by the prevailing philosophical vagaries of their time, they nevertheless contain an amount of common sense which it behooves us to pause and consider.

It may be said, in general, that all those influences which impair the general health, interfere with the proper circulation, or impair the constituents of the blood, retard the processes of digestion and assimilation of food, or beget a hypersensitive condition of the vaso-motor nervous system, react upon the upper respiratory tract, in common with the other organs of the economy, and predispose, other things being equal, to catarrhal inflammation of the same. Thus the latter is more liable to develop in anæmic persons with weak, relaxed conditions of the tissues, and who lead sedentary lives, and in those of highly nervous organization, than in those of strong and vigorous constitution, and who pass most of their time in active outdoor exercise. The existence of syphilis or tuberculosis in an individual is a constant invitation to catarrhal inflammations of the nose and throat, and the same is true in regard to the rheumatic, gouty, scorbutic diathesis, to chronic alcoholismus, and a host of other affections.

Over-indulgence of the appetites, excesses of all kinds, habitual interference with the bodily excretions, notably the intestinal, predispose to inflammatory disease of the naso-laryngeal tract, so that Schneider was not far from the truth when he said that the cure of catarrhs consisted in "sobriety, continuous bodily exertion, and tranquillity of mind."

Besides being predisposed to or conditioned by pathological states of the system as a whole, *catarrhal affections of the nose and larynx are not infrequently the result of reflected irritation from its individual parts*, as, for example, disease, over-stimulation, or suppression of the functions of the cutaneous (eruptions, suppression of perspiration, etc.), gastro-intestinal (habitual constipation, hæmorrhoids, parasites, etc.), or genito-urinary apparatus (Bright's disease, utero-ovarian irritation, etc.), teeth and gums (caries, dentition, etc.), external auditory meatus or middle ear (inflammation, impacted cerumen, parasites, etc.) Let us examine this subject more closely : As the respiratory passages and skin are the sole avenues through which oxygen reaches the blood, and as they are held in close interdependence by virtue of their community of function, it naturally follows that the abrogated activity of the one will necessitate vicarious action on the part of the other. This supplementary or compensative action, if prolonged, sooner or later transcends its physiological limits and eventuates in morbid conditions of the organs, whose machinery has been thereby overtaxed. Familiar examples of this vicarious action are the congestive or

* The alternate subjection of the pharynx and larynx to extremes of heat and cold in the ingesta acts, though to a far less degree, in the same manner in determining catarrhal inflammation as the sudden changes in the temperature of the external air.

inflammatory disorders of the respiratory apparatus which follow sudden or prolonged interference with the cutaneous functions, as in sudden chilling of the external surfaces, or in the exanthemata, in the sudden suppression of tinea capitis and eczema, and finally, in the night-sweats of consumption. One word in regard to the eruptive fevers. The catarrhal naso-laryngeal disease may usher in the attack (especially is this the case in measles), may occur coincidently with the exanthem, or may follow the disappearance of the latter, or, finally, it may not develop until convalescence has begun. The catarrhal affections complicating the essential fevers may disappear completely during the latter period, but in many cases go on to the chronic state. This is especially true, in my experience, in regard to affections of the naso-pharyngeal space. *There seems to be a special tendency to the localization of the disease in this region, and a large majority of the cases of hyperplastic conditions of the adenoid tissue coming under my observation, are directly traceable to some acute blood-poisoning in infancy, as scarlet fever, measles, diphtheria, etc.* This is doubtless due, to a great extent, to the fact that the naso-pharyngeal affection is overlooked by the attendant; but it may be that the *tendency of the eruptive fevers to leave traces of their existence in the glandular structures of the throat (notably the tonsils) may determine diseased conditions of the adenoid elements of the nasal pharynx.*

It now and then happens that during convalescence from acute infectious processes *irregular fluctuations in the temperature* occur, and even a veritable septicæmic condition, inexplicable by the ordinary examination of the functions of the patient, and which depend upon the persistence of the inflammatory process in the retro-nasal space. I have observed this after scarlet fever and diphtheria, but there is no reason why it should not occur in other and allied affections. This is an important practical point, for by simply cleansing the naso-pharynx of decomposing secretion (I find bichloride of mercury to be the best agent for this purpose) the temperature becomes normal and the disagreeable symptoms dissipated. In this connection let me observe that in all infectious processes characterized by inflammatory manifestations in the pharynx the greatest relief to the child may be secured through careful cleansing of the retro-nasal cavities. In diphtheria, for example, the greatest comfort is experienced by attention to this expedient. To digress still further: In the ordinary acute catarrhal throat affections of infancy much comfort may be given, and the tendency to spasm diminished, by careful attention to the nasal and retro-nasal cavities.* There is an old woman's saying, in this part of the country, that "if a croupy child sneezes, it is well." But no one ever thinks of the nasal passages in connection with a croupy infant. Yet there is, nevertheless, always more or less inflammation of the post-nasal passages, and the tendency to spasm may be diminished by cleansing the passages of mucus, especially before the child retires for the night.†

There is an affection of the skin which is observed in connection with certain forms of coryza, and notably that of sympathetic origin, or rhinitis sympathetica. I refer to urticaria. It appears and subsides with the coryza, and seemingly depends upon the imperfectly defined neurosis or vaso-motor influence which is probably the connecting link between the two affections (possibly some functional derangement of the cervical sympathetic).

Passing now to the *reciprocal relationship existing between the turbinated nasal tissue and the auditory meatus and middle ear*, it is not an uncommon matter in my experience to find that the subjects of chronic nasal inflammation suffer from a more or less constant dryness and itching of the former or a tendency to the inspissation of cerumen, and this, apart from existing disease of the middle ear. I have on several occasions adverted to the rôle of congestive conditions of the erectile tissue in the production of middle-ear affections (doubtless through reflex influence). It remains for me to call attention to the fact that unilateral coryza, either acute or chronic, sometimes depends upon irritation of the external auditory passage. Two years ago I was consulted concerning a case in which a severe unilateral discharge, with stoppage of the nostril, hemicrania, and other phenomena referable to the same side, of a number of weeks' duration, was completely dissipated by the removal of a mass of impacted cerumen from the ear of the affected side; and recently, a similar case has come under my professional care, in which the swelling of the erectile tissue disappeared upon removal of the ceruminous plug. In the presence of these facts the conclusion is irresistible that an intimate physiological relationship exists between the nasal cavities and the auditory meatus.*

It has thus been shown *that nasal and laryngeal inflammation may proceed from the direct or indirect (reflex) irritation of a host of substances derived from the external world, from an almost indefinite number of pathological conditions of the system as a whole, or from irritation or disease of organs distant from the seat of local inflammation.* The predisposing influence of *certain structural peculiarities of the nasal chambers* remains to be briefly adverted to. These consist most commonly in deflection (or malposition) and perforation of the septum, anomalous conditions of the turbinated bones (hypertrophy, abnormal position, atrophy ?), and disturbance of the anatomical relations of the nasal fossæ, either through accident or disease. There are certain anomalies of structure of the throat and nasal passages that are seen in several members of the same family which are undoubtedly inherited, and which are of such a nature as to give rise to no inconvenience, or, on the other hand, encourage the development of inflammatory processes; in the latter case their influence is purely mechanical. There also exists in some families a *peculiar vulnerability of the mucous membrane* of the nose and throat, which is sometimes conspicuous for several generations. Such persons are said to "inherit" catarrhal inflammation, or to be the subjects of the "catarrhal diathesis"—a view which has descended to us chiefly from the earlier French physicians. It is undoubtedly true that the children of parents debilitated by disease, excesses, or other causes, or who inherit, for example, the enfeebled constitution of the syphilitic or tubercular, diatheses well known as predisponents to catarrh, may, by virtue of the inheritance of a vice of constitution, yield more easily than those of healthy parentage when exposed to the exciting causes of the disease; but there is no evidence yet adduced that puts beyond a reasonable doubt the descent of a simple inflammation from father to son. These remarks apply with equal force to the so-called catarrhal diathesis, which latter may be looked upon simply as a generic term for a multitude of varied physical peculiarities, each susceptible, upon close analysis, of reference to a definite and tangible cause, or to a combination of injurious influences.

Catarrhal inflammations of the nose and throat in the newly born, when not due to gonorrhœal inoculation, probably owe their origin to causes operating during intra-uterine life.† It occasionally happens that inflammatory affections of these cavities are *ushered in at some physiological epoch, as puberty, or existing disease dissipated by the nutritive changes which occur at that period.* The subacute laryngitis which occurs at puberty occasionally de-

* In this disease, too, the paralytic condition of the palatal muscles interferes materially with the voluntary removal of secretion from the retro-nasal space.

† *The influence of the febrile state is also occasionally exerted in the direction of cure of existing catarrhal disease of the nasal passages and throat.* This is especially true of those affections with special tendency to local manifestation in the throat, and the cure may be permanent or temporary. I have also observed complete disappearance of a naso-pharyngeal catarrh during the course of malarial fever. (See paper read before the Am. Laryngological Association, May 12, 1884.)

* In certain persons notably those of highly developed nervous organization, or in the hysterical or hypochondriacal, coryza is occasionally produced by direct impression upon the olfactory nerve, or, from simple association of ideas, by physical or mental over-exertion or emotional excitement. Here there is usually some coexisting local nasal disease or vaso-motor neurosis, and such cases are closely allied to, if not a part and parcel of, the sympathetic form of rhinitis (rhinitis sympathetica). (See abstract in Maryland Medical Journal, April 11, 1885, of paper read before the Clinical Society.)

† See article by the author in Phila. Medical News, October 4, 1884.

velops into a chronic inflammation, especially in the subjects of inherited constitutional vices—a fact which it is well to bear in mind both in a prophylactic and prognostic point of view. Inflammatory conditions of the throat and nasal passages occasionally make their appearance at the menstrual period, appearing either coincidently with the uterine hæmorrhage or as the vicarious representative of that process, and I have seen one case where a catarrhal affection of these passages ushered in the menopause and subsided with the termination of menstrual life.*

Etiology of Pharyngeal and Laryngeal Inflammation.—The chief predisposing causes of acute pharyngo-laryngeal inflammation are the existence of chronic hyperæmia or inflammation of the naso-bronchial tract, abnormal state of vitality from inherited or acquired disease, excesses, subjection to imperfect sanitary conditions, and constant confinement to a vitiated atmosphere. While in the vast majority of instances acute inflammation of the pharynx or larynx occurs as a complication of acute or chronic naso-pharyngeal (or bronchial) catarrh, it may nevertheless be met with as a primary affection. I do not share the extreme view of my friend Dr. Bosworth, who has written so well upon this subject, that acute laryngitis only occurs as a symptom of the chronic form. While I regard the existence of the latter as its most prominent predisposing cause, it is nevertheless true that the disease may appear as a primary affection limited to the laryngeal or pharyngeal structures.

Apart, then, from the inflammation resulting from local pathological processes, mechanical or chemical injury, abuse of the forces of expiration and inspiration, the isolation of this disease in the larynx (acute primary laryngitis) is one of the rarest of pathological events. In adult and infant it most commonly occurs as a complication of acute nasal catarrh, or as a part of a general inflammatory condition of the naso-bronchial tract. I am inclined to believe that in the irritable state of the nasal tissues and notably the cavernous bodies, resides an important etiological factor in the adductor spasm which characterizes the disease in the infant; the engorgement of the sensitive area when the recumbent posture is assumed and the gravitation of the nasal secretions into the laryngeal vestibule being the most important agents in awakening the reflex laryngeal spasm. In the adult, acute catarrh of the larynx is a relatively rare disease, a fact which is remarkable, as Flint[7] has pointed out, in view of the frequency of acute pharyngeal inflammation, and illustrates the conservatism of the natural law in regard to the extension of inflammation.

The reflex or collateral hyperæmia of the larynx which is present in inflammatory conditions of the nasal and pharyngeal cavities is too often mistaken for acute inflammation, and confusion too often arises, especially when the laryngoscope is not available, from failure to remember the simple truth that hoarseness is not laryngitis.

Chronic catarrhal laryngitis as an isolated affection is rarely met with; it is almost invariably secondary and associated with inflammatory disease of the nose or nasal pharynx, upon which it, in the large majority of cases, depends. Indeed, setting aside the inflammation which results from purely local irritation, it may be laid down as a law that the vast majority of cases of catarrhal, pharyngeal, and laryngeal disease originate primarily in inflammation of the nasal cavities. Catarrhal rhinitis leads to inflammation of the pharynx and larynx in one or all of the following ways:

1. By mouth-breathing, which, I may say, acts not only through the irritation of the cold, dry, and impure air inspired through the mouth, as in nasal obstruction, or through the nasal passages, as in atrophy of the turbinated structures, but also by crippling the respiratory and vocal forces, shortening both inspiration and expiration, compelling rapid respiration and resulting vocal and respiratory fatigue.
2. By the constant endeavor to overcome the loss of nasal power and resonance, and the consequent pharyngeal and laryngeal fatigue.
3. In certain cases, by interference with the normal motility of the palatal structures.
4. Through reflected irritation.
5. By the irritation of the atmosphere, vitiated in some instances, not by virtue of its passage through the mouth, *but through the nasal chambers themselves.*
6. By so-called extension of inflammation.
7. Possibly by irritation of secretion.

In studying the pathological conditions of the naso-pharyngeal space and middle ear, we may, for practical purposes, regard these cavities as accessory to the nasal chambers, so intimately interwoven is their pathology with a diseased condition of the nasal fossæ. As stated elsewhere,[8] in a large proportion of cases of so-called middle-ear inflammation the latter "is merely a symptom of nasal catarrh, and gradually disappears without special treatment upon the removal of its primary cause." When the middle-ear affection is thus symptomatic, it is generally traceable to mechanical causes or to reflected irritation.

Inflammatory conditions of the naso-pharyngeal cavities are encouraged, and existing disease of these structures perpetuated by paralytic conditions or defective muscular power (*e.g.*, from existing chronic inflammation, enlarged tonsils, defective innervation, etc.), or from abnormal approximations of their walls (from adhesions). As a consequence of the impaired functional exercise of the structures thereby induced, congestive and catarrhal processes develop in the laryngeal cavity, which result from the constant endeavor by abuse of the expiratory forces to overcome the loss of power in the pharynx. Both loss of power and adhesions, which latter act by crippling muscular action and disturbing normal anatomical relations, tend also to prevent voluntary cleansing of the retro-nasal space, and thus form another factor in the persistence of the chronic inflammatory process.

Finally, I wish to observe that in a large proportion of cases it will be found, upon careful examination, that the existence of the nasal, pharyngeal, or laryngeal affection is not due to any one particular cause, but to a combination of injurious influences—the resultant of a number of internal and external forces.

Hyperæmia of the Larynx and Trachea.—Hyperæmia of the larynx and trachea may be active or passive, acute or chronic, according to the causes to which it owes its existence. In addition to those which determine hyperæmia and catarrhal inflammation of the mucous membrane of the respiratory tract in general (*vide* article on Etiology of Catarrhal Affections), hyperæmia of the laryngo-tracheal membrane occurs as the result of mouth-breathing from nasal and post-nasal obstruction, by extension from adjacent cavities, or as a purely reflex phenomenon from disease or irritation of the ear, nose, pharynx, and buccal cavity, and in some instances from over-stimulation or disease of the generative tract. Hoarseness and congestion of the larynx have been observed, too, in connection with the presence of parasites in the intestines and hæmorrhoidal affections. Faulty methods of singing and breathing, and especially, as Mandl[9] has pointed out, the habitual use of the clavicular method of respiration, the irregular use of the voice, loud declamation, singing, etc.; in fine, anything which induces fatigue of the vocal organs, will culminate in laryngeal hyperæmia. Long-continued and violent paroxysms of coughing may induce it, but their influence has been doubtless overrated The habitual use of alcohol, and in some persons tobacco; the unnatural gratification of the appetites; constant exposure to the fumes of irritating gases and vapors; confinement to an impure, close, dusty, or overheated atmosphere, and the use of comforters and other forms of neck-wrap predispose to congestive disorders of the laryngo-tracheal membrane. It occurs as a complication of syphilis, tuberculosis,

* See on this subject a paper by the author, on Irritation of the Sexual Apparatus as an Etiological Factor in the Production of Nasal Disease, Am. Jour. of the Med. Sci., April, 1884. (Prize Essay, Maryland Academy of Medicine.)

rheumatism, gout, Bright's disease, malarial poisoning, the acute infectious diseases, influenza and coryza ; of growths, ulcers, foreign bodies, and certain diseases of the œsophagus and thyroid gland.

Passive hyperæmia of the larynx and trachea is present in chronic valvular diseases of the heart and obstructive lesions of the lungs ; in compression of the neck, thorax, or abdomen by articles of clothing, tumors, aneurisms, enlarged glands, hypertrophied thyroid, abscess, etc.; in fine, anything that tends to produce obstruction to the venous circulation of the throat and neck.

The change of voice at puberty is associated with more or less laryngeal hyperæmia. Elongation of the uvula, if it act, as has been alleged, as an excitant of laryngeal hyperæmia and cough, probably does so through the medium of reflex action and not from direct irritation of the laryngeal membrane.*

Hyperæmia of the larynx occurs from the presence of foreign bodies in the œsophagus, or from disease of its membranous or muscular coats, and in certain pathological conditions of the thyroid gland. It also occurs in some females at the menstrual period, in the course of pregnancy, and during or after coition. It may complicate paralytic conditions of the intrinsic muscular apparatus of the pharyngo-laryngeal tract, or occur as a manifestation of hysterical and hyperchondriacal affections and pathological states of the brain and spinal cord. Pressure on the recurrent laryngeal nerves sometimes induces hyperæmia through vaso-motor influence reflected through the superior cervical ganglion.

Eppinger calls attention to the fact that, in suffocation from direct mechanical compression, venous hyperæmia does not occur, while the pharynx becomes deeply cyanotic ; and offers as an explanation of this fact the protected situation of the thyroid artery, the easy escape of venous blood into collateral channels, and an especially well-marked contractility of the arterial vessels.[10]

Hyperæmia of the larynx occurs from suppression of the functions of the skin, or from the sudden disappearance of a cutaneous exanthem.

I would call special attention to the laryngeal hyperæmia which sometimes results, not from excessive vocal strain and fatigue, but from habitual or intermittent disuse of the voice. Systematic functional exercise is necessary to the physiological integrity of the vocal apparatus. In voluntary or enforced rest of the voice, if prolonged, a passive hyperæmia is occasionally produced of sufficient pathological importance to demand the recognition of the practitioner. This, which may be termed hyperæmia from disuse of the vocal forces, is especially well marked in public speakers and singers in the intervals of rest from professional labors, and disappears without treatment upon the resumption of the same.

The systematic use of the voice is a safeguard against congestive conditions of the larynx ; its irregular use, on the other hand, often predisposes to the opposite result. Thus, for example, the public speaker who makes daily professional use of the voice is much less liable to yield to conditions productive of hyperæmia than he who exercises his vocal muscles to the same extent, but at longer intervals.

A certain degree of hyperæmia may exist without impairment of function, even in those who habitually use the voice in the exercise of their professional duties. It is not uncommon, for example, to find a more or less congested or muddy condition of the cords in public speakers and singers, and that without the slightest abrogation of their vocal powers.

The laryngoscopic appearances consist simply in localized or diffuse injection of the mucous membrane, with a peculiar pinkish coloration of the cords due to dilution of the rays of the reflected light.

The parts most frequently affected are the interarytenoid fold, the vocal cords, the mucous covering of the arytenoid cartilages and the epiglottis. The normal lustre of the tracheal rings becomes dulled, and the spaces between them dark and congested. The color of the membrane varies greatly according to the causes which produce the hyperæmia. It may be said, in general, that the hyperæmia which results from arterial dilatation produces a brighter coloration, while that which follows venous obstruction, and that occurring in low forms of acute disease, expresses itself in darker shades of red. Occasionally, and especially is this the case in arterial congestion, small ecchymotic spots are discovered which represent small capillary hæmorrhages. In long standing cases, when the hyperæmia is due to some obstruction to the circulation, a varicose condition of the vessels is found, which has been compared to analogous hæmorrhoidal conditions of the rectum.

A peculiar mottled appearance of the mucous membrane, and especially of that covering the vocal cords, is said by some to be characteristic of syphilis, but it may also occur in other conditions. If this mottled condition, however, be bilateral and symmetrical, it should arouse a certain amount of suspicion as to the nature of the disease, and direct attention to its possible specific origin.

The microscopical appearances consist simply in dilatation and engorgement of the blood-vessels of the upper layers of the membrane. The thickening of these structures and the œdematous infiltration which are observed in long-standing cases of venous congestion, are more probably referable to commencing catarrhal inflammation than to a purely vascular disturbance.

Symptoms.—A certain degree of laryngeal hyperæmia may exist without exciting attention, its presence being detected only by accident or during the professional use of the voice. When limited to the interarytenoid fold, it manifests itself as a short, hacking, explosive cough, generally accompanied or preceded by a sense of tickling, usually referred to the region of the crico-thyroid space. When the cords are involved the voice becomes veiled, loses its tension, becomes easily fatigued, and hoarseness of different grades supervenes. The larynx feels dry and sometimes painful sensations are complained of after smoking, drinking, or indulgence in excesses of any kind, or after the use of the voice in singing or speaking.

The *Prognosis* and *Treatment* will obviously depend upon the causes that condition the hyperæmia. These should be carefully sought for, and, if possible, removed. The measures addressed to the larynx itself consist in soothing inhalations, and mild astringent and alterative sprays. A weak solution of an astringent in oil or glycerine, or the oil alone, will be found most soothing to the irritable mucous membrane. For the tickling and cough a powder containing boracic acid and morphia, allowed to dissolve slowly on the tongue, or lozenges of guiac, cubebs, cocaine, and similar substances may be confidently recommended.

In cases of persistent laryngeal hyperæmia due to loss of vaso-motor control, much benefit may be derived from tonics addressed to the nervous system.

HÆMORRHAGE FROM THE LARYNX AND TRACHEA.—Hæmorrhage from the larynx and trachea occurs as the result of mechanical or chemical injury, as a symptom of various pathological conditions, or it may be the vicarious representative of a physiological process.

The hæmorrhage which results from traumatism generally takes place into the submucous areolar tissue, and is commonly associated with more or less laryngeal œdema. It may occur directly after the accident, or several days thereafter, as in the case reported by Barbillier,[11] in which hæmorrhage with consecutive fatal œdema took place six days after an incised wound between the thyroid cartilage and hyoid bone.

Violent expiratory efforts, as in paroxysms of coughing, loud declamation, or forced intensity of the voice from any cause, may give rise to extravasations of blood, which usually come from the small vessels which course along the edges of the cords. In these hæmorrhages, which take place upon the upper surface of one cord, both being rarely affected, the clot may form beneath the membrane, or rupture of the latter may occur, with extravasation

* The elongated uvula rests upon the dorsum of the tongue, and does not insinuate itself into the laryngeal cavity. Moreover, it would require an uvula of extraordinary length to impinge upon those portions of the larynx that are concerned in the production of cough.

upon the surface of the cord. The affected cord may or may not be suffused.

Capillary hæmorrhages, or apoplexies, are found not infrequently in inflammatory conditions of the larynx (see sections relating to these subjects) in purpura, scurvy, hæmatophilia, and allied affections, in hæmorrhagic smallpox, and from the toxic or "idiosyncratic" influence of certain drugs, as phosphorus, mercury, chromium, antimony, and other agents eliminated through the mucous membrane of the respiratory tract.

More or less bleeding is common to all ulcerative processes in the larynx; in carcinoma and tuberculosis it is not infrequently the immediate cause of death, and a case is recorded by Türck in which the latter occurred from erosion of the lingual artery from a syphilitic ulcer of the right sinus pyriformis (see article on Larynx, Syphilis of). In women suffering from catarrhal disease of the larynx, hæmorrhage occasionally takes place at the menstrual epoch, or it may occur in the normal larynx as a vicarious flux. Tobold [12] relates a case in which hæmorrhage of the vocal cord occurred during the vomiting of pregnancy.

Erosion and thinning of the walls of the trachea by an aneurismal or other form of tumor may lead to alarming hæmorrhage from the windpipe. The blood may be expectorated at intervals and in small amounts at a time, or sudden perforation may occur, and immediate death ensue.

Hæmorrhage from the larynx occasionally takes place from the rupture of varicose veins during violent expiratory efforts.

The hæmorrhage occurring in the course of catarrhal affections, or as the result of vocal strain, is usually inconsiderable in amount and need not excite alarm, extensive idiopathic fatal hæmorrhage, as in the cases of Bogros [13] and Pfeufer [14] being probably exceedingly rare.

Under the title "Laryngitis Hæmorrhagica" Fraenkel [15] and others have described a parenchymatous hæmorrhagic infiltration of the mucous membrane which occurs apart from any specially well-marked indication of laryngeal disease, but there seems to be no legitimate anatomical reason to justify such a clinical refinement.

The hæmorrhage which follows operations on benign growths in the larynx is, as a rule, trifling in amount. When old adhesions from syphilis, etc., have to be divided it is, however, often considerable, and a case is recorded in which ligation of the carotid was necessary to arrest the bleeding produced by the division of a syphilitic adhesion with the galvano-cautery.

Slight hæmorrhage manifests itself in a reddish or reddish-brown discoloration of the sputa. Hæmorrhage into the substance of the vocal cords may be suspected when sudden and complete aphonia, accompanied or followed by tickling or pain in the larynx, occurs during the overuse of the voice, and is followed by the expectoration of a small quantity of clotted blood; especially if after such an event there is a painful sensation in the throat upon attempted phonation. When the hæmorrhage is extensive, as occurs, for example, in certain low forms of fever, symptoms of laryngeal obstruction at once supervene which call for tracheotomy, or which may be relieved by the expectoration of the clots, as happened in the case of Fraenkel.

The local application of astringents by cotton carrier, spray, or powder, either alone, or assisted by the swallowing of cracked ice, or by hypodermatic injections of morphine, is generally sufficient to arrest most hæmorrhages proceeding from the larynx. In extensive hæmorrhage with œdema scarification should be at once resorted to, and in the event of failure to relieve the urgent dyspnœa no time should be lost before resorting to tracheotomy.

Acute Catarrhal Laryngitis.—*Historical Sketch.*—The history of laryngeal inflammation is coextensive with the literature of laryngology. Laryngitis, although often confounded by the ancients with pharyngitis and diseases of the tonsils, has always been one of the most common affections to which the human race is liable. While, then, it does not come within the scope of the present work to offer a complete historical narrative of this affection, it may be interesting to refer very briefly to the writings of those who, in the prelaryngoscopic era, chiefly directed attention to the larynx as a frequent seat of inflammatory processes.

In the ancient Hindoo system of medicine, coryza and catarrhal affections in general were supposed to arise in some vague manner from he three sources, which the writers of that period looked upon as the fountain-heads of all diseases, viz., the bile, the air, and the phlegm. Hippocrates and his followers taught that the vapors arising from the body excited in the brain a secretion which flowed down into the nose through the perforations in the cribriform plate, and through the ethmoidal and sphenoidal cells. Galen went so far as to assert that the pituitary gland and the ventricles were the reservoirs from which the discharge was obtained.* These views of the Greek physicians, whose notions of the etiology of disease were curiously influenced by the prevailing philosophical doctrines of their time, were followed by those of the Arabian school, which were imported into Europe and prevailed on the Continent as late as the seventeenth century, when they were completely overthrown by the colossal labors of Conrad Victor Schneider.[16] It is true that Van Helmont [17] had long before assailed with consummate satire "the gray-haired dreams of the Grecians;" that Cardan [18] had previously shown that the secretion came sometimes from the secreting portions of the nasal mucous membrane, and that Botal [19] had entered an anatomical protest against the hypothesis of the ancients; but it is chiefly due to the exhaustive anatomical researches of Schneider that their absurdity was demonstrated.

According to Schneider, catarrh is a disease of the blood which manifests itself as a discharge of mucus from the vessels of the various mucous membranes of the body. Among the external causes of the disease the dampness which comes from certain conditions of the atmosphere was supposed to enter the circulation through the pores of the skin and excite catarrh in the different organs. In this way, too, vitiated air, entering and stirring up the blood, was supposed to account for the epidemic occurrence of coryza.

Schneider [20] gave a good description of laryngitis under the title of "Catarrh of the Posterior Pituitary Membrane," and his versatile contemporary, Severinus,[21] dilated upon the subject with considerable detail.

About the middle or latter part of the seventeenth century, the illustrious Sydenham [22] described inflammatory affections of the upper respiratory tract under the generic term "quinsy," and looked upon them, as did Hippocrates [23] before him, as diseases of the spring.

In 1675, an excellent treatise on the voice and its affections appeared, written by Schelhammer,[24] who, following the ancients, included laryngeal inflammation under the terms *raucedo* and *aphonia*.

In 1688 Ettmuller [25] described the disease as it occurs in children, and in 1680, Lower,[26] evidently inspired by the discovery of Harvey, and the anatomical researches of Schneider, devoted an essay to the pathological nature of catarrhal affections. Among the many special treatises and essays which appeared in the seventeenth century, the dissertation of Hannæus [27] deserves special mention, as an excellent exposé of the etiology of laryngeal affections.

In the following century Bonetus,[28] inspired by the experience of Spigelius, adverted to inflammation of the larynx, and Boerhaave,[29] and later his learned and devoted commentator, Van Swieten,[30] showed their knowledge of the various forms of laryngeal inflammation by the accuracy and thorough-going way in which they described them.

The writings of Boerhaave, and later Schacht,[31] were taken up by their pupils and followers, and a large number of theses appeared, among which the dissertation of Esgers [32] deserves special commendation.

In 1760 Morgagni [33] prepared the way for the study of the pathological anatomy of the disease, and endeavored

* For the various theories concerning the nature of catarrhal processes, see the article on Nose, Catarrhal Affections of.

to stimulate research in the direction of laryngeal affections. Neglected by contemporaneous, and subsequent observers, the subject was again prominently brought into notice by the observations of Benjamin Rush [34] in this country, and John Millar in England.[35] The literature which followed the publications of Rush and Millar is enormous, and amounts simply to a confusion of acute and chronic laryngitis with asthma, croupous laryngitis, and various reflex laryngeal neuroses. Of his contemporaries, Josef Peter Frank [36] seems to have had the clearest conception of the laryngeal affection, which he portrayed in a chapter which, for terseness of style and accuracy of description, outranks the productions of his predecessors.

In the meantime, Hoffmann [37] had advanced the view that catarrh was the local expression of a general febrile state, and that the appearances on the mucous membranes were evoked by the irritating properties of the serum and lymph, which were cast off as a critical discharge from the glandular parts. Hence, among subsequent writers, the inflammatory affections of the nose and throat are lost in the inflammatory fever, or febris catarrhalis of the last century.

In 1799 the attention of the medical world was forcibly called to acute laryngeal inflammation by the death of Washington. At this time the disease was scarcely recognized as an independent affection.

In the early part of the present century the subject of laryngeal inflammation received considerable attention at the hands of Vogel [38] and Reil,[39] in Germany, and Cabanis [40] and Portal,[41] in France, and a number of cases illustrative of its pathological anatomy were collected by Van der Bosch,[42] Voigtel,[43] and Otto.[44]

About this time Pinel [45] taught that catarrh was an inflammation or exaggeration of function of the mucous membrane—a view which soon obtained a foothold among his contemporaries.

Up to the year 1808 the greatest confusion prevailed concerning the acute form of laryngeal inflammation. By the majority, or perhaps all, of the writers of that period the disease was unknown, or confounded with various spasmodic affections. The first to distinctly announce its existence as a separate disease seems to have been Dr. Dick,[46] who, in an article on croup, described acute laryngitis under the title *Cynanche Laryngea.* Four years later the same affection was described as a new disease by Matthew Baillie,[47] Everard Home,[48] and Farre;[49] and later on the more chronic form of the disease was portrayed by Albers,[50] in Germany, Porter [51] and Stokes,[52] in Dublin, Ryland,[53] in England, and Chapman [54] and Swett,[55] in America.

In 1846 appeared the work of Horace Green,[56] which was destined to revolutionize the treatment of laryngeal affections, and to throw new light upon their pathology. Green's researches form an epoch in the study of laryngeal inflammation. The universal comment which they excited led to a number of communications upon the subject, which were followed some years later by the dawn of the laryngoscopic era.

Varieties of the Disease.—There are two forms of acute catarrhal laryngitis. In the one the morbid process is limited to the mucous membrane, while the other is characterized by its extension to the submucous connective tissue. The former is not infrequently met with; the latter, when not produced by direct violence or acute infectious processes, is a much rarer type of disease.

Etiology.—The existence of hyperæmia and chronic inflammation of the naso-bronchial tract, a lowered state of vitality from inherited or acquired disease, excesses, subjection to imperfect sanitary conditions, and constant confinement in a vitiated atmosphere are the chief predisposing causes of acute catarrhal laryngitis. The disease generally occurs as a complication of acute nasal or bronchial catarrh, and rarely from extension of inflammation from the lower pharynx. The infrequency of its occurrence in the latter case, as Flint [57] has pointed out, is remarkable, in view of the frequency of acute pharyngeal inflammation, and illustrates the conservatism of the natural law in regard to the extension of inflammation.

Acute laryngitis complicates scarlet fever, measles, and other essential fevers, and has been observed as a leading feature during the epidemic occurrence of certain diseases, notably erysipelas. A subacute form is often present in so-called "influenza," and "hay-fever," and allied disorders, and may even exist as a complication of certain cerebro-spinal affections.[58] It must be remembered, on the other hand, that some diseases of the cervical cord may so simulate laryngitis as to render resort to the laryngoscope necessary to diagnosis.[59]

Acute laryngitis occasionally results from the suppression of a rheumatic or gouty attack. In the former disease, the inflammatory action may or may not proceed from the articulating surfaces of the larynx, and Klencke [60] has described an "inflammatory aphonia," which occurs after suppressed gout leading to exudation into the muscles and nerve-sheaths.

A mild form of catarrhal laryngitis is occasionally seen as the result of reflected irritation from remote or adjacent organs of the body, as the skin, the genito-urinary and gastro-intestinal tracts, the teeth, gums, tonsils, turbinated nasal structures, external auditory meatus, thyroid gland, œsophagus, etc.

A violent form of acute laryngitis follows the inspiration of flames, boiling water, the incautious use of instruments and certain topical applications, the presence of foreign bodies, and various surgical injuries of the larynx and neck. (See also Glottis, Œdema of the.)

Abuse of vocal intensity, as, for example, in forced declamation, screaming, etc., may precipitate a mild attack of laryngeal catarrh. (See also section on Etiology of Catarrhal Affections.)

Pathological Anatomy.—The pathological appearances are those of simple catarrhal inflammation. There is more or less diffuse swelling of the entire mucous membrane, or the process may be limited to individual portions of the larynx, as the ary-epiglottic folds and epiglottis, and even the vocal cords may be alone affected, the remaining portions of the larynx participating but slightly in the inflammation. The hyperæmia is not always well marked after death, a fact due, as Niemeyer [61] has pointed out, to the richness of the laryngeal membrane in elastic tissue, and the consequent expulsion of the blood from the capillaries during the post-mortem contraction of its fibres. The writer recalls cases where the laryngeal mucous membrane of those dying during the existence of acute laryngeal catarrh presented the very opposite condition from that of injection, and in which the only evidences of a pre-existing inflammatory condition consisted in slight desquamation of the epithelium, and minute extravasations of blood into the substance of the mucous membrane.

Superficial erosions of the mucous membrane are not infrequently met with, and are due not only to the inflammatory process, but also, in some instances, to the loosening of the epithelium from violent expiratory efforts. It is questionable whether true ulceration ever occurs as a result of acute catarrhal laryngitis.

The swelling is not always confined to the superficial layers, but involves the deeper portions of the membrane with their glandular constituents. In the secretion, therefore, in addition to the cast-off cells of the upper layer and the lymphoid corpuscles, we find the epithelial elements of the glands themselves. It is the preponderance of these so-called "mucous cells" that gives to the secretion its peculiar frog-spawn appearance.

Symptoms.—Acute inflammation of the larynx may develop insidiously, the symptoms at first resembling those of hyperæmia or a mild form of subacute inflammation; or its onset may be sudden and severe. The voice, at first shrill, hoarse, uncertain, becomes rapidly aphonic; pain is felt in its attempted use, and disagreeable sensations, referred to the presence of a variety of foreign substances (pins, hairs, sand, etc.) in the throat, are constantly present, which provoke a short, hacking cough, and ineffectual efforts to clear the throat. Tenderness of the larynx on pressure is sometimes complained of, and a sense of constriction; but these symptoms are generally inconspicuous in the superficial form of the disease.

Respiration is rarely embarrassed, except in children and in the parenchymatous variety of the disease. In the latter the amount of its impairment depends not only upon the degree of swelling, but also upon its anatomical seat.

At the outset the laryngeal secretions are arrested, the throat feels dry and rough, and the paroxysms of coughing are ineffectual. Later, there is a mucous expectoration, resembling somewhat frog-spawn, which is sometimes streaked with blood, and which becomes muco-purulent as the disease undergoes resolution. Febrile movement, if present, is not, as a rule, well marked.

In children the small size of the rima glottidis, the imperfectly developed and more vulnerable laryngeal structures, and the notable tendency to spasmodic affections of the larynx, combine to make the affection one of considerable gravity. The symptoms detailed above are accentuated, and the suffering is much more intense. The cough assumes a peculiar stridulous, or shrill metallic, "croupy" character, which has suggested the synonyms "inflammatory croup," "stridulous laryngitis," "laryngitis spasmodica," "pseudo-croup," etc.

Acute catarrhal laryngitis in children is characterized, then, by the occurrence of suffocative attacks of glottic obstruction, which are paroxysmal in nature, and which take place nearly always during sleep. During the paroxysm the symptoms are those of laryngeal obstruction or stenosis (see articles on these subjects). The character of the breathing will depend upon the portions of the larynx involved. If the upper part alone be affected, the dyspnœa will be wholly inspiratory, while if the entire surface become swollen or œdematous, both acts of respiration will be embarrassed. During the attack, which varies greatly in duration, death seems imminent; the temperature rises often to a considerable height, and there is hardness and increased frequency of the pulse. A painful, abortive cough adds to the intense suffering, symptoms of asphyxia develop, and coma and convulsions may ensue. Generally, however, the paroxysm is terminated by vomiting, or by the copious expectoration of a muco-purulent secretion, the alarming symptoms subside, and the child falls asleep, probably from the drowsy condition determined by the excess of venous blood in the brain. In some cases, in which the attack has been of long duration, the little patient may pass from this drowsy condition into a state of coma or delirium.

The spasmodic dyspnœa, which is characteristic of the disease in children, has been variously interpreted. According to some, its explanation lies in the spasmodic approximation of the vocal cords from the reflex adductor spasm, and in the relatively small size of the glottis in children. Others, again, as for example, Ziemssen[62] and M. Mackenzie,[63] attribute it to obstruction of the glottic orifice during sleep by inspissated mucus. It is more than probable that both of these views are partially true, and that the chain of events may be as follows: (1) Gravitation and accumulation of inspissated mucus, not in the glottic chink, but in the interarytenoid fold (laryngeal cough area), to which it is directed by the recumbent posture; (2) stimulation of this area, and (3) resulting reflex adductor spasm.

The writer is inclined to lay stress upon the swollen and irritable condition of the nasal tissues, and notably the cavernous bodies, as an important etiological factor in the production of the adductor spasm of this disease, the engorgement of the sensitive nasal area (*vide* Nose, Neuroses of) when the recumbent posture is assumed, and the gravitation of the nasal secretion into the vestibule of the larynx being the most important agents in awakening the reflex laryngeal spasm. In some cases, at least, the acute laryngitis, so called, is simply a symptom of nasal irritation, and will subside upon appropriate treatment of the nasal cavities.

The *laryngoscopic appearances* are redness and swelling of the affected portions of the mucous membrane, with the occasional presence of minute capillary hæmorrhages or illy-defined erosions. During life the latter are inconspicuous and liable to be overlooked. Inspection not infrequently reveals the fact that the changes in the voice may be due not only to the inflammatory condition of the cords themselves, but also to the interference with their mobility from the mechanical obstruction offered by the swollen mucous membrane. Thus the approximation of the vocal ligaments may be prevented by swelling of the interarytenoid or anterior commissures, or by great thickening of the ventricular bands. Ziemssen,[64] however, thinks that the hoarseness of the voice depends more often upon some imperfectly understood change in the innervation or in the muscles of the larynx themselves, leading to an inequality in tension of the vocal cords. This, furthermore, explains, according to the same writer, the peculiar shrillness and jarring character of the voice in the early part of the disease, as well as the bowed condition of the cords and patency of the respiratory glottis which are sometimes seen on laryngoscopic examination.

Secretion is usually scanty, and is generally found on the surface of the cords or issuing from the ventricles. Occasionally the mucous membrane has a whitish appearance, as if brushed over with nitrate of silver (Türck), due to cloudy swelling of the epithelium.

The symptoms of the parenchymatous form of acute laryngitis are those of laryngeal œdema and stenosis. (See articles on these subjects.)

Complications and Sequelæ.—Acute inflammation of the larynx may be complicated by acute coryza, naso-pharyngeal catarrh, tracheo-bronchitis, and pneumonia, or may occur as a part of an acute diffuse inflammation of the whole respiratory tract. Severe cases may lead to œdema and cellulitis of the neck or trachea,[65] and to laryngeal abscess, with necrosis and exfoliation of cartilage, or they may leave behind them permanent structural changes in the muscular apparatus of the larynx, and in rare instances a chronic laryngitis may date its appearance from an acute catarrh. The disease generally lasts from three to ten days; may become subacute, rarely chronic, except, perhaps, from constitutional causes.

Diagnosis.—If a laryngoscopic examination can be made, there will be no difficulty as to the diagnosis. If this be impossible, careful inquiry into the history of the case, examination of the pharynx and nasal passages, and a full appreciation of the constitutional symptoms, when present, with the physical examination of the neck and thorax, will serve to differentiate the affection from diphtheria, "false croup," and other spasmodic diseases of the larynx. It should be remembered, in this connection, that hoarseness is not laryngitis. The pressure of a thoracic aneurism, hysteria, and certain affections of the cervical cord, give rise to symptoms which resemble those of acute laryngitis, or the disease may be simulated, as in the classical case of Demosthenes.

The prognosis will depend upon the age of the patient. Acute laryngitis in the adult is never fatal, except when complicated by œdematous infiltration or hæmorrhage into the submucous tissue. In children the prognosis is less favorable, but good, though the tendency to prolonged spasm, and, in some cases delirium and coma, should not be lost sight of.

Treatment.—The management of acute laryngitis must be regulated by the principles which govern the treatment of acute inflammation in general, with certain modifications which the peculiar physiological properties of the respiratory and vocal organs necessitate.

The patient should be placed in a slightly moist atmosphere ranging from 75° to 80° F., should be made to breathe through the nose, and should keep the vocal organs at rest. If necessary, the bowels should be opened and the transpiratory action of the skin encouraged.

Remedial agents in this disease are constitutional and local. Among the former, the most reliable are quinine and opium. The former should be pushed to cinchonism, and, if taken at the outset, not infrequently aborts the disease or mitigates the severity of its course.* The same is true, in a measure, of the salts of salicylic acid and allied substances. Less efficacious are the prepara-

* In the administration of large doses of quinine and allied drugs due regard should be had to the injurious effects of these agents on the cerebral and aural circulations.

tions of mercury and antimony. The latter, if given at all, should be well diluted to prevent their irritative local influence on the throat (Flint). In order to control the vaso-motor paresis, which is more or less conspicuous in all forms of throat inflammation, resort may be had to the bromides, morphine, belladonna, and allied substances. The tendency to spasm may be lessened by opium and other antispasmodics. Bearing in mind the probable mechanism of the spasm, it is well to thoroughly cleanse the nasal passages and upper pharynx before the child retires for the night. The external application of cold compresses is often of benefit, not only in controlling the inflammatory process, but also in diminishing the tendency to spasm.

Of local remedies, the most rational and efficacious are the vapors of sedative or mildly stimulating substances, such as benzoin, camphor, hops, eucalyptol, cubebs, juniper, and other essential oils. These may be taken by direct inhalation, or their vapors may be diffused in the air of the apartment. In children the latter method is of especial value, or resort may be had to the "tent."

The topical application as spray of a two per cent. solution of muriate of cocaine, a weak spray of boric acid and bromide of potash in glycerine and water, followed by one of oil of sweet almonds, have been used by the writer with gratifying results. The latter spray should also be used in the nasal passages. Later in the disease, weak astringent solutions may be resorted to, and resolution hastened by the administration of alkaline or sulphur waters. Any constitutional tendency or existing diathetic disease should be carefully sought for, and appropriate treatment adopted to secure immunity from possible permanent weakening or injury of the vocal organs.

Caution should be exercised in the topical application of such drugs as strong solutions of the nitrate of silver (Horace Green). While it is undoubtedly true that the anæsthetic, and perhaps alterative, effect of the latter drug is sometimes of decided benefit, it must nevertheless be remembered that the same, if not better, results may be accomplished by a host of other and simpler measures, and the danger thereby avoided of producing a great deal of possible mischief.

An acutely inflamed larynx should be handled with the utmost delicacy, and should not be invaded by probang, cotton carrier, and mop. The writer regards, too, the insufflation of medicine in solid form (powders) as an unnecessary and injudicious procedure in the acute form of laryngeal inflammation. Heed should also be taken not to subject the larynx to unnecessary treatment and manipulation, to the neglect of coexisting disease of the upper throat and nasal passages.

The question of tracheotomy must be decided on the individual merits of each particular case. As a rule, it is uncalled for. In connection with the operation, two things should be kept in mind: (1) that the tendency of the spasm, however alarming to the uninitiated, is to subside without dangerous consequences, and, on the other hand (2) that, in the presence of increased frequency and prolonged duration of the glottic obstruction, the surgeon should hold himself in readiness to make an artificial opening in the trachea.

Subacute Laryngitis.—Subacute laryngitis is a very common affection, whose symptoms are those of a mild form of acute laryngeal catarrh, for which it is often mistaken. It is a common complication of coryza and bronchitis, and is not infrequently the starting-point of chronic laryngeal inflammation.

The laryngoscopic appearances are those of diffuse or localized congestion, with moderate swelling of the mucous membrane and pinkness of the vocal cords. The disease derives its importance from the fact that it is often the precursor of chronic inflammatory affections of the larynx. Bearing this fact in mind, treatment should be begun at once and carried out in accordance with the general principles which regulate the management of simple catarrhal inflammation of the larynx.

Chronic Laryngitis.—Chronic catarrhal laryngitis, as an isolated affection, is rarely met with. Nearly always it is associated with chronic inflammatory disease of the nose or naso-pharynx, upon which it, in the large majority of cases, depends. The manner of its development in this case will be pointed out in the article on Nose, Catarrhal Affections of, and its predisposing and exciting causes will, therefore, be found under that head, and in the sections relating to Laryngeal Hyperæmia and Acute Laryngitis.

While it is doubtless true that frequently occurring attacks of acute laryngitis predispose to the disease, it is rarely ushered in by an acute attack, except under particularly unfavorable circumstances, such as the presence in the individual of some constitutional vice, or the persistent neglect of hygienic and remedial measures. Much more frequently it is the result of a neglected subacute inflammation, or is essentially chronic from the first.

Pathological Anatomy.—Upon post-mortem examination, the mucous membrane of the larynx presents a dark or yellowish-red appearance, pigmented in places; its vessels are enlarged and tortuous, and here and there the remains of capillary hæmorrhages can be seen. It is covered with a more or less muco-purulent exudation, which consists mainly of lymphoid corpuscles and degenerated epithelium. The vessels of the mucosa and submucosa are increased in number and perceptibly enlarged in calibre, and surrounded by a round-cell infiltration. The epithelial layer presents a marked increase in volume, due to an abundant proliferation of its elements. Here and there the epithelium is wanting, or is replaced by a granular or fatty detritus. At the places where the epithelium is more or less intact or undergoing commencing degeneration, the individual cells are surrounded or crowded apart by lymphoid corpuscles. In some cases the papillæ are hypertrophied, and the glands show an increase in volume with desquamation of their epithelium.

There is always more or less hyperplasia of the submucous tissue, which is especially well marked in the hypertrophic form of the disease. The latter is probably more common than is generally supposed, and histological examination discloses more or less hypertrophy of the mucous membrane, in all its layers, in most cases of long-standing catarrhal laryngitis. It is also probable that atrophy of the membrane may occur as a sequel to the hypertrophic form, although this is a question which will have to be determined by future research.

In the so-called "trachoma" of the cords, the histological changes are essentially those of hypertrophy of the different layers of the mucous membrane. In the same category may be placed, too, that form, or rather sequel, of chronic laryngitis first described by Rokitansky,[66] and to which Gerhardt[67] has given the ponderous title of *chorditis vocalis inferior hypertrophica.* The pathological nature of the latter condition, which, as its name implies, occurs most frequently in the subglottic region, has given rise to much discussion. It is characterized by an indurated, tumor-like hypertrophy of the subglottic tissues, with occasional implication of the cartilages and perichondrium,[68] which, in some cases, reaches such a grade as to necessitate tracheotomy.[69] This peculiar indurated hypertrophy of the larynx may owe its origin to a number of pathological states, of which the fibroid degeneration of syphilis, perhaps, forms a not inconspicuous percentage (*vide* article on Syphilis of the Larynx).

Virchow[70] has described as a sequel to chronic laryngitis, occurring especially in chronic alcoholismus, a veritable pachydermatous condition of the vocal cords and adjacent structures, whose starting-point is usually the vocal processes.

In the chronic laryngitis which results from obstructed circulation, the epithelial layer, according to Eppinger,[71] presents simply a slight exfoliation of the epithelium without cell proliferation, and a thickening or condensation of the connective tissue which proceeds from the adventitia of the dilated blood-vessels. Beneath the basement membrane is an aggregation of lymphoid cells, which is especially pronounced between the acini of the conglomerate glands. Particularly well marked is the looseness of the submucous connective tissue. In this

form of laryngitis the secretion is frothy, serous, and contains fewer lymphoid cells.[72]

Symptoms.—The loss of function produced by chronic laryngitis will vary with the extent and character of the inflammation, and with the physiological importance of the structures involved. The symptoms therefore present all grades of local functional impairment, from a slight huskiness of the voice and uneasy sensations in the throat to serious interference with both the inspiratory and expiratory forces of respiration.

Chronic laryngitis is, as a rule, insidious in its development, and the membrane may be affected long before the sensations of the patient lead him to suspect the existence of disease of the vocal organ. Its phenomena are usually preceded by the symptoms of chronic inflammation of the nasal passages and pharynx, and are intensified by those of the accompanying catarrhal naso-pharyngeal affection.

In singers and in all who make a professional use of the voice, the interference with vocalization leads to an earlier detection of the malady. In them it asserts itself in fatigue of the voice after moderate exertion, either as loss of tension, tendency to unnatural hoarseness after singing, or some other form of vocal disability. Great singers rarely suffer from the disease, nor do those in general whose voices have been trained by correct methods of culture, the proper and systematic use of the voice being one of the best prophylactics against inflammatory conditions of the larynx. This fatigue of the voice is due, in a large proportion of cases, to insufficiency of the vocal forces, brought about in the first instance by an unnatural attempt to overcome by abnormal contraction of the expiratory muscles the loss of power and function resulting from naso-pharyngeal disease. The congested condition and increased secretion of the larynx thus brought about are manifested at first by indefinite sensations in the throat with a tendency to cough, and hoarseness on arising in the morning or after the continuous use of the voice, or indulgence in wines, tobacco, and stimulating articles of food.

These symptoms become gradually more severe ; there is a more or less constant sensation of a foreign body in the throat, which gives rise to a short, harassing cough, and efforts of hawking to remove it. The throat becomes dry, and at night a sense of constriction is complained of which sometimes causes the patient to start from his sleep.

The secretion is, as a rule, scanty, and gives rise to little trouble during the day ; but at night accumulates in the larynx and is coughed up in the morning as pellets of more or less tenacious and discolored mucus. It is occasionally streaked with blood.

The changes in the voice present infinite gradations in impairment, from very slight hoarseness to a harsh, raucous or metallic sound, or, in long-standing cases, complete aphonia.

In a mild case of laryngitis, the voice becomes husky only from some unusual exertion, exposure, excesses, emotional excitement, or at some physiological period, as that of menstruation, and returns apparently to the normal when the exciting cause is removed. Very extensive inflammation of the mucous membrane of the larynx is compatible with freedom from hoarseness, provided the vocal cords be not included in the inflammatory process.

Deglutition is never interfered with to any extent, but disagreeable sensations in swallowing are not infrequently complained of. Respiration is rarely affected, except when the thickening is extensive and sufficient to diminish considerably the lumen of the larynx.

There are a number of symptoms referable to impairment of the muscular apparatus of the larynx, which will be discussed under the heading Neuroses of the Larynx (in the Appendix) which are the expression of inflammatory infiltration of the muscle-substance, or even fatty degeneration of the same.

In some persons—generally in those of a hypersensitive or nervous organization, although by no means limited to this class—various phenomena, referable to reflex action, show themselves in other organs remote from the seat of disease, whose dependence upon the laryngeal affection must be inferred from their disappearance or mitigation with the cure of the latter.

These consist in neuralgic conditions in the path of the nerves which radiate from the laryngeal plexus, and find their expression in so-called rheumatic pains in the regions which receive the terminal distribution of their fibres.

Various paroxysmal affections, such as asthma, violent cough, spasmodic affections of the cords, etc., are also traceable to chronic laryngeal irritation or inflammation.

The *laryngoscopic picture* of chronic laryngitis presents a great variety of pathological appearances. The mucous membrane may be affected as a whole, or the inflammatory process may be limited to individual portions. Some of the older writers, accordingly, speak of chronic epiglottiditis, chorditis, etc., but this is obviously an unnecessary refinement of specialism, and tends to introduce confusion in the clinical study of the disease.

It is often difficult to determine exactly where inflammation commences and where chronic hyperæmia ends. The first stage of the former is essentially a condition of hyperæmia, the inflammatory process being recognized by the practised eye by slight swelling and puffiness of the mucous membrane.

The redness may be diffuse or limited to the aryepiglottic folds, the arytenoid cartilages, the ventricular bands, etc., and, in rare instances, to the vocal cords. The vessels of the epiglottis are often enlarged, tortuous, and, in exceptional cases, varicose. In old people the varicose condition is sometimes especially well marked. In the laryngitis of habitual drinkers the redness is very pronounced, and often assumes an angry look, which, if associated with hypersensitiveness of the mucous membrane, is somewhat characteristic. Occasionally, small capillary hæmorrhages can be detected in different portions of the larynx.

A frequent seat of congestion is the vocal process and the posterior third of the vocal cords. The cords themselves vary in color from a pale, dull, lustreless pink to a pronounced reddish hue. The vessels are often enlarged, presenting the appearance of fine linear streaks running parallel with the long axis of the cord. In long-standing cases the coloration of the membrane is not always so pronounced, and the interior of the larynx presents a reddish-yellow color, as if the cartilage could be seen shining beneath it.

In old cases of laryngitis the mucous membrane presents a thinned, pale, lustreless, grayish-red color, with a perceptible diminution in thickness, which doubtless represents a condition of commencing atrophy.

Thickening of the mucous membrane occurs either as a uniformly smooth, diffuse, or circumscribed swelling, or as a rough, uneven, almost nodular condition, due to enlargement of the papillæ and glands, which has led to the creation of the terms glandular laryngitis or granular hypertrophy of the larynx. It is generally associated with corresponding changes in the pharynx, and seems to depend upon the same causes which lead to the latter disease.

Infiltration of the vocal cords appears either as a well-marked rounded swelling of their upper surface, or as an uneven condition of their free edges, which may be mistaken by the uninitiated for loss of substance. Sometimes the surfaces of the true and false vocal cords present a peculiar granular appearance, due to the aggregation of nodules of varying size, which consist of hyperplasiæ of the epithelium, *plus* an hypertrophy of the submucous tissue.[72] This condition is described by Tuerck under the title *chorditis tuberosa*, or trachoma of the vocal cords, from its resemblance to trachoma of the conjunctiva. We have met with this condition only in hospital practice and among the badly nourished, and invariably upon the vocal cords. A similar trachomatous condition of the interarytenoid fold has been described by Stoerck,[74] as occurring in stout persons after exhausting diseases, or in women after labor, as the result of constant coughing and hawking from dryness of the arytenoid fold, due to suppressed or diminished secretion.

In some cases of chronic laryngitis from any cause, simple, syphilitic, or tubercular, small cysts are occasionally seen on the vocal cords, generally posteriorly, on the laryngeal surface of the epiglottis and in the ventricles, which result from the changes in the glands in the granular form of the disease.

Superficial erosions, which occur most frequently on the vocal cords and in the interarytenoid fold, are not uncommonly met with, and are due to purely mechanical causes. Stoerck[75] describes at great length, under the title "Fissura Mucosa," a fissured condition of the interarytenoid fold which is prevented from healing by the constant separation of its edges by the muscular motions of the posterior laryngeal wall.

It is extremely doubtful whether true ulceration ever occurs as a complication or result of simple laryngitis.

In a certain proportion of cases—more often, perhaps, than is generally supposed—a true hypertrophy of the laryngeal membrane, as a whole, is met with, which, in some rare instances, is so great as to diminish considerably the lumen of the larynx. Diffuse hypertrophy is doubtless rare, but it is not uncommon to find nodular or polypoid excrescences which may be regarded as localized hypertrophies.

In very rare instances a condition of the mucous membrane of the larynx is found which, from its resemblance to an analogous condition of the nasal passages, has received the name *ozœna laryngis*.[76] As in the nasal affection, this is characterized by the formation of crusts and the development of excessive fœtor. The crusts adhere to the atrophied membrane with great tenacity, and leave eroded surfaces upon their separation. The condition is analogous to the chronic blennorrhœa of the mucous membrane, said by Stoerck to be common to the inhabitants of Poland, Galicia, and Bessarabia.

Diagnosis.—There should be no difficulty in the laryngoscopic recognition of chronic laryngitis. The hypertrophic form may be confounded with the fibroid degeneration of syphilis (see article on Syphilis of the Larynx), but in the latter case the history and objective evidences of pre-existing syphilitic lesions in the pharynx and other organs of the body will put the diagnosis beyond a doubt. For its differentiation from the laryngitis of secondary syphilis, the article on Syphilis of the Larynx should be consulted. It may be laid down as a diagnostic maxim that ulceration of the laryngeal membrane, except when due to mechanical or chemical causes, is nearly always the expression of some constitutional morbid state, either inherited or acquired. The existence, therefore, of laryngeal ulceration should lead to the careful examination of the patient and his antecedents, and to a guarded prognosis on the part of his medical adviser. The presence of ulcers is the most reliable test in the separation of chronic catarrhal inflammation from the early laryngitis of tuberculosis, that is, at the stage when the peculiar infiltration of the latter disease has not become so pronounced (see article on Larynx, Phthisis of the).

Prognosis.—In simple chronic laryngitis the prognosis is good, provided its treatment be carried out in accordance with the fundamental principles indicated below. Where pronounced thickening of the tissues has occurred the prognosis is less favorable, and in trachoma of the cords and the advanced hypertrophic form, decidedly bad. The destruction of function produced by atrophic laryngitis is, of course, irremediable, but great relief may be afforded by the measures recommended under the head of atrophic rhinitis. The prognosis will, furthermore, vary with the course of the disease and its duration, and a host of other influences which modify the course of catarrhal inflammations in general.

Recovery from chronic laryngitis may be permanent, or, as not infrequently happens, the individual may be predisposed thereafter to attacks of acute and subacute inflammation.

Catarrhal inflammation of the larynx occasionally disappears completely and permanently during the course of an acute febrile disease (see also article on Nose, Catarrhal Affections of).

Complications and Sequels.—Besides those already mentioned, the disease may lead to chronic inflammation of the trachea and bronchi, or to irritative (congestive) conditions of adjacent organs, as the œsophagus, stomach, and thyroid gland. It may also form the connecting link between a number of so-called rheumatic or neurotic conditions in various parts of the body, or awaken the predisposition to the local expression of constitutional vices or diseases. Whether a simple inflammation of the larynx, *per se*, without the previous existence of constitutional taint, may determine the eruption of diathetic diseases, as, for example, tuberculosis in the laryngo-tracheal structures, is a question which, in the present state of medical knowledge, must be answered in the negative.

Interference with the normal excursions of the vocal cords is not infrequently observed, and probably depends upon inflammatory infiltration of the intrinsic muscles. This may lead to a simple paresis, or, in long-standing cases, the interstitial infiltration may undergo metamorphosis and fatty degeneration of the muscular substance ensue, with consequent atrophy. Pronounced œdema is uncommon, and perichondritis is rarely, if ever, a sequel of simple laryngitis.

A rare complication of chronic laryngeal inflammation is eversion or prolapse of the ventricles, cases of which have been recorded by Moxon,[77] Morell Mackenzie,[78] Lefferts,[79] Waldenburg,[80] Cohen,[81] Elsberg,[82] the writer,[83] J. D. Arnold,[84] and Major.[85] The etiology of this accident is obscure, and the imperfect data which the literature of the subject affords render it difficult to arrive at any definite conclusions regarding its precise pathological significance. It is possible that it may be due to a variety of causes. A remarkable feature of most of the recorded cases is that the prolapse occurred in persons suffering from chronic catarrh and relaxation of the mucous membrane of the respiratory passages, and it is therefore not improbable that an important predisposing cause of the condition may reside in chronic inflammatory disease of the ventricles themselves. Inflammation leads to eversion by causing relaxation of the ventricular supports. If long continued, it may lead to infiltration and fatty degeneration, and finally induce a paralytic state of the muscular walls of the sac; and it is not difficult to understand how such a condition may eventually lead to abrogation of the suspensory function of the internal superior fibrous ligament of the sac. In chronic inflammatory disease of the ventricle, descent of the latter may be furthermore facilitated by hyperplasia of the periventricular areolar tissue, which thus, acting as a *vis a tergo*, may push the walls of the sac downward toward the cavity of the larynx. When the inferior segment of the pouch engages in the constricted portion which separates the two ventricular divisions, or, in other words, when inversion is complete, strangulation takes place, vascular dilatation supervenes, and the sacculus presents itself at the glottis as a protuberant mass, covered externally by its thickened, congested mucous membrane, and consisting internally of its connective-tissue bed in a state of inflammatory proliferation.

A sudden loss of voice, therefore, with more or less stridor in inspiration after violent expiratory efforts, or occurring without assignable cause in a person suffering from chronic catarrhal affections of the respiratory mucous membrane, would suggest the possibility of ventricular prolapse; but the diagnosis can only be made with the laryngoscope. Here the prolapsed ventricle may be confounded with fibrous polypus. If the case be seen before strangulation of the mass takes place, and when the sacculus presents itself at the glottis as a thickened fold, the diagnosis may be made by the rolling inward in phonation and disappearance within the ventricular orifice of the prolapsed sac, as described by Lefferts and Elsberg; or it may be returned within the orifice by means of a suitably bent probe. If, however, the dislocated ventricle has become strangulated and converted into a mass of inflammatory tissue, its differentiation from fibrous polypus may be aided by attention to its immobility, its attachment in its entire length to the ventricular band, the negative results of forced respiratory acts, its more or less

pear-shape, with the long axis parallel with the ventricular band and vocal cord, and its smaller end in front. The retraction of the mass within the ventricular orifice under astringent applications strongly favors, if it does not absolutely confirm, its inflammatory nature; and if the mass be bilateral, polypus may be safely excluded. The rules which regulate the surgeon in the removal of laryngeal growths in general are equally applicable here. If forceps be used, care should be exercised lest the ventricle be torn too forcibly from its insertion. It should be remembered, too, that retraction of the sacculus within the ventricular orifice may be sometimes secured by the persistent direct application of astringents.

Treatment.—The treatment of chronic laryngitis is prophylactic and curative. The former consists in the adoption of the precautionary measures discussed in the sections on *Nasal* and *Pharyngeal Inflammation,* and the successful remedial treatment will depend upon the recognition and removal of the predisposing and exciting causes of the disease.

In carrying out both prophylactic and curative measures, it should be forever borne in mind that chronic inflammation of the larynx is rarely a primary affection; that in the vast majority of instances it is secondary to, or symptomatic of, a diseased condition of the nasal and naso-pharyngeal cavities; and that its proper management will often depend more upon the intelligent appreciation of associated, though remote, pathological processes than upon the routine treatment with which the larynx is too frequently assailed. In addition, therefore, to local applications, attention should be given to the general health, and the different organs of the body and their functions should be systematically interrogated. While too much stress should not be placed upon constitutional medication, the adoption or rejection of the latter is often sufficient to turn the balance in favor of success or failure, and in all cases local treatment is assisted by the stimulation of the nutritive processes by a judicious tonic regimen.

In simple chronic laryngitis, the local treatment consists in the topical application of astringent, stimulant, and alterative preparations to the laryngeal mucous membrane, either in the form of vapor and spray, or by means of cotton carriers, brushes, etc. The physician should commence with weak solutions and gradually increase the quantity of the medicament until the maximum strength is reached from which the patient suffers no lasting inconvenience. The substances most commonly employed are the salts of zinc (chloride and sulphate), iron (sesquichloride, sulphate, ammonio-ferric alum), the nitrate of silver, iodine, and the iodides (sodium, potassium, and ammonium), carbolic and boracic acids, and bichloride of mercury. In cases which have resisted ordinary measures, and are accompanied with profuse secretion, the writer has used a weak solution of the dioxide of hydrogen, combining the local application with the internal administration of the remedy in doses of half an ounce of a four per cent. solution, three or four times a day.

The process of inhalation may be most conveniently carried out by the use of the various forms of inhaling apparatus in common use, or those which work by the compressed air, or water power, as used by American specialists; or the substance may be volatilized in the air of the patient's apartment; or, for those who can afford it, temporary residence in an atmosphere impregnated with balsamic odors furnishes the most excellent method of inhalation. It may be said, in general, that cold inhalations are more efficacious than hot, and are not open to the (same) objections which the use of the latter involves.

The application of remedies in solid form (powders) to the larynx often does more harm than good, from the irritation which they produce, and tends to increase rather than to dissipate the inflammatory symptoms. If medicine in solid form is to be employed, it should be applied in some such vehicle as cosmoline, vaseline, etc. This may be used with the cotton carrier, or liquefied for use in spray.

Where moderate thickening exists, much advantage may be derived from applications of the yellow or red oxide of mercury. When there is decided thickening destructive measures are to be used (cautery, acids, etc.).

The granular or trachomatous condition is best treated with the galvano-cautery, or by the local application of absolute alcohol or chromic acid.

The use of the various sulphur, alkaline, and alum waters, preferably at their sources, is often of decided benefit in the treatment of chronic laryngitis. Mineral waters should not, however, be used indiscriminately, nor for too great a length of time. General tonics, and especially those which act upon that portion of the nervous system which regulates the contraction and dilatation of the blood-vessels, are often indicated, particularly in cases of long duration.

The hygiene of the naso-laryngeal tract is coextensive with that of the general organism, and the hygienic management of catarrhal affections must be, therefore, governed by the laws and principles of health. It is impossible to lay too much stress upon the hygienic treatment of these affections, for it is often the key to their successful management. This is a proposition which is often on the tongue but seldom in the mind, and the fact is too often lost sight of, that nothing militates so much against the success of local treatment as the improper hygienic surroundings of the patient.

It sometimes happens that, despite judicious local and general treatment, the inflammatory process shows little or no disposition to subside, and in this event change of residence offers the surest hope of relief to those whose means and convenience will permit them to move to a more suitable climate. The general rules governing the selection of a place of residence must be deduced from what has already been laid down in treating of the geographical distribution of catarrhal affections. Patients generally do better in a moderately high and cold region, where the atmosphere is bracing, equable, and pure, and the temperature and humidity of the air do not vary greatly before and after nightfall. Many mountain resorts are, for example, rendered unfit for the relief of catarrhal affections by the sudden dampness and chilliness which follow the setting of the sun. A very warm climate is not, as a rule, desirable in cases of simple catarrhal inflammation, the depressing effect of the heat upon the nervous apparatus often more than counterbalancing the good results produced by change of scene and air. Individuals are variously affected by the air of the ocean. A sea voyage, or residence at the sea-shore, is, in the large majority of instances, productive of good, and the effects of surf-bathing are often magical. In some persons, on the other hand, the respiratory mucous membrane seems to resent the presence of the salt air, but these are the exceptions to the general rule.

Œdema and Abscess of the Larynx.—From a strictly pathological standpoint, abscess of the larynx should be considered under the head of acute laryngitis, and the same is likewise true of laryngeal œdema, except, perhaps, when occurring as the pathological analogue of other infiltrations into the serous, submucous, or subcutaneous tissue. Neither is a distinct disease *per se,* but is always found as the complication or result of local or systemic conditions—as the symptomatic expression of some internal, and it may be imperfectly understood, morbid process. In the following articles we shall therefore look upon them, not as distinct diseases, but as complications which, in view of their tendency to fatal result, merit the right of separate and special consideration.

Historical.—That the ancients recognized a form of laryngeal angina which killed by suddenly closing the windpipe, is beyond a doubt, but their recorded observations render it questionable whether œdema and suppuration were familiar to them as complications of the severe type of catarrhal inflammation of the larynx. While, then, it is probable that the fathers of medicine confounded œdema and abscess of the larynx with various spasmodic affections of the air-passages and suppuration in the pulmonary parenchyma (see especially Aretæus), the testimony of certain of the earlier poets and historians would seem to lead inferentially to the conclusion that

the danger of sudden death from constriction of the larynx in simple quinsy (*angina*) was a matter of popular recognition. Thus Plautus, in the "Mostellaria," makes Philo utter the wish that he be transformed into the quinsy, to seize the throat of the old wretch and put an end to the wicked mischief-maker:

> In anginam ego nunc me velim verti, ut venesicæ illi,
> Fauces prehendam et enecem scelestam stimulatricem.
> *Plautus*, Most., Act. i., Sc. iii., v. 61, seq.

And we are informed by Festus[86] that those who were suffocated by drink were said to have the *angina vinaria*. Pliny[87] hints at strangling as an effect of quinsy; Livy[88] tells of an angina which threatened suffocation; and finally, the Romans had a goddess, Angerona, whose aid they invoked in cases of suffocative throat affections.

It is probable, however, that the ancient physicians confounded these affections with analogous conditions of the pharynx.* Although it is quite possible that the so-called hydatid tumors of the larynx described by the older writers, and found in the ephemeral productions of several centuries ago, were in reality none other than cases of œdematous infiltration; and although Boerhaave,[89] and later Van Swieten,[90] had distinctly announced the frequent implication of the larynx in a disease whose pathological nature was subsequently brought to light by the scalpel of Morgagni,[91] and elucidated by the genius that directed it, the attention of the scientific world was first prominently called to the importance of the subject by the publications of Bayle † and Thuillier.[92] Inspired by their researches, the study of the disease was taken up by a number of their countrymen, of whom may be specially mentioned Bouillard,[93] Lisfranc,[94] and Cruveilhier,[95] while much light was thrown upon the treatment of the affection by Gurdon Buck[96] and Bartlett,[97] in this country; and upon the host of observations, theses, essays, etc., which followed the publications of these writers, was founded the classical mémoire of Sestier.[98]

Abscess of the Larynx.—*Etiology.*—An acute idiopathic, circumscribed, purulent infiltration of the tissues of the larynx is one of the rarest of diseases. Such a condition, when present, is usually preceded by, or occurs in the course of, a violent laryngeal inflammation. Collections of pus, in this situation, whether circumscribed or diffuse, are in the majority of cases directly traceable to a local or systemic infection, or complicate existing malignant disease of the organ. They occur, for example, as metastatic phenomena in the various forms of septicæmia, as complications of the exanthemata, typhus and typhoid fever, diphtheria, erysipelas, and glanders, or as the result of chondritis and perichondritis from tuberculosis, syphilis, and cancer. Purulent formations occasionally develop in the neighborhood of ulcers of the larynx, or from external or internal violence to its structures, as in wounds and fractures, and from the presence of foreign bodies in its interior. Suppuration also occurs sometimes as a termination of the laryngitis which results from scalds and burns, or from the injury done to a contiguous organ. In a case observed by the writer, the abscess followed the transfixion of the left arytenoid cartilage by a fish-bone, which had become impacted in the œsophagus.[99]

Pathology.—The affection is characterized anatomically by the presence of a purulent or sanguino-purulent exudation into the submucous connective tissue. As in laryngeal œdema, these collections of pus are usually limited to those portions of the larynx which are especially rich in loose areolar tissue, diffuse suppuration being very rarely met with. The abscess is usually single, or becomes so from the coalescence of small, multiple, submucous centres of purulent infiltration. There is almost always a certain amount of accompanying laryngeal œdema, which may be so great as to mask the original affection. Occasionally the glandular apparatus of the larynx is the part principally involved, and small follicular abscesses result which may be with propriety classed under this head.

Symptoms and Diagnosis.—There are no symptoms which are characteristic of laryngeal abscess, and the diagnosis can therefore be only made with certainty with the laryngoscope. Even with its aid, the affection is often only to be differentiated by the closest inquiry into the history of the case. When perichondritis coexists with abscess, it is often exceedingly difficult to say which is the primary disease. The accompanying œdema which is so often present, together with the close resemblance of the purulent swelling to that of ordinary œdema, still further interferes with certain diagnosis. The distinctly circumscribed character of the swelling, a discolored condition of the mucous membrane covering it (commencing necrosis), or the presence of pus beneath it, indicated by a peculiar yellowish refraction, and especially the latter, are strongly suggestive of the disease; but the point can, in many cases, be only definitely settled by the use of the laryngeal lancet. This procedure will not only facilitate the diagnosis, but, in either event, will accomplish the desired curative result.

Complications, Course, and Sequels.—While absorption of the exudation is, of course, possible, it is highly probable that this rarely, if ever, occurs. Usually there is a rapidly progressive formation of pus, which, if it does not in the meantime lead to death by suffocation, is discharged spontaneously. The latter is accomplished by rupture of the abscess into the larynx* or pharynx, or by its perforation through the walls of the œsophagus. Occasionally it burrows to the base of the tongue, to the cartilages, producing a suppurative perichondritis, or finally finds an exit by invading the cellular tissues of the neck.

The pus is discharged by sloughing of the mucous membrane, from which an ulcer usually results, which under favorable circumstances cicatrizes, but which often, especially when due to blood-poisoning, becomes phagedenic. The contraction of the larynx in the cicatrization of the larger ulcers is sometimes so great as to produce decided laryngeal obstruction. In other cases, when the purulent infiltration is diffuse, chronic thickening of the submucous tissues results, with diminution in the calibre of the larynx.

The *prognosis* in simple abscess, uncomplicated by any systemic infection, and when burrowing has not occurred, is good, provided the pus can be evacuated. When extensive undermining of the tissues with sloughing occurs, death generally ensues, or chronic disease of the laryngeal structures results, with perichondritis, thickening, stenosis, fistulæ, etc. When discharged spontaneously, the pus is generally coughed up; but a case is recorded in which death resulted from its entrance into the trachea.[100] Relapses of pus-formation in the larynx now and then occur.

Treatment should be carried out on general surgical principles. If possible, the abscess should be opened at once, and the expulsion of the pus by the mouth facilitated by bowing the head of the patient downward and forward. If asphyxia threatens from accompanying œdema, tracheotomy should be performed.

Œdema of the Larynx.—Œdema of the larynx may be acute or chronic. Acute œdema may be primary or secondary. Acute œdematous infiltration of the laryngeal structures is a comparatively rare affection, while chronic œdema is common to a number of different pathological states.

The *etiology* of acute idiopathic or primary œdema is obscure; but the vast majority of these cases are to be traced to some constitutional vice, systemic infection,

* Albers states that Roland, of Parma, centuries ago, opened a laryngeal abscess with the knife, but it is not stated whether the abscess pointed within the larynx, or externally in the neck. Albers, in introduction to his Path. u. Therapie der Kehlkopfkrankheiten, Leipzig, 1829.

† Bayle first brought the subject before the Société de l'Ecole de Médecine of Paris in August, 1808, but his first published account appeared in the Dict. des Sciences Médicales, art. Œdème de la glotte, 1817. (See also his Mémoire sur l'œdème de la glotte, ou l'angine laryng-œdemateuse, Paris, 1819.) In the interval which elapsed between the communication of Bayle and its publication, appeared the important essay by Thuillier, which cast much light upon the pathology, diagnosis, and treatment of the affection.

* In a case recorded by Döring (Zeitschrift von Henle u. Pfeufer, quoted by Rühle, Die Kehlkopfkrankheiten, Berlin, 1861, S. 166), sudden death resulted from the rupture of an abscess in this situation.

or obstructive anomalies of the circulation from organic lesions of other organs. Acute œdema of the larynx occurs most frequently perhaps during the course of acute laryngeal catarrh. It also is present as a secondary phenomenon in the laryngeal affections of diphtheria, in the exanthemata, in syphilis, cancer, tuberculosis, erysipelas, glanders, scurvy, purpura, and allied affections, in obstructive disease of the lungs, and in abscess, chondritis, and perichondritis of the larynx ; or as a complication of the acute inflammation of the latter induced by burns, scalds, foreign bodies, wounds, fractures, and other surgical injuries.

Acute œdema of the larynx occurs in the course of organic diseases productive of dropsical conditions in various portions of the body. Its occurrence as a frequent complication of Bright's disease is affirmed by some and strenuously denied by others. As Flint [101] has justly remarked, however, it is important to bear in mind the fact that it may occur as the first and only dropsical condition connected with renal disease. It may complicate acute inflammation of adjacent structures, as the thyroid, cervical, and parotid glands, and even the tonsils, and may develop during the course of cervical erysipelas and cellulitis.

It has been known to occur during whooping-cough, suppurative disease of the liver, poisoning by certain drugs, as iodine and mercury, and during convalescence from the essential fevers.

Laryngeal œdema takes place sometimes as the result of extension from contiguous structures, as the pharynx, tonsils, mouth, œsophagus, mediastinum, neck, etc. Contiguity of structure, however, by no means implies the probable extension of the inflammatory process, for œdema of the pharynx comparatively rarely terminates in serous infiltration of the laryngeal structures. The exudation here may be brought about by direct extension of the morbid process, or it may occur as a collateral phenomenon—the collateral œdema of Virchow.

Chronic œdema occurs as an accompaniment of almost every affection attended by general dropsy ; from obstructed circulation, organic or mechanical, in the vascular and lymph-channels of the neck, chest, and abdomen, and in chronic laryngeal disease, especially in the neighborhood of cancerous, phthisical, and syphilitic ulceration.

Œdema of the larynx is more commonly met with among men than among women ; in adults it occurs more frequently than in children, from the anatomical fact that the greater laxity and abundance of the connective tissue in the former favors the exudation of serum. Other things being equal, it is more liable to occur in those whose powers have been enfeebled by disease or excesses than in the healthy and robust.

The œdematous swelling, which is usually confined to that portion of the larynx above the vocal cords, is generally bilateral, but may be confined to one side. It is most commonly seen as an infiltration of the aryepiglottic folds or epiglottis.

Some writers speak of a subglottic œdema, but it is doubtful whether such a condition ever occurs as a primary affection.

Pathological Anatomy.—The macroscopic appearances of the swellings in the cadaver often differ materially from those observed during life. They are generally more or less collapsed, the diminution in size being due to the wealth of elastic tissue in the larynx and the evacuation of their contents by its post-mortem contraction. This gives the overlying mucous membrane a more or less wrinkled appearance at the situations where œdema has occurred. When the swellings are incised, a serous or sero-purulent fluid exudes, which is often tinged with blood, or contains a more or less copious quantity of lymphoid cells (pus-corpuscles).

The exudation in chronic œdema is much clearer, and contains, according to Eppinger,[102] masses of fat and albuminoid granules.

The histological appearances consist in distention of the muscles and of the areolar tissue by the exudation, which in acute œdema leads to compression of the glands and great tension of the mucous surface. In chronic œdema, on the other hand, the glands are dilated by the transudation, and their epithelium is found in a state of desquamation.

Symptoms.—The transudation may take place suddenly, a fatal issue supervening within a few moments ; or its approach may be insidious, with gradual obstruction to respiration. The central symptom is dyspnœa. This is at first more or less paroxysmal, is most likely to occur at night, and is chiefly limited to the act of inspiration. During the paroxysm, there is a feeling of impending suffocation, as from a foreign body, and a degree of anxiety and terror is produced which is quite characteristic. Inspiration is laborious, stridulous, and often arrested before the full accomplishment of the act. Expiration is at first free and noiseless ; but later, when the œdema extends deeper into the larynx, both acts of respiration are interfered with, cyanosis supervenes, the pulse becomes small, feeble, and accelerated, the eyeballs protrude, orthopnœa is present, and coma and delirium ensue.

The voice is not affected, unless laryngitis be present ; there is no tenderness on pressure over the larynx, and the symptoms of respiratory distress are not relieved by digital manipulation of the organ.

Cough and expectoration, if present, are not well marked, and the amount of dysphagia varies greatly according to the size and position of the œdematous tumors.

When œdema is secondary its symptoms are, of course, associated with those of the conditions which it complicates.

In chronic œdema the symptoms come on gradually, and the patient only becomes aware of the existence of laryngeal obstruction by the occurrence of dyspnœa on exertion, or by the accession of sudden suffocative paroxysms.

Diagnosis.—In some cases the œdematous swellings can be seen by depressing the tongue, or provoking retching. Should they not become visible by these methods, the finger may be carefully introduced, as originally suggested by Thuillier, into the larynx, and the smooth, hard, globular character of the swellings made out. It should be remembered, however, that by this method dangerous spasm may be brought about, as happened in the oft-quoted case of Trousseau.[103]

The nature of the disease will be at once apparent, however, upon laryngoscopic examination.

Œdema of the epiglottis appears as a more or less translucent, turban-shaped swelling, of smooth contour and pinkish or yellowish-red color, which varies in size, and occasionally, as Cohen [104] has pointed out, presents the appearance of two bladders instead of one, from constriction of its central portion by the glosso-epiglottic ligament.

The swellings of the aryepiglottic folds are pyriform or egg-shaped. They meet occasionally in the middle line and obliterate the view of the lower segments of the larynx.

Subglottic œdema appears as two rounded, translucent, bladder-like tumors below, and apparently springing from the under-surface of the vocal cords.

When laryngoscopic examination is not possible, the peculiar inspiratory distress, the absence of hoarseness, and the failure to relieve the dyspnœa by digital manipulation of the larynx, are of great value in the differentiation of œdema from affections which may simulate it.

Prognosis, Course, and Sequels. — The prognosis in acute œdema is decidedly unfavorable. In those cases where effusion takes place suddenly, and especially as a secondary phenomenon, death is almost always the result. The prognosis will furthermore depend upon the conditions under which the œdema develops. When it occurs, for example, as the result of acute blood-poisoning, as in small-pox and typhoid fever, in cervical cellulitis and erysipelas, or in serious organic disease of neighboring parts, the result is decidedly unfavorable.

When the infiltration is limited to a small portion of the larynx, or follows an inflammatory condition of the pharynx, the prognosis is more favorable. The course and sequels of chronic œdema will obviously

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depend upon the causes which produce it. In this form the principal danger lies in the liability to sudden accessions of the acute form of the disease.

Treatment.—In some cases the swelling may be reduced by local depletion, counter-irritation, the external and internal administration of ice, or soothing and astringent inhalations. Failing in these, or when the symptoms are urgent from the outset, no time should be lost before scarifying the œdematous portions. This is most satisfactorily accomplished with the laryngeal lancet, or a curved bistoury covered with adhesive plaster to within a third or a quarter of an inch from its distal extremity, and guided by the index-finger of the opposite hand, may be used to scarify the parts, as successfully accomplished by Gurdon Buck. (See under Glottis, Œdema of.) After scarification, the head of the patient should be so placed as to encourage the flow of liquid into the pharynx and mouth. Should scarification not afford relief, and symptoms of asphyxia threaten, resort must be had at once to tracheotomy.

Acute and Chronic Catarrhal Tracheitis.—Apart from the inflammation arising from local or mechanical causes (irritation of tracheotomy tube-wounds, etc.), acute and chronic inflammations of the trachea, rarely, if ever, occur as isolated affections. Usually they are met with in connection with disease of the larynx, bronchi, or œsophagus, or as a part of a diffuse inflammatory condition of the upper respiratory tract.

Pathological Anatomy.—In the tracheitis which results from a simple catarrhal process, the anatomical appearances are similar to those found in the larynx, and consist in diffuse or localized hyperæmia, moderate swelling of the mucous membrane, and enlargement of its glandular elements.

When the trachea is opened, a small quantity of glairy, more or less tenacious, muco-purulent secretion is found in the most dependent portions on the posterior wall. Upon removing this, the latter is found dark and congested, and covered with minute whitish or pinkish nodules, which represent swollen glands with their dilated ducts. On pressure with the finger, a small quantity of secretion exudes, which varies in consistency from that of a fluid to something of a more solid nature (cheesy nodules).

The color of the mucous membrane varies greatly, from a brilliant scarlet to a dark purplish hue, according to the nature and cause of the inflammatory process. The most hyperæmic portions are not infrequently indicated by a spray of bright crimson lines running parallel with the long axis of the tube. The hyperæmia is most marked upon the posterior wall and in the intervals between the tracheal rings.

The trachea affords an excellent field for the post-mortem study of hyperæmic and catarrhal processes. The vessels of the mucous membrane are occasionally dilated, tortuous, varicose. When the inflammation has reached an intense grade, and especially in the tracheitis which complicates acute infectious processes, or which occurs as the expression of phosphorus and other forms of poisoning, small hæmorrhages into the submucous tissues are not infrequently met with.

Swelling is generally inconsiderable, and is most marked upon the posterior wall and between the cartilaginous rings. The trachea is peculiarly exempt from œdematous and suppurative processes, from the compact nature of the submucous tissues and the tenacity with which the mucous membrane clings to the walls of the tube.

In a large number of cases examined post-mortem I have never met with ulceration in the simple form of tracheal inflammation.

The most striking microscopical appearances are marked dilatation of the superficial blood-vessels and a swollen condition of the glands and their ducts. The submucous tissues are more or less infiltrated with round cells, and here and there the epithelium is wanting or degenerate.

Symptoms and Diagnosis.—There are no characteristic symptoms of tracheal inflammation, and the diagnosis can therefore only be made with certainty with the laryngoscope.

Complications.—Small cystic formations, tracheal diverticula, and papillomatous excrescences are not infrequently met with as the result of chronic tracheitis. The latter are especially prone to follow chronic irritation of the trachea in the negro race. Occasionally hyperplasia of the muscular layers can be detected, and, in rare instances, a degree of thickening sufficient to diminish considerably the lumen of the tube. Amyloid degeneration of the tracheal walls has been detected by Balser,[105] and Petit[106] reports a case of asthma cured by excision of an eroded tracheal ring.

Prognosis and Treatment.—The prognosis will depend upon the cause of the tracheal inflammation, and the treatment must be carried out in accordance with the principles indicated in the section devoted to Laryngitis. Local medication of the tracheal membrane is best attained by inhalation of the medicament either as vapor or as a finely divided spray. *John Noland Mackenzie.*

[1] Sat. i., v. 33 et seq. [2] Ibid., iii., v. 99. See also v. 113.
[3] Sexti Pompeii Festi, de verborum significatione, vol. i., p. 77. Lond. ed., 1826. [4] Epod., xii., 5. [5] Epist. ad Attic. [6] Epod., i., 106–108.
[7] Principles and Practice of Medicine, p. 263. Philadelphia, 1873.
[8] Trans. of the Med.-Chir. Fac. of Maryland, 1883.
[9] Gazette médicale, 1855.
[10] Pathologische Anatomie des Larynx und der Trachea, S. 33. Berlin, 1880.
[11] Quoted by Sestier. Traité de l'Angine laryngée œdémateuse, p. 137. Paris, 1852.
[12] Chronic Diseases of the Larynx, trans. by Beard, p. 117. New York, 1868. [13] Bogros: Quoted by Sestier, op. cit., pp. 63 and 114.
[14] Zeitschrift für rat. Medicin, N. F., Bd. iii. (Ziemssen's Cyclop., Am. ed., 1876, vol. iv., p. 152.
[15] Berliner klinische Wochenschrift, No. 2, 1874, S. 16.
[16] De Catarrhis. Witteburgue. 1661–62.
[17] De deliramentis catarrhi, and the English Trans. Lond., 1650.
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LARYNX, CONGENITAL MALFORMATIONS OF THE. Congenital malformations of the larynx may be classed under four heads, namely: 1, Absence; 2, excessive development; 3, cleft; and 4, deviations of form and situation.

Complete absence of the larynx occurs in the rare cases of monsters in which the head and the thorax are wanting, and which are known as acephals, amorphi, and acardiaci. A complete absence of the larynx has also been noted in a monster described as "inclusio fœtalis peritonei."

Partial absence may consist either in a general atrophy of the organ, or in the absence of one or more of the cartilages. Thus, in some instances there is a complete absence of the epiglottis; in others it is represented by a high rudimentary ridge; while in one case it is described as merely a fold of the mucous membrane. The thyroid, cricoid, and arytenoid cartilages may be absent. They also may be rudimentarily developed, either altogether as regards one of them, or only in certain parts of each. For instance, the thyroid may lack one or both superior cornua. Again, the thyroid may be cleft, and the two plates may be connected together by a cartilaginous band. The same abnormality has been observed in the cricoid, in some instances to such an extent that the connecting band may take the place of the original cricoid, and thus cause it to resemble a tracheal cartilage. Finally, the whole larynx may be abnormally small, as seen in the male when there is congenital atrophy of the testicle, or when castration has been practised early in life. In such cases it resembles the larynx of the female or of a child.

Hypertrophy.—This division may be made to include the double formation of the larynx observed in the case of double monsters, namely, in the so-called thoracodidymis, and also in the dihypogastricis. These possess two larynges, but only one pharynx and one œsophagus. A cartilaginous plate is sometimes found interposed anteriorly between the wings of the thyroid.

Supernumerary cartilages are occasionally found on the outer corner of the cricoid cartilage. They are analogous to sesamoid bones. Supernumerary folds of the mucous membrane are sometimes seen, as, for instance, a transverse fold below the epiglottis.

The laryngeal ventricle may be abnormally wide and deep, and thus render the part more liable to eversion, to the lodgement of a foreign body, or to other accident. The anterior section of the glottic space may be more or less occluded by a web-like formation, of considerable density, and somewhat resembling an imperforate hymen.

Cleft Formations.—There is no such thing, it is said, as a congenital laryngeal fistula of the neck. A case of cleft epiglottis has been reported by French.

Congenital deviations of form and situation of the larynx are rare, and occur only in connection with congenital malformations of the most marked type, such as hemicephalus, and double spina bifida of the upper portion of the spine, and in extreme lordosis of the cervical vertebræ. In these the whole larynx is depressed and moved backward to the level of the upper dorsal vertebræ. The thyroid is placed very obliquely, by which the inferior diameter of the larynx is markedly increased, while the cricoid is situated much deeper, in proportion to the thyroid, and thereby the true and the false vocal cords are abnormally lengthened. The sinus pyriformis on each side is obliterated.

Slight asymmetry of the larynx, as to position and form, is not infrequently met with. *D. Bryson Delavan.*

Klebs: Handbuch der path. Anat. Berlin, 1880.

LARYNX, ERYSIPELAS OF THE. Erysipelas of the mucous membrane of the pharynx and larynx is, pathologically, similar to the same malady when situated on the skin. It occurs either primarily or by extension from the face along the mucous tracts of the mouth, nose, or ear. Its causes are the same as those which give rise to it when situated upon the external parts of the body, although it has been most often observed in the course of general epidemics of the disease. Of eighteen patients seen by Cornil, in whom the pharynx was affected, fifteen were under the age of thirty, and twelve were females. On inspecting the pharynx, the appearance of the mucous membrane, when affected with erysipelas, differs considerably according to the form of the disease which is present; the local phenomena are generally very different from those of tonsillitis, but sometimes cannot be distinguished from those of simple inflammation of the part.

Cornil makes three divisions of the malady, viz.: (1) Erysipelas with simple redness; (2) erysipelas with phlyctænulæ; and (3) erysipelas terminating in gangrene. Erysipelas most commonly reaches the larynx from the pharynx, but the former organ may be primarily affected while the pharynx remains healthy. The disease may extend still farther down the respiratory tract, and become associated with pulmonary congestion and œdema. In cases which come under the first division the diagnosis must remain doubtful, except where the throat lesion is accompanied by manifestations upon the skin.

Erysipelas of the head and neck is often accompanied by more or less congestion of the mucous membrane of the larynx. The symptoms are dysphagia, hoarseness or loss of voice, and pain, increased on pressure from without. Sometimes the disease is much more active, and may result in acute œdema, tending rapidly to a fatal termination. It is believed by some that the so-called primary œdema of the larynx, or phlegmonous laryngitis, corresponds clinically to a localization of erysipelas in the larynx, and that many cases reputed as primary œdema of the larynx are in reality erysipelas. The two affections seem at least to be closely allied.

As to the prognosis, the dictum of Hippocrates—namely, "When erysipelas extends from within outward it is a favorable symptom, but when it removes to the internal surfaces it is a deadly one"—has been confirmed by modern observation. In nine cases analyzed by Cornil, in which the face was first attacked, seven deaths occurred; whereas in nine other instances in which the exanthem preceded the skin eruption, seven recoveries took place. Mackenzie states that he has seen but four cases in the whole course of his practice.

The treatment must be both local and constitutional. The latter should be guided by the general principles which govern the management of the disease in other parts of the body.

As to local treatment, the application of cold to the throat, by allowing cracked ice to dissolve in the mouth, should be practised as long as there is any hope of check-

ing the inflammation. Hypodermatic injection of pilocarpin may abort the attack if given early, and mild alkaline sprays, with a small amount of alcohol, have an excellent effect. A solution of morphine applied in the form of spray is recommended by Mackenzie. While this treatment is of utility and promises much in the way of relief, the systemic effect of the drug must be carefully remembered, and caution observed lest the patient be unintentionally narcotized. Should the disease progress and tumefaction of the mucous membrane of the larynx take place, the conditions become similar to those found in acute œdema of the larynx, and the same measures for relief are required, namely, scarification of the engorged tissue, and, if this prove ineffective, tracheotomy. With regard to the latter extreme measure, it is to be hoped that in this condition, as well as in œdema of the larynx, it may be supplanted by the method of intubation of the larynx, as recommended and successfully practised by O'Dwyer. (*Vide* also article on Glottis, Œdema of.)

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D. Bryson Delavan.

LARYNX, FRACTURES AND DISLOCATIONS OF THE. These injuries, although rare, may occur from several causes, namely, violent manual compression, falls, accidents with machines, rolling vehicles, hanging, etc. Of fifty-two cases collected by Hénocque, the thyroid alone was fractured in twenty-three, the cricoid alone in seven, both of these cartilages in seven, while in the rest the hyoid bone, larynx, and trachea were all involved in a common injury. A direct blow upon the larynx may produce a contusion of the soft parts, but can hardly result in fracture, unless the organ is supported to some extent upon the spinal column. Ossification of the cartilages will necessarily render them more liable to injury.

The *symptoms* are pain and tenderness, dyspnœa, expectoration of bloody mucus, and cough, with, sometimes, emphysema of the neighboring areolar tissue. Crepitation and, occasionally, overriding of the fractured edges may also be felt.

The *prognosis* is very grave, especially in fracture of the cricoid; and, unless the symptoms are not urgent, tracheotomy should be performed at once, or intubation of the larynx may be resorted to, with the same object in view.

Should the cartilages be much crushed, Mackenzie suggests that it may be well to lay open the whole length of the larynx and endeavor to replace the fragments in their proper position, and he calls attention to the fact that, in extreme cases, extirpation of the larynx or resection may have a future, while Panas advises that in some cases the fragments be kept in place, and the patency of the laryngeal canal preserved by the introduction of a small, hollow, india-rubber plug into the larynx from the tracheal opening, and by its subsequent inflation. Leeches to the neck, and ice, both externally and internally, will sometimes prove of service.

Intra-laryngeal dislocations of the larynx are extremely rare, and of the three cases recorded all are of the arytenoids and two seem to have been due to cicatricial contraction. *D. Bryson Delavan.*

LARYNX, INTUBATION OF THE. By "intubation of the larynx" we mean the introduction through the mouth of a tube which rests solely in the larynx and trachea and allows the epiglottis to close over it during the act of swallowing. This term was introduced by Dr. E. F. Brush to indicate my method of treating stenosis of the larynx, and will serve to emphasize the fact that all previous attempts in this direction, with the exception of Bouchut's brief experiments and failure with short tubes, in the year 1858, were made with catheters or long tubes of similar construction.

The use of tubes to overcome obstruction in the larynx was first suggested by Hippocrates in the following language: "Cannulas should be carried into the throat along the jaws, so that the air may be drawn into the lungs." It was practised by Desault in 1801, by Finaz in 1813, and subsequently by Lallemand, Benoit, Depaul, Loiseau, and Gros in France; by Weinlechner, Trendelenburg, and Von Hüttenbrenner, in Germany; by Paton, Liston, Sanctuary, and Macewen, in England; by Dr. Horace Green, in this country, and a host of others too numerous to mention.* But the experiments of all these workers were made with long tubes, one end of which passed into the trachea, and the other protruded from the mouth or nose.

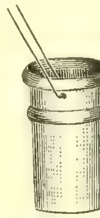

FIG. 2040. – Representing Tube used by Bouchut, with String *in situ.*

The scope of this article will not permit of any detailed description of the various stages of development through which "intubation" has passed from its inception in January, 1880, to the present time. I shall therefore confine myself to giving a few of the most important reasons why these tubes have assumed their present form and size. A cross-section of them presents an elliptical outline, which conforms as nearly as possible to the shape of the rima glottidis, and the transverse diameter of that portion which occupies the chink is made very narrow, in order to avoid dangerous pressure on the vocal cords.

The calibre of the tubes is a matter of the greatest importance. In my earlier experiments I used much larger tubes than I do at present, but found that they produced ulceration in the subglottic division of the larynx, corresponding to the long antero-posterior diameter. At the expense of the lumen of the tube I gradually reduced this diameter until this ceased to occur, and demonstrated by a large number of cases of croup, many of which could breathe comfortably through a tube intended for a child several years younger, that there was ample breathing space left. But the most convincing proof that they are large enough as at present constructed is the fact that my smallest adult tube, which has the same calibre as that intended for children from eight to twelve years of age, was worn for several days, and with comfort, by a woman forty years of age. The report of this case may be found in *The Medical Record*, June 5, 1886.

At this point I desire to call attention to a fact that I have never seen referred to in any articles or treatises on croup, and this is, the existence of a fatal subglottic stenosis while there is still sufficient breathing room between the cords to sustain life. I have observed this to a marked degree in two cases. It can only be demonstrated by making a cross-section through the cricoid cartilage about one-fourth of an inch below the vocal cords in cases that have died without operative interference. It will not be noticed when the trachea and larynx are laid open in the usual manner. Although it is an anatomical fact that the infraglottic division of the larynx is smaller than the trachea, its very small size in children is not generally recognized. My attention was particularly called to it while using tubes, with very small heads, that would sometimes slip below the vocal cords, but were always held at this point. In the healthy larynx it is not difficult, even with the large-headed tubes now used, to push them through the chink of the glottis, but it would be exceedingly difficult to force them past the cricoid cartilage into the trachea. This location of the stenosis would explain those fatal cases of croup, not infrequently reported, in which death was supposed to have been due to either spasm or paralysis of the vocal cords, because no serious obstruction could be found at the autopsy.

As only a small portion of the calibre of the air-passages is required for easy respiration in a state of rest, violent exertion alone calling into play their full capacity, it is not necessary to have a tube even approximate in size to that of the trachea. While a tube of larger lumen than is necessary for the free ingress and egress of air may lessen the danger from occlusion by detached pieces of pseudo-membrane, it has the great disadvantage of still further diminishing the expulsive power of the cough.

* For most of these references I am indebted to Dr. Dillon Brown, who has made an exhaustive review of the literature of the subject.

Cough, to have its full expulsive power, requires a full inspiration, complete closure of the glottis, and then a violent expiratory effort which compresses the air in the lungs and forces it through a very small space between the still contracted vocal cords. Coughing through a tube, on the contrary, whether in the larynx or trachea, means inability to close the glottis, with little power of compressing the air and, consequently, little expulsive power. Therefore, the smaller the tube compatible with free respiration the better, as there will be more power to expectorate and less accumulation of secretions in the air-passages, which predispose to the development of bronchial catarrh and broncho-pneumonia.

The tubes, as now made, are five in number, and vary in length from one and one-half inch for the smallest to two and one-half inches for the largest. I began with tubes about one inch long and continued to increase them as I found that they could be introduced until they would extend almost the whole length of the trachea. I subsequently reduced them to the dimensions just given, in order to permit the use of a larger size than the one indicated by the scale of years without any danger of obstruction below by contact with the spur of the bifurcation. The object of having them so long, when much shorter tubes will overcome obstruction in the larynx equally well, is to retain the pseudo-membrane *in situ* as it becomes detached from the tracheal walls until maceration takes place, when it is readily expelled through the tube.

The head or shoulder occupies the lateral and posterior portions only, the anterior being rounded off and the metal at this point left thick to avoid the formation of a cutting edge under the epiglottis, which comes in contact with it during every act of swallowing. The metal at all other points of that portion of the tube which occupies the chink of the glottis is made as thin as possible, compatible with sufficient strength to resist the pressure of the extracting instrument.

The heads on my first tubes were made very small, to permit them to sink well down in the larynx so that the epiglottis could perform its functions more perfectly and also to allow some action of the constrictor muscles of the larynx during deglutition. Notwithstanding that I have quadrupled their size I can see no difference in the ability to swallow fluids. Some will swallow well and others badly with the same tube. I am therefore led to believe that the condition of the epiglottis has more influence in this respect than the size or shape of the head of the tube. If the mobility of this fibro-cartilage be very much crippled by inflammatory thickening and the deposit of pseudo-membrane the deglutition of fluids will be difficult with any form of tube in the larynx; while, on the contrary, if it be comparatively healthy, which is not uncommon, especially in ascending croup, fluids will be swallowed with much greater ease.

My experience with intubation in the adult, although limited to two cases, tends to confirm this conclusion. In the first case the epiglottis was very much deformed from cicatricial contraction following syphilitic ulceration, and fluids were swallowed with considerable difficulty, but better while lying on the back than in any other position. In the second case there was a large overhanging epiglottis, and fluids of all kinds—even undiluted brandy—were swallowed without the slightest difficulty. In judging to what extent a tube in the larynx interferes with deglutition, it should be remembered that in ordinary pharyngeal diphtheria, especially when complicated with nephritis, it is often extremely difficult, and sometimes impossible, to induce children to take nourishment of any kind. After intubation some children will refuse milk, or choke and cough at each attempt to swallow it, but will readily drink water, beer, or any fluid that they like. When they can be induced to take it, solid and semi-solid food is swallowed with comparative ease from the beginning, and the ability to swallow fluids increases with time.

I was convinced very early in my experiments of the necessity of having the upper extremity of the tubes curved slightly backward, as the straight ones frequently produced ulceration at the base of the epiglottis, in one case completely perforating this cartilage. After many attempts I succeeded in giving them this curve, which I found even more essential in adults than in children.

The most difficult problem of all was to make them self-retaining, and this was accomplished by a very simple device, after a trial of several complicated ones. It consists in an increase of the narrow transverse diameter, about the centre, by leaving the metal thick enough at this point to make the tube almost cylindrical, and tapering gradually in either direction. This answers perfectly the purpose intended, without interfering in the least with the introduction or removal of the tubes. As at present constructed, this retaining swell is only sufficient to hold them loosely in the larynx, in order to permit of their easy expulsion in case of occlusion from a piece of detached membrane too large to pass through. This accident is rare, and has happened to me only once; in this case the tube, filled with a partial cast of the trachea, was coughed out. In about half the cases that recover they are expelled when no longer needed, thus giving the advantage to the patient of getting rid of the tube at the earliest possible moment, and to the physician of avoiding the most difficult part of the operation. At the same time they are not infrequently coughed out when there is neither obstruction in the tube nor permanent relief to the obstruction in the larynx; but the breathing is usually better for some time after than before the insertion of the tube, and there is plenty of time for its reinsertion.

The indications for intubation are the same as for tracheotomy. Those who believe in the early performance of one will also believe in an early resort to the other. I believe that the operation should be postponed as long as there is any reasonable chance for life without entailing too much suffering. Everyone who has seen much croup knows that a certain number of cases, if given the opportunity, will recover without surgical interference. Those who operate early only know this by having cases which recover, after permission to do the operation was refused, and such cases are not rare.

The best of all indications is marked recession at those parts of the chest that yield to the external air-pressure when the internal counter-pressure has been very much diminished. This, of course, will be more marked in rachitic than in non-rachitic, in young than in old children.

Another scarcely less important sign is continued restlessness, due to an insufficient supply of oxygen; but this may be masked by a condition of apathy or semi-coma, the result of carbonic-acid or uræmic poisoning. Absence or marked feebleness of the respiratory murmur over the lower posterior part of the lungs is another valuable indication, the comparatively small amount of air that passes the obstruction entering only the upper portion of the lungs.

I have been surprised at the importance attached by many physicians to the frequency of the respirations as an indication of the amount of obstruction in the larynx. I was recently called by a physician of large experience to introduce a tube in a case of croup, because the respirations were thirty-five per minute. The child was getting an ample supply of air, as proved by a good respiratory murmur, absence of recession, and restlessness. The next day, when the stenosis became so marked as to call for surgical interference, the respirations were only thirty per minute. I have seen the respirations as low as thirteen and fifteen, and as high as fifty or sixty to the minute, with the most marked laryngeal stenosis. We need not be surprised at the brilliant results obtained by those tracheotomists who operate early nor by those who claim that they do not operate early, but at the same time regard a certain number of respirations per minute as a sufficient indication for opening the trachea.

The dangers of intubation are few, and seldom serious. The operation, when skilfully performed, requires only a few seconds, and does not exclude a subsequent tracheotomy. The first accident liable to happen, and this only to beginners, is apnœa, from holding the finger too long in the larynx. It is safer to make several rapid attempts before succeeding, than one prolonged effort.

Another accident, scarcely worth mentioning, is forcing the tube through one of the ventricles of the larynx and down on the outside of the trachea. I have seen this occur during practice on the cadaver. It is scarcely possible, on the first introduction in pseudo-membranous croup, where the ventricles, as a rule, are obliterated by swelling of the mucous membrane, and bridged over by the fibrinous exudate; but it might happen on reinserting the tube, or in other forms of stenosis, such as œdema of the glottis. The result would be complete suspension of respiration. An amount of force necessary to accomplish this would be unjustifiable, as the resistance offered to the entrance of the tube by any form of acute obstruction in the larynx is not great.

The danger from premature expulsion of the tube has already been referred to; it is not serious, unless the patient is at a considerable distance, in which case it would be safer to use a tube of larger size than the one indicated by the scale of years.

Pushing down membrane before the tube in sufficient quantity to produce obstruction, I feared, in the beginning of my experiments, would be a common occurrence, but it has happened only three times in my own cases. In the first case the tube was quickly removed by the string, which was still attached, and a cast of the trachea was expelled after it. The obstruction soon returned, and the tube was reinserted with marked relief. The child died the next day, and the autopsy showed that the trachea was again lined with a thick layer of pseudo-membrane, and that death was due to extension into the bronchial tubes.

In the second case there was complete cessation of respiration on each introduction of the long tube, but the use of a short one, only long enough to extend through the larynx, overcame the difficulty.

The same thing happened in the third case, and even the short tube failed to give relief. Tracheotomy was performed, but the insertion of the tracheal cannula also produced complete obstruction. It was removed and several pieces of membrane were extracted with forceps. It was reinserted without relief, and the child died on the table. At the autopsy false membrane was found in the larynx, very thick in the trachea, and extending into the bronchial tubes as far as the third or fourth division.

This accident has never happened to me on the first introduction of the tube, and can only occur when the pseudo-membrane has had time to become detached from the tracheal walls, as it requires the accumulation at one point of a considerable mass of membrane to produce serious obstruction. Similar conditions exist in those cases that develop very slowly, but they usually indicate a milder type of the disease, and there is not likely to be a large deposit in the trachea.

It is a common occurrence, soon after the insertion of the tube, for small pieces of membrane to be coughed up, which were detached from the chink of the glottis or the anterior wall of the trachea.

In a certain number of cases that cough but seldom, and particularly if there is very little secretion, the tube becomes lined with what appears to be a mixture of mucus and milk-curd, which is sufficient to produce obstruction. In such cases its removal for the purpose of cleaning is necessary.

It is here that the steam atomizer, with a weak alkaline solution, such as bicarbonate of soda, gr. xv. to ℥ j., is of the greatest advantage, and will, I believe, in the majority of cases, prevent this accumulation.

I have on several occasions excited a vigorous attack of coughing by coating the tube, before insertion, with a tenacious ointment containing nitrate of silver.

It is a remarkable fact that the tubes, when expelled from the larynx, if not interfered with, are never swallowed, but invariably escape by the mouth. I have seen this so often, especially while using plain tubes that would be coughed out several times each day, that I have come to regard it as a rule without any exception. If found in the stomach, it was either never inserted in the larynx, or, having been inserted, a string was left attached, and this first entered the œsophagus and drew the tube after it.

I believe that future experience will demonstrate that the laryngeal tube can be dispensed with earlier than the tracheal cannula. In the thirteen cases of recovery which have occurred in my own practice the tubes were retained, on an average, six days. In the first three cases very imperfect tubes were used, and the average time was over eight days. In two other cases they were worn eleven and fourteen days respectively. In both of these the long retention was, I believe, due to œdema excited by the frequent application of strong astringents, such as nitrate of silver, ʒ j. to ℥ j., or tannin of the same strength. They were applied by coating the tube with a stiff ointment of this strength, which melted slowly at the heat of the body. I know of several recoveries after intubation, in the practice of other physicians, where the average time the tube was worn was less than four days.

It has been noticed by others as well as myself that the pressure of the tube causes the early disappearance of the membrane, not only from the chink of the glottis, but also from that portion of the trachea which is brought in contact with the lower end of the tube in the movements of the neck. Were the pseudo-membrane the principal factor in producing the stenosis in croup, this would be of great importance, but in the majority of the autopsies I have witnessed in this disease the main cause of the obstruction was the intense swelling of the mucous membrane and submucous tissues, while the fibrinous deposit on the surface played an unimportant part in this respect. At the same time, I believe the average time required for the retention of the tube in the larynx will be less than for that in the trachea, because the gentle pressure it exercises also favors the early subsidence of the swelling. Keeping the larynx in use will also contribute to the same result, as the inspiratory expansion of the glottis is a purely reflex act due to the contact of the inspired air, and ceases completely as soon as the air enters by another channel.

In addition to overcoming stenosis, these tubes can be used for the purpose of making local applications to the larynx in the manner referred to above. Whatever effect the occasional application of strong solutions of nitrate of silver, so highly praised by several of the older authorities, may have in croup, I am fully convinced that when used of the same strength in this way it is highly injurious. I used this salt in several cases besides those already mentioned, and believe that, in one case at least, the intense œdema of the glottis found at the autopsy was produced by it.

The continuous effect of mild astringents, combined with the pressure of the tube, will in all probability prove efficacious in relieving intractable chronic inflammations of the laryngeal mucous membrane.

As dilators in the treatment of chronic stenosis of the larynx these tubes will, I believe, supersede all other methods. I have already used them in two such cases, with the most satisfactory results, and demonstrated that they can be retained for a long time without any danger of becoming obstructed or of causing much irritation or ulceration. In the first case there was such an abundant secretion of tenacious mucus, after the tube had been inserted several times, that I feared it might produce serious obstruction, but it was readily expelled by coughing. In the second case, after having left the tube in the larynx, on two occasions, for eight days continuously without inconvenience, I concluded to leave it in for a month. At the end of this time Dr. J. J. Reid, in whose service the patient was at Charity Hospital, procured a pass for her to come to my office to have it removed. It is now more than a month since she left the hospital, or over two months since the tube was last inserted, but I have not heard from her. Being a dissipated character, she is probably serving a term in some of the prisons. This patient wore a cannula in the trachea for over two years, and latterly suffered a great deal from bronchitis, which improved very materially after the tube had been inserted in the larynx and the external opening closed.

METHOD OF PRACTISING INTUBATION.—Each tube is supplied with a separate obturator, which serves the double purpose of attachment to the introducer, and of rounding off the lower extremity into a probe-point. The numbers on the scale (Fig. 2041) represent years. The smallest tube, when applied to the scale, will reach the first line, marked 1, and is suitable for children one year of age and under. I have used this size in children two years of age, and, although there is no danger of its slipping into the trachea, it is very liable to be coughed out. The second size will reach the line marked 2, and is intended for children between one and two years of age. The third size, marked 3—4 on the scale, should be used between two and four years of age, respectively. The largest tube can be used up to, but not after, the age of puberty, as the rapid increase in the size of the larynx at this time would render it liable to slip through; but it may be used with safety, even in the adult, by having a string attached.

FIG. 2041.

In selecting the tube to be used some allowance should be made for the fact that the male larynx, in children as in adults, is larger than the female, and also for the size of the child compared with its age. A puny, delicate child aged four years might require only a two-year size, while another very large, of the same age, would need the five- to seven-year size. When in doubt, it is better to use the larger tube, especially if the case is at a distance, when coughing the tube out would entail a good deal of inconvenience and some danger as well.

After selecting the proper tube to be used, a fine thread about twelve inches long, preferably of braided silk, is passed through the small hole near the anterior angle, and the ends tied to prevent its being accidentally pulled out, either in removing the obturator or by the patient's getting the hands free and seizing one end of it. It should not be thick enough to interfere in the least with the easy removal of the obturator, or to hold it too firmly in the tube. The obturator is now screwed tightly to the introducer (Fig. 2042) to prevent its rotating while being inserted, which would be liable to bring the posterior projecting portion of the head under the epiglottis, and passed into the tube when it is ready for use.*

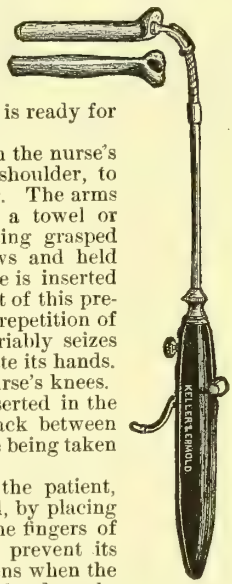

FIG. 2042.

The patient is held upright on the nurse's lap, with its head on her left shoulder, to prevent interference with the gag. The arms are secured either by wrapping a towel or sheet around the body, or by being grasped in either hand below the elbows and held firmly by the sides until the tube is inserted and the string removed. Neglect of this precaution will often necessitate a repetition of the operation, as the child invariably seizes the string as soon as it can liberate its hands. The legs are held between the nurse's knees.

The gag (Fig. 2043) is then inserted in the left angle of the mouth, well back between the teeth, and opened widely, care being taken not to use too much force.

An assistant, standing behind the patient, holds the head inclined backward, by placing one hand on either side, with the fingers of the left overlapping the gag to prevent its slipping, which sometimes happens when the child struggles very much. The head, neck, and body should be kept in a straight line.

The operator, holding the introducer (Fig. 2042) in the right hand, inserts the index-finger of the left, raises the epiglottis, and locates the cavity of the larynx; then, placing the lower extremity of the tube in contact with the finger, follows the same curve by elevating the handle of the introducer, which is held close to the patient's chest in the beginning of the operation, as it advances and passes into the larynx beside the finger. Very little force is necessary to overcome the resistance offered by any form of acute stenosis, and if the tube does not enter easily it should be withdrawn and another attempt made.

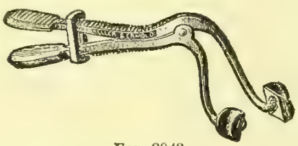
FIG. 2043.

When the tube is supposed to be inserted it is detached from its obturator by pressing forward the button on the upper surface of the handle of the introducer, and in removing this from the mouth the movements required for its insertion are reversed. While doing this it is necessary to keep the finger in contact with the head of the tube to prevent it from being also withdrawn. The joint in the shank of the obturator is intended to facilitate this part of the operation.

The gag is now removed, and the tubal character of the cough, together with the relief to the dyspnœa, is sufficient proof that the tube is in the larynx. If no relief follows it will be found to have entered the œsophagus, and the operation should be repeated. With the rare exceptions previously alluded to, the tube will always relieve dyspnœa due to any form of obstruction in the larynx. The dyspnœa produced by the pressure of a retro-pharyngeal abscess, of which I saw two cases within a year, supposed to be either croup or œdema of the glottis, will continue to be mistaken for obstruction in the larynx.

As soon as it is ascertained with certainty that the tube is in the larynx, the finger is again inserted and brought in contact with the head of the tube while the string is removed. In older children this can always be done without reinserting the gag, as they will readily open the mouth to get rid of the thread, which causes a great deal of irritation.

The removal of the tube is accomplished by guiding the extractor (Fig. 2044) into the tube along the index-finger of the left hand, which is brought in contact with its head and then carried as far as possible to the patient's right, in order to uncover the aperture and allow the instrument to enter in or near the perpendicular. Firm pressure is then made with the thumb on the lever above the handle while the tube is being withdrawn.

The time that the tube should be allowed to remain in the larynx will be determined by the progress of the case and the age of the patient. It should be removed whenever urgent secondary dyspnœa occurs, as it is often impossible to say whether the obstruction is in the tube or in the bronchi. About the same amount of recession, restlessness, and suffering will occur in either case. I have noticed almost invariably a better respiratory murmur over the lower posterior portion of the lungs when the obstruction is in the bronchial tube than when it is in the larynx.

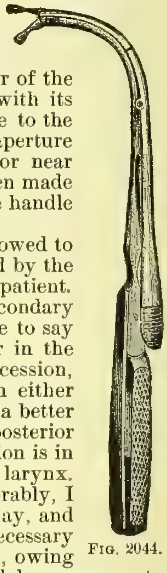
FIG. 2044.

In older children who progress favorably, I remove the tube on or about the fifth day, and in the majority of cases it will not be necessary to reinsert it. In very young children, owing to the small size of the larynx, it will be necessary to leave it in longer.

Intubation in the adult is practised in a similar manner, with the patient seated on a chair and the head inclined backward. The tube can be guided into the larynx either by the finger, as in children, or by the aid of the mirror. Those who are familiar with the use of the laryngoscope will no doubt prefer the latter method.

The dilatation of chronic stricture by this plan is very rapid, as the tube can be left in the larynx continuously for a week or even longer, as in the case referred to above. While using the smaller sizes they will fre-

* Since writing the above this accident happened on inserting a tube in an adult. It was easily rectified by making firm traction with the string at first to the patient's left, then around to the median line, keeping the index-finger of the left hand in contact with the tube while so doing.

quently be expelled, because the self-retaining swell has to be made very small to render their introduction possible. But when a sufficient degree of dilatation has been accomplished, a tube can be used that will be retained as long as desired.

MANAGEMENT AFTER INTUBATION.—The principal cause of the mortality in croup after operation is the extension of the membrane into the bronchial tubes. It existed, to a greater or less extent, in about seventy per cent. of the autopsies that I have witnessed in this disease. I do not believe that any drug yet discovered will prevent this spreading or influence its course in the least. Were we possessed of such a remedy, it should with greater reason prevent the extension from the pharynx to the larynx, as there is usually more time in this case for it to take effect.

I therefore administer no medicine after the introduction of the tube, except for complications or to procure rest, but confine myself to giving the blandest kind of nourishment, and this, when possible, in the solid and semi-solid form, such as ice-cream, rare-boiled eggs, custard, canned condensed milk, which is sweet and often readily taken, or any other kind that the child can be induced to take. Stimulants should be given well diluted with milk. As coughing is the means by which the tube is kept clear, it is sometimes desirable to give fluids for this purpose, such as lime-water, which would be beneficial if some of it should enter the tube. Cracked ice is very grateful when there is much thirst, and also excites cough.

The use of the steam atomizer with a weak alkaline solution is of great benefit in softening the tenacious mucus and rendering its expectoration more easy. It will also dispense with the necessity for keeping large fires to generate steam, which over-heat and rarefy the air to such a degree as to render it difficult even for a person in health to breathe. It should not be held so close to the mouth during waking hours as to counteract its good effect by the struggles of the child to avoid it.

Nephritis is an extremely common complication of diphtheria, whether of the pharynx or of the air-passages. I have seen a number of cases of croup where the fatal termination was due either to exhaustion from persistent uræmic vomiting, or to uræmic convulsions after all obstruction had disappeared from the larynx. Its early recognition and treatment would undoubtedly save a certain number of such cases. As a rule it is not discovered until late in the disease, when the time for effective treatment has passed. Where it is difficult to obtain a sample of the urine for examination it is better to assume its existence, and begin treatment at once by giving a teaspoonful of the infusion of digitalis (English leaves) three times a day, more or less according to the age, and enveloping the trunk from the armpits to the hips in a hot pack covered with oiled silk. This is more effectual in producing diaphoresis than poultices and less troublesome, as it requires to be changed but seldom. Should a later examination prove the non-existence of albuminuria, this treatment will have done no harm. *Joseph O'Dwyer.*

LARYNX, LEPROSY OF THE. HISTORICAL.—In the Ayur-Véda, one of the most ancient of medical writings, suppression of the voice is given among the signs of leprosy,[1] and Hans von Gersdorff[2] states that in the Middle Ages a hoarse voice and shortness of breath were regarded as characteristic of the disease. At the commencement of the present century Martius[3] speaks of ulceration of the palate (velum) and also of the trachea which occasion great difficulty of respiration, as symptoms of the tauric lepra, which occurred in the Crimean war, and which was supposed to have been imported by the Russian troops engaged in the war with Persia. Among other subsequent writers, Struve[4] also alludes to alteration of the voice and difficult breathing; but nothing was known of the laryngoscopic appearances of the affection until their study during life was made possible by the introduction of the laryngeal mirror.

In recent times the disease, as it affects the larynx, has been described by Danielsen and Boeck,[5] Hillairet,[6] Wolff,[7] Gibb,[8] Tobold,[9] Schrötter,[9] Virchow,[10] Hebra and Kaposi,[11] Elsberg,[12] Thoma,[13] Eppinger,[14] M. Mackenzie,[15] Mackern,[16] Basini,[17] Thin,[18] Virchow,[19] Plumert,[20] Rake,[21] Kaposi,[22] and others.

Lepra of the larynx is generally secondary to, or appears coincidently with, pronounced lesions of the pharynx or nose, and as a complication of a more or less advanced stage of the cutaneous affection. It may, however, occur without involvement of the skin, as in Elsberg's first case.

The anatomical appearances vary from uniform thickening and redness to extreme tubercular induration and proliferation, which may reach the cartilages, and even the structures of the external neck (Virchow). The laryngeal disease develops as a diffuse hyperæmia and swelling of the mucous membrane, or the process may be limited to individual parts, as, for example, the epiglottis. At isolated spots of the hyperæmic laryngeal membrane there develop subsequently hard, nodular, extremely vascular excrescences or tubercles, which are the anatomical analogues of the tubercles on the skin and other mucous membranes. In their incipiency these resemble, according to Virchow, the mucous patch of syphilis. The epithelium covering the tubercles which stud the mucous membrane, as if sprinkled there, is thrown off and granulating ulcers are formed, which finally cicatrize with the production of considerable deformity. Extreme destruction with necrosis of the cartilages is thus sometimes brought about, and the larynx is occasionally so constricted by cicatricial tissue as to threaten danger from suffocation.

The tubercles vary in size from a pinhead or millet-seed to a small pea (Wolff). Their number varies considerably; sometimes only a few are found scattered here and there over the membrane, while in other cases they are so closely aggregated as to resemble a diffuse infiltration, which gives to the parts affected a pallid, grayish appearance (Hillairet).

The cicatrices which result from the healing of the laryngeal ulcer of leprosy resemble in physical characters the stratiform scars of syphilis. The tubercular nodules, when examined under the microscope, are seen to be identical in structure with those found on the skin, consisting of a granulation tissue characterized by the presence of the granular lepra-cell and bacillus, which shows a remarkable tendency to remain as such, and which ultimately becomes converted into a dense cicatricial mass. In rare instances papillomatous excrescences are observed similar to those which result from syphilitic ulceration.

The leprous process develops slowly in the larynx, and years may elapse before ulceration takes place. The natural tendency is, however, to ulceration and scar-formation.

SYMPTOMS.—The symptoms are those of ordinary chronic catarrh. The voice is generally hoarse, and in the subsequent stages of the disease the respiration becomes embarrassed. Secretion is notably increased, sometimes bloody, and, according to Lamblin,[23] the breath is exceedingly fetid, and the thyroid is tender on pressure. In the anæsthetic form of the skin affection the normal sensibility of the larynx is correspondingly diminished.

COMPLICATIONS.—The most dangerous complication, according to those who have resided among the victims of this disease, is acute œdema. In other cases the leprous infiltration leads to disturbances of the motor apparatus of the cords, and, together with the development of fibrous tissue, to stenosis of the larynx and trachea.

DIAGNOSIS.—Although the anatomical diagnosis between this disease and syphilis or lupus may be difficult from gross appearances alone, its clinical recognition is always possible from the peculiar appearance of the larynx, the slow development of the affection, and the lesions of the external surface.

PROGNOSIS.—It is sufficient to state that, as laryngeal lepra is the local expression of an incurable general disease, the prognosis is necessarily bad.

TREATMENT.—The treatment, therefore, is palliative, and must be guided by the general principles involved in the care of chronic laryngitis. Elsberg speaks favorably

of the topical use of an ethereal solution of iodoform, and calls attention to gurjun oil (balsam dipterocarpi) as a valuable local, as well as general, remedial agent. Should œdema occur, the parts must be scarified, and in stricture of the tube, life may be prolonged by tracheotomy.

John Noland Mackenzie.

[1] Tom. i. Nidanast 'h'ana, id est Pathologia, cap. v., p. 181 (Hessler's translation, Erlangen, 1844).
[2] Cited by Virchow: Die krankhaften Geschwülste, ii., S. 519.
[3] De lepra taurica, specimen medico-practicum. Lipsiæ, 1806.
[4] Ueber die Aussatzartige Krankheit Holsteins, 1820. See also extract in the Edinb. Med. and Surg. Journal, vol. xviii., p. 92. See also the work of Ludwig Hunefield: Die Radesyge oder scandinavische Syphiloid. Leipzig, 1828.
[5] Traité de la Spedalskhed, p. 121. Paris, 1848; and Atlas, Pl. i., v. and xi. [6] Mém. de la Soc. de Biologie, 1862 (cited by Virchow).
[7] Virchow's Archiv, Bd. xxvi., 1863, S. 44.
[8] Dis. of the Throat, etc., p. 272. Lond., 1864.
[9] Schrötter's Laryng. Mittheilungen, 1871–73, Bd. ii., S. 84 (cited by Ziemssen). [10] Die krankhaften Geschwülste, Bd. ii., S. 519.
[11] Virchow's Spec. Path. u Ther., Bd. iii., Abth. ii., S. 402.
[12] N. Y. Med. Record. January 4, and August 2, 1879.
[13] Virchow's Archiv, 1873, Bd. lvii., S. 445.
[14] Path. Anat. der Larynx u. der Trachea, p. 181. Berlin, 1880.
[15] Dis. of Throat and Nose. Lond., 1880, vol. i., p. 400.
[16] Lond. Lancet, 1881, vol. ii., p. 129.
[17] Bolletino dell' orrechio, della gola, etc., 1884, No. 6 (Int. Centralblatt für Laryngologie, etc., No. 9, 1885.
[18] Brit. Med. Journal, July 19, 1884.
[19] Berlin. klin. Wochenschrift, 1885, No. 12, S. 189.
[20] Wiener med. Ztg., 1884, No. 34 to 37.
[21] Trans. Path. Soc. Lond., 1885, vol. xxiii.
[22] Wiener med. Wochenschrift, 1885, No. 47 to 49.
[23] Etude sur la lèpre tuberculeuse, etc. Paris, 1871. Cohen: Dis. of the Throat, etc., p. 531. 1880.

LARYNX, LUPUS OF THE. Historical.—Our positive knowledge of laryngeal lupus dates from the laryngoscopic studies of Türck.[1] The occurrence of the disease in the larynx has also been observed and described by Virchow,[2] Tobold,[3] Ziemssen,[4] Grossman,[5] Thoma,[6] Stilling,[7] Lefferts,[8] Béringier,[9] Eppinger,[10] Morell Mackenzie,[11] Knight,[12] Asch,[12] Breda,[13] Chiari,[14] Bowen,[15] Chiari and Riehl,[16] Hunter Mackenzie,[17] Van Santvord,[18] and others.

Lupus of the larynx is a relatively rare disease. While it is probably true that it occurs more frequently than is generally supposed, it is equally certain that this affection has been confounded, as regards its manifestations in both the pharynx and larynx, with syphilis, and particularly the congenital form of the disease. Its alleged frequency among young females may possibly be accounted for by the confusion of this disease with congenital syphilis.

Lupus of the larynx is usually, if not always, consecutive to lupus of the nose and pharynx. It generally invades the upper portion of the larynx, and the epiglottis is the structure most frequently attacked.

Anatomical Appearances.—The principal anatomical appearances consist in more or less diffuse or localized hypertrophic enlargement of the tissues, peculiar granular nodules or efflorescences, and ulceration. There is nothing absolutely characteristic in the laryngeal hypertrophy of lupus. The so-called lupous granulations appear as more or less well-marked vascular papillary nodules, of varying size and contour, generally multiple and scattered over the epiglottis, more rarely in other portions of the larynx, and occurring singly. They present the appearance of tuberous knobs, varying in size from that of a millet-seed to a small pea. These nodules, which, according to Virchow, bear a close resemblance to soft granulation-tissue in their histological structure, are considered by Lefferts, and Hebra and Kaposi[19] as characteristic of the disease in the larynx. According to the latter, they are often the first anatomical lesion, and in this case present a pale gray degeneration of the epithelium, which latter is subsequently exfoliated, leaving small erosions or ulcerated surfaces behind, a phenomenon which Eppinger thinks points to the hyperplastic character of the process. Beginning as small projections from the mucous membrane, they slowly gain in size, not only from hyperplastic increase in the nodules themselves, but also by the development of efflorescences in their neighborhood. An irregular mass is thus formed, which may remain as such for a long time, or finally break down and ulcerate.

The ulcer of laryngeal lupus resembles an ordinary granulating sore. Its edges are hard, irregular, swollen, and covered with excrescences; its base is filled with irregular fleshy granulation-tissue with scanty secretion. In Lefferts's case the ulceration was worm-eaten in appearance, resembling that of tuberculosis. The tendency of the ulcer, as in other morbid processes in the larynx—as for example, in lepra—is toward imperfect cicatrization, and the subsequent increased formation of nodules in the cicatrix and its neighborhood. It rarely attacks cartilages other than the epiglottis (but may descend to the deeper cartilaginous structures). The efflorescences which develop in the neighborhood of the ulcers, or rather in the cicatrices, are, according to Chiari and Riehl, not papillary in nature, but are identical with the tumors found on the external surface.

Symptoms.—These are not characteristic. The ulceration is not, as a rule, painful, and extensive changes may occur without impairment of function.

Prognosis.—The disease is essentially chronic. Imperfect cicatrization followed by the development of fresh granulation-tissue is the rule, and the prognosis is therefore unfavorable. Stenosis of the larynx and perichondritis are probably rare, but danger may arise from the sudden occurrence of œdema (case of Béringier).

Diagnosis.—As it is highly probable that the disease in the larynx is rarely, if ever, met with, except as a late manifestation of the cutaneous or nasal affection, there will be little difficulty in its recognition. Should a doubt arise, it may be differentiated from lepra and syphilis by careful attention to the anatomical peculiarities of these diseases.

Treatment.—The treatment should consist in the administration of tonics and the stimulation of the local process by caustic applications. Nitrate of silver was used by Türck and Ziemssen, with somewhat favorable results, and iodoform is recommended by Chiari and Riehl. In Lefferts's case, caustic applications seemed to aggravate the local trouble, and milder measures were substituted for them.

John Noland Mackenzie.

[1] Klinik, S. 425. Atlas, tab. xx., 6, and xxi., i. Also, Zeitschrift d. Gesellschaft d. Aerzte in Wien, 1859, No. ii.
[2] Die krankhaften Geschwülste, ii. B., 2, S. 496.
[3] Laryngoscopie u. Kehlkopfkrankheiten, S. 307. Berlin, 1874.
[4] Ziemssen's Cyclopædia, Am. ed., 1875, vol. vii., p. 853.
[5] Anzeiger d. k.k. Gesellsch. d. Aerzte in Wien, 1877, No. 27.
[6] Virchow's Archiv, Bd. 55. [7] Zeitschr. f. Chirurgie, 1877, Bd. viii.
[8] American Journal Med. Sc., April, 1878, p. 370.
[9] Annales des mal. de l'oreille et du larynx, Juli, 1878.
[10] Path. Anat. der Larynx und der Trachea, S. 163. Berlin, 1880.
[11] Dis. of Throat and Nose, vol. i., p. 396.
[12] Archives of Laryngology, July, 1881.
[13] Gaz. Med. Ital., Prov. Veneto. Padova, 1881, xxiv., 425 (Index Medicus). [14] Monatsschrift f. Ohrenheilkunde, Berlin, 1882, No. 8.
[15] Trans. Rhode Island Med. Soc., 1882, ii., pt. 6, 487.
[16] Vierteljahresschr. f. Dermatologie u. Syphilis, 1882, ix. Jahrgang, 4 Heft. [17] Edinburgh Med. Journal, October, 1885.
[18] N. Y. Med. Journal, December 5, 1885.
[19] Virchow's Handbuch, iii. Bd., ii. Abth., S. 325.

LARYNX, PHOTOGRAPHY OF THE. Photography of the larynx was attempted by Czermak soon after the discovery of the laryngoscope, and efforts, alike unsuccessful, have since been made by J. Solis-Cohen, Elsberg, Cutter, and Stein. In 1883 Mr. Lennox Browne, of London, published three or four good photographs of the larynx of one well-trained subject, and stated, in presenting them at a meeting of the British Medical Association, that he did not anticipate that the art could be carried beyond the boundary of physiology, and that it was plainly unreasonable to expect photographs from life of pathological conditions. Mr. Browne's method of procedure consisted in taking, by means of an ordinary camera and a strong artificial light, a negative which, while representing the laryngoscopic mirror in position and the laryngeal image as seen therein, included at the same time the mouth and part of the face of the subject.

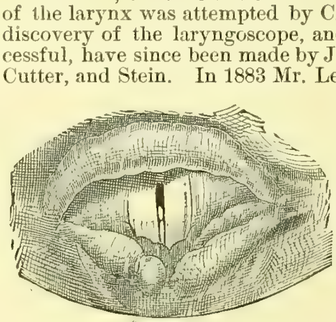

Fig. 2045.

It was necessary that the subject should possess sufficient skill and tolerance to demonstrate his own larynx, and an exposure of several seconds was required.

In 1882 Prof. Thomas R. French, of Brooklyn, N. Y., aided by Mr. George B. Brainerd, began a series of experiments, which were explained in a paper read by Dr. French at the meeting of the International Medical Congress, held in Copenhagen in 1884, and which have resulted in the elaboration of a complete and perfect method, all of the difficulties which had formerly prevented successful work having been met and overcome. The advantages of Dr. French's method over all former attempts are as follows: 1. Any larynx which can be seen in the laryngoscopic mirror can be photographed. 2. Pathological as well as physiological conditions can be reproduced. 3. The exposure of the plate is instantaneous. 4. Illumination by means of sunlight is employed. 5. Only the laryngeal image as reflected in the mirror is included in the picture. 6. Five negatives can be taken, and in rapid succession. 7. Not only can perfect photographs, representing the parts with clearness and accuracy, be secured, but the work can be done with ease and without assistance. A period of five minutes is sufficient in which to prepare and arrange the instruments, while not more than five minutes are needed to secure a good negative of the larynx. This negative can afterward be developed and printed at leisure, and the finished picture may then be exhibited in the form of a photograph or passed over to the engraver. The results may be seen in the accompanying illustrations, which have been engraved directly from the photographs. Figs. 2045, 2046, 2047, and 2048 show the normal larynx in the act of singing, and exactly represent the photographs, excepting that they are somewhat enlarged. Fig. 2049 represents the larynx of a soprano in the act of singing the extraordinarily high note C, above the high C, for the production of which the vocal bands, it is said, must vibrate 2,100 times a second. Fig. 2050 represents the same larynx while singing the lowest note of which it was capable, C, bass clef, second space. The difference in the position of the vocal bands and the other laryngeal structures is graphically shown.

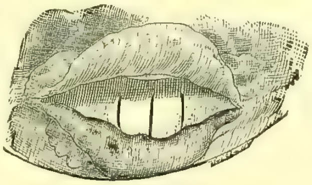

FIG. 2046.

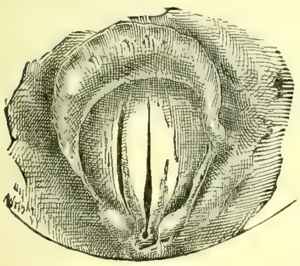

FIG. 2047.

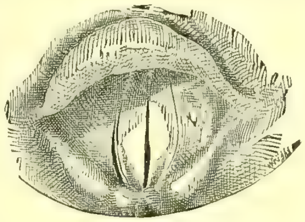

FIG. 2048.

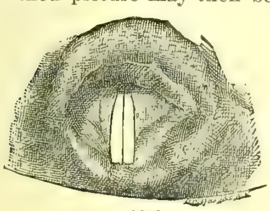

FIG. 2049.

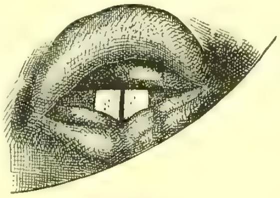

FIG. 2050.

While it would not be practicable to supply here actual specimens of the photographs taken by Dr. French, the publishers have kindly consented to furnish a series of sixteen photo-engravings of exactly the same size as the original photographs. Although much care has been expended in the preparation of these, it is impossible by any known process to reproduce the wonderful clearness and distinctness of outline, and the artistic beauty, of the original photographs, so that the perfection to which the art has attained can be judged only from the photographs themselves.

The apparatus designed by Dr. French (Fig. 2053) consists of: 1, an instrument for concentrating the rays of the sun; 2, a camera with a throat-mirror attached; 3, a perforated forehead reflector.

The sunlight concentrator consists of a hollow truncated cone of metal, 10 inches long, in the large end of which is a double convex lens, 5 inches in diameter, which has a focal length of 13 inches. At the outer end of a short movable tube, fitted into the small end of the cone, is a plano-concave lens of 1¾ inch diameter, with its plane surface outward; this is placed an inch or so inside of the point of focus of the double convex lens, and in that position intercepts the converging rays and makes them parallel or divergent, according to its distance from the first lens. With this device a powerful light is obtained,

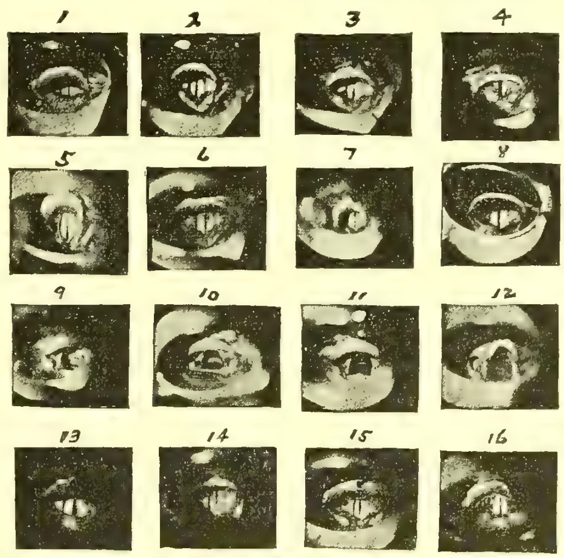

FIG. 2051.—From Photographs of the Larynx, Original Size. Nos. 1, 2, 3, and 4, female larynx in phonation; Nos. 5, 6, 7, and 8, male larynx in phonation; Nos. 9, 10, 11, and 12, respiration; Nos. 13, 14, and 15, catarrhal laryngitis; No. 16, swollen arytenoids in laryngeal phthisis.

and that, too, without material heat. The cone is mounted on a rod by means of a universal joint, the rod being fastened to the frame of a window into which the sun shines.

The camera (Fig. 2052) consists of a box, 10½ inches long, 1½ inch wide, and ¾ of an inch in thickness. The back opens upon hinges, and allows the introduction of the ground glass or plate-holder. The plate-holder is long enough to admit of five pictures being taken. On the front face of the camera a telescopic tube, 3½ inches long when run out to its full extent, is attached, and at the outer end of this tube the lens is placed. The lens is made up of two achromatic meniscus lenses of one half-inch diameter, and has a focal length for parallel rays of 1⅝ inch. In the front part of the camera is a narrow compartment in which slides a drop-shutter of hard rubber. The shutter is released by means of a key on the front face of the camera. At the side of the tube holding the lens is a hollow handle of brass, into which the shank of the throat-mirror is passed and fixed by a thumb-screw. The shank is attached to the right side of the frame holding the mirror. The object of this is, mainly, to allow of the lens being held opposite any part of the opening of the mouth. The mirrors used are slightly convex, the radii of their spherical surfaces varying from

twelve to twenty-four inches, twelve inches radius being as small as can be used without danger of distortion.

The manner in which the apparatus is used in taking photographs of the larynx is as follows:

A concave reflector, attached to a head-band, is so arranged over the left eye that the beam of sunlight will be received upon it and thrown into the mouth of the subject. It is important that the beam of light should be thrown from the inner side of the reflector, that nearest the nose, for in this way the angle between the reflected beam and the axis of the lens is reduced to a minimum. As a rule, the tongue must be protruded and held well out between the thumb and forefinger of the subject's right hand, though in exceptional cases the tongue may be allowed to remain in the mouth. The throat-mirror, with camera attached, held in the right hand of the observer, is now placed in position in the fauces. The mirror and light should be so adjusted that with the observer's left eye only the central portion and left side of the larynx can be seen, and be seen to be well illuminated.

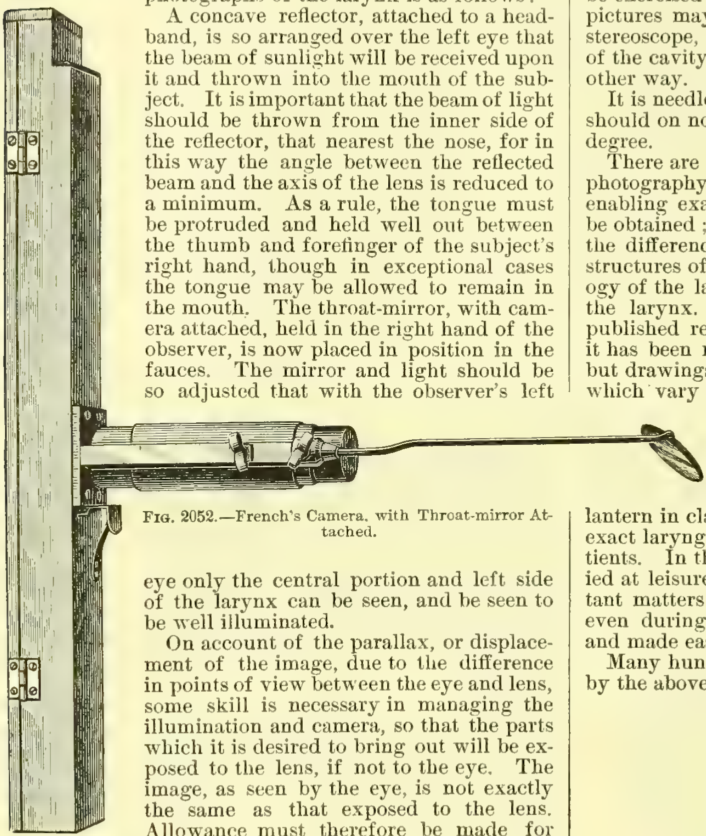

Fig. 2052.—French's Camera, with Throat-mirror Attached.

On account of the parallax, or displacement of the image, due to the difference in points of view between the eye and lens, some skill is necessary in managing the illumination and camera, so that the parts which it is desired to bring out will be exposed to the lens, if not to the eye. The image, as seen by the eye, is not exactly the same as that exposed to the lens. Allowance must therefore be made for this fact, the mirror being held in such a position in the fauces that a straight picture will be insured.

If, now, the tongue does not mount up above the level of the lower edge of the lens and the lower edge of the mirror, it may be taken for granted that, when the plate is exposed, the picture received upon it will be nearly the same as that seen with the left eye in the throat-mirror. The plate is exposed by pressing upon the key with the index-finger; this releases the shutter, which, in falling, makes an instantaneous exposure, amounting, perhaps, to one-sixth of a second.

While satisfactory photographs, as a rule, may be obtained at the first sitting, two sittings are sometimes required. In the first the focus is to be found. In the second, the focus being known, if all the other conditions are fulfilled, as many good pictures may be obtained as are desired.

The manner in which the focus of any subject is found is as follows: The distance from the position occupied by the mirror in the fauces to the vocal bands varies markedly in males and females, and to a less extent in individuals of the same sex. In using the instrument described by Dr. French, with the throat-mirror eight inches from the front face of the camera, in men, with the tongue in or out, the lens must occupy a position of from $2\frac{26}{32}$ of an inch to $2\frac{23}{32}$ of an inch from the face of the camera. In women, from $2\frac{29}{32}$ of an inch to $2\frac{27}{32}$ of an inch from the face of the camera. The difference in the focus, whether the tongue is protruded or not, is about $\frac{1}{32}$ of an inch.

These figures being known, in order to find the exact focus, three exposures should be made, varying the position of the lens $\frac{1}{32}$ of an inch within the limits indicated above. By following these directions, one or more pictures of the larynx or trachea, in good focus, can almost invariably be obtained in three exposures.

If, in taking several photographs of the larynx, care be exercised to vary the position of the mirror slightly, pictures may be obtained which, when viewed with the stereoscope, will present an appearance of greater depth of the cavity of the larynx than can be obtained in any other way.

It is needless to say that photographs taken in this way should on no account be retouched, even in the slightest degree.

There are many ways, Dr. French believes, in which photography of the larynx will prove of value: 1. By enabling exact reproductions of the laryngeal image to be obtained; this will lead to a greater familiarity with the difference in size, shape, and position of the various structures of the larynx. 2. In the study of the physiology of the larynx. 3. In the study of the pathology of the larynx. 4. By enabling truthful illustrations for published reports of cases to be furnished. Heretofore it has been necessary to use drawings to illustrate cases, but drawings are at best only approximations to the truth, which vary according to the skill of the draughtsman and his familiarity with the parts which he attempts to represent. 5. In enabling types of the larynx, both normal and diseased, to be shown in text-books. 6. In enabling photographs of the larynx to be shown with the lantern in class-room instruction. 7. In reproducing the exact laryngeal images for the records of histories of patients. In this way the existing conditions may be studied at leisure, and, therefore, more thoroughly. Important matters of detail, which may have escaped notice even during a careful examination, may be developed and made easy of recognition by the photograph.

Many hundred laryngeal photographs have been taken by the above process, illustrating every conceivable physiological and pathological condition of that organ, while attempts made to photograph the retro-nasal space have met with brilliant results. By means of this method important questions of diagnosis, particularly in the department of neuroses of the larynx, have been settled beyond dispute, while in the investigation of the physiology of the singing voice it has practically opened a new era.

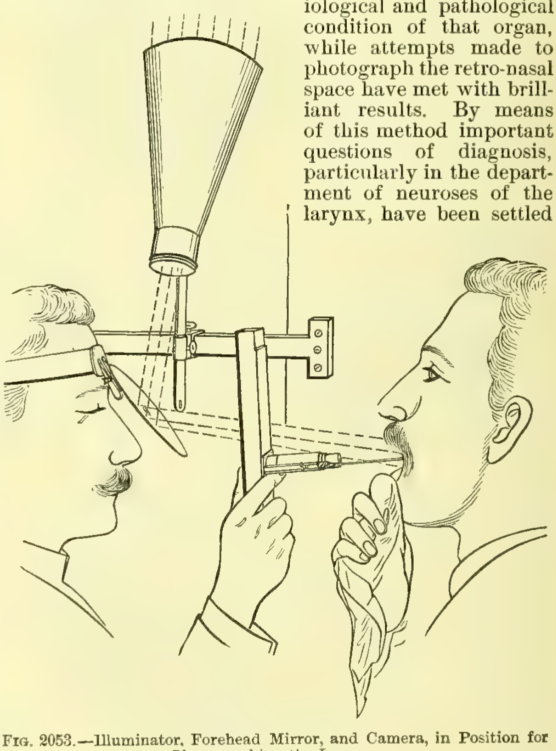

Fig. 2053.—Illuminator, Forehead Mirror, and Camera, in Position for Photographing the Larynx.

Thus it will be seen that the patience and ingenuity

displayed in the long series of experiments made by the distinguished inventor of the process of laryngeal photography herein described have been rewarded by complete and signal success, and he may fairly be said to have conceived, created, and perfected a contribution to the methods of scientific investigation the value of which has not even yet been fully realized. *D. Bryson Delavan.*

LARYNX, PHTHISIS OF THE. DEFINITION.—Laryngeal phthisis is a disease characterized by the development in the laryngeal mucous membrane of a slowly progressing ulcerative process, which involves not only the membrane itself in its destructive action, but also extends in many cases to the perichondrium and cartilages, resulting in caries of these parts.

HISTORY.—Ulcerations on the larynx were first definitely described by Morgagni,[1] and subsequently researches were made by Petit,[2] Sauvée,[3] and others. The close relation, however, existing between laryngeal and pulmonary phthisis was not clearly established until 1825, when Louis[4] made public his famous contribution. In this treatise Louis laid especial emphasis on the point that "ulcerations of the larynx, and especially those of the trachea and epiglottis, must be considered as lesions of phthisis." The acceptance of so broad a statement as this necessarily led to many errors of diagnosis and much confusion, which, however, were cleared up by the publication, two years later, of the result of the investigations of Trousseau and Belloc,[5] who showed the existence of three kinds of ulcerations in the larynx, viz., those caused by syphilis, phthisis, and cancer, respectively.

With the settlement of the clinical status of laryngeal phthisis, as an ulcerative process belonging to the tubercular dyscrasia, and entirely distinct from syphilis and other diseases, there sprang up a new topic for dispute, viz., as to the tubercular or non-tubercular character of the disease. Louis[4] denied the existence of tubercle in the affection, taking the ground that the ulcerations in the larynx were due to the corroding action of the discharges from the diseased lung passing over its surface. Trousseau and Belloc,[5] on the other hand, believed that there were deposits of true tubercle in the laryngeal membrane which gave rise directly to the ulcerative process, although they acknowledged that their researches had failed to discover them.

The teaching of Louis, as to the non-tubercular character of the disease, was followed by Andral,[6] Cruveilhier,[7] Ruhle,[8] and others.

The tubercular character of the disease was asserted by Barth[9] and Lhéritier,[10] in France, and by Rokitansky,[11] Günsberg,[12] Tobold,[13] and Virchow,[14] in Germany.

The latter, in giving the weight of his great name in favor of the tubercular theory, recommends the larynx for the study of those who "wish to know true tubercle," and in a later contribution[15] writes: "I am absolutely convinced that laryngeal phthisis is due to tuberculization of the larynx."

The later and very painstaking investigations of Heinze,[16] supplemented by those of Eppinger,[17] have been so thorough and so exhaustive that they have received very general acceptance as settling this vexed question in favor of the view which traces the origin of the disease to a direct deposit of true tubercle.

We thus reach the conclusion that laryngeal and pulmonary phthisis are one and the same disease, and yet the tubercular process shows marked differences in its manifestations and development in the two regions. This difficulty, however, has been very ingeniously overcome by Virchow,[14] who explains that a superficial deposit of miliary tubercle in a membrane exposed to injury is very liable to break down early, and to change into an ulcerative process before the more advanced or caseous changes have had time to set in.

ETIOLOGY.—The cause of the disease, then, is, probably in all cases, either a previously existing pulmonary disease, or that peculiar habit or dyscrasia which favors the development of phthisis.

The question as to the possibility of a tubercular deposit occurring primarily in the larynx has long been a subject of discussion. That the disease has often been observed in the larynx before any evidence of lung disease could be detected by physical examination cannot be doubted; and yet many writers insist that a primary laryngeal phthisis never occurs.

The value of this discussion does not seem very evident. Few facts are more certain in clinical medicine than that an attack of phthisis of the larynx will be followed, sooner or later, by the development of pulmonary phthisis, if this did not exist previously. That the pulmonary disease must necessarily precede the laryngeal is not imperative. The argument in support of this view is based entirely on the clinical fact that in adults tubercle is rarely deposited in other organs of the body except as a disease secondary to pulmonary phthisis. The rule is not a universal one, however, and there is no good reason for regarding the larynx as exempt from a primary tubercular deposit.

Laryngeal disease is always one of the serious complications to be feared in phthisis pulmonalis. Heinze,[16] in an examination of 1,226 cases of pulmonary disease, found laryngeal phthisis in 376, or about thirty per cent.; Mackenzie,[18] in 100 cases examined, found laryngeal disease in 33; while Willigk[19] found only 236 cases with laryngeal complication out of 1,317 examined, or eighteen per cent.

The age at which the disease most frequently occurs is between twenty and thirty. Heinze's statistics do not differ very greatly in their results from those of Mackenzie or Marcet,[20] and are as follows:

Age.	Pulmonary phthisis.	Laryngeal phthisis.
Under one year	13	1
One to ten years	39	4
Ten to twenty years	92	23
Twenty to thirty years	406	130
Thirty to forty years	303	112
Forty to fifty years	179	67
Fifty to sixty years	104	27
Sixty to seventy years	53	9
Over seventy years	25	3
Age unknown	12	..
	1,226	376

While in pulmonary phthisis males and females are affected in about equal proportion, in the laryngeal affection we would naturally expect that the proportion of males would exceed that of females, on account of the greater frequency of catarrhal disorders among the males. Heinze's statistics show 33 males to 21 females. Holmes,[21] in an examination of 227 cases, found 155 males to 72 females; Mackenzie, in 500 cases examined, found 365 males to 135 females; while Marcet found much the same proportion.

This very remarkable preponderance of males affected by the disease is somewhat startling and not easy of explanation. It is, however, probably due to the fact that males are so often compelled to follow out-door avocations and to expose themselves so much to changeful and inclement weather, after the disease has fixed itself upon the lungs, that they become thereby so much more liable to this most distressing complication of consumption.

This excessive liability to the disease in males would seem to lend much weight to the view that, in addition to the pulmonary phthisis as the main direct cause of the disease, a very powerful predisposing cause lies in the existence of a catarrhal laryngitis or any affection which weakens the larynx and lessens its power of resisting disease. This factor in the etiology of laryngeal phthisis has been especially dwelt upon by Bosworth,[22] who records a number of cases in support of this view.

PATHOLOGY.—In the earlier stage of the disease, before ulceration has set in, the microscope reveals a notable infiltration of both the mucosa and submucosa with lymphoid corpuscles, the membrane being swollen to two or three times its normal thickness. In addition to the large number of inflammatory corpuscles, there are found a number of tubercles scattered about, some isolated and others conglomerate. In the conglomerate masses are found occasional giant-cells.

The blood-vessels are also the seat of notable changes, the walls of the veins being converted almost entirely into tubercles, while the outer and inner coats of the arteries have undergone the same metamorphosis. The formation of the ulcer is due merely to the breaking down of these tubercular masses, both the isolated and the conglomerate, resulting in a broad, shallow ulceration which extends laterally rather than deeply, and whose surface is covered with detritus and tubercles in a more or less advanced stage of caseation.

Stages of Development.—Many writers describe the first stage of the disease as one of anæmia. It is undoubtedly true that anæmia of the larynx precedes the development of the disease in many cases, and yet there is nothing in this condition which belongs especially to this disease. We find anæmia of the larynx in most diseases which impair the general health and impoverish the blood, but it is not a condition which is indicative of anything more than impaired general health.

The first manifestation of the disease which points specifically to laryngeal phthisis is what has been called pyriform thickening of the mucous membrane covering the arytenoid cartilages, or, as it is sometimes designated, "club-shaped arytenoids." This swelling is due to the primary infiltration already noticed, which causes a swelling of the membrane to two or three times its normal thickness. This swelling, in the very large majority of cases, occurs over the arytenoids, although very exceptionally it may begin elsewhere. The appearance of the arytenoids is peculiar and characteristic. The contour of the cartilages is completely lost in the rounded, boggy swelling, which often bulges so far anteriorly as to prevent the closure of the cords, and, again, extends upward in such a manner as to entirely fill and bridge over the normal notch between the cartilages. The color of the membrane is also peculiar—it is not the bright red of acute inflammation, nor, again, the purplish hue of chronic inflammation, but is a half-dull, glassy, opaque red; the swollen membrane is smooth and rounded, and presents an appearance, which once seen, will be remembered as belonging essentially to this disease.

The second stage consists in the infiltration of the epithelial coat of the mucous membrane. The tubercles, being first deposited beneath the epithelial layer, are not visible, but now, as the second stage sets in, we see appearing on the surface a number of small yellowish-white spots, slightly clouded, as if seen through a diaphanous covering, and the size of a millet-seed or smaller. These little masses appear wherever the first swelling may have been most prominent, and spread slowly over its surface. Each, however, preserves its own individuality. These little masses may remain quiescent for some time, or they may break down rapidly, forming small ulcers which, spreading laterally and enlarging their borders, extend until they meet others, and uniting with them, form broad, shallow ulcers; and thus begins the next stage.

The third stage is the stage of fully developed ulceration. In this stage there is noticed what is a prominent feature of the whole morbid process, viz., rapid cell growth. While the destructive action is progressing on the surface of the ulcer, there occurs a rapid growth from beneath, as a result of which, even while rapid waste is going on, the contour of the part is increased. Thus a tubercular ulcer in the larynx is not unlike, in some respects, a pot boiling over. There is also another peculiar manifestation of the rapid cell growth, and that is in the formation on the surface, or on the border of the ulcerated part, of small, pointed, warty growths, which may be so extensive as partially to overhang the ulcerated surface. They are soft, pliable, and easily removed; but, as a rule, should be let alone.

Diagnosis.—A phthisical ulcer presents an appearance which is characteristic and typical. It resembles no other form of ulcer, and with careful observation, as a rule, the diagnosis should not be difficult. It is a broad, shallow ulcer, whose surface is rarely depressed below the surface of the surrounding tissues. It is of a gray color, and covered with mucus, not pus. Fränkel likens the surface of a phthisical ulcer to cut bacon. Laboulbène compares it to the track of an earthworm in wet sand. Perhaps a better illustration would be to liken it to a dish of wet meal which birds have pecked at, or it has something of a worm-eaten aspect perhaps. The edge of the ulcer merges into the surrounding tissues, presenting no sharp line of demarcation. There is no areola surrounding it, the general coloration of the ulcer and that of the membrane being not unlike. The progress of the ulcer is essentially slow, its destructive action being very limited; hence the surface is not covered with pus and detritus, but rather by a grayish, ropy, tenacious mucus, which is not so much the discharge from the ulcer as the morbid discharge from the bronchi lodging upon and adhering to it.

The principal diseases with which laryngeal phthisis is liable to be confounded are syphilis and scrofula. Grouping the prominent characteristics of each of the three forms of ulceration, we find that they present marked differences as follows:

Syphilis.	Phthisis.	Scrofula.
Deeply excavated.	No apparent excavation.	No excavation.
Deep red, angry-looking areola.	No areola.	No areola.
Sharp-cut edges.	Edges somewhat irregular, not sharp-cut.	Everted and raised edges.
Well-marked line of demarcation.	Line of demarcation not distinct.	Line of demarcation well shown.
Yellow purulent discharge.	Grayish, ropy, semi-opaque mucous discharge.	Muco-purulent discharge.
Rapidly destructive.	Slowly destructive.	Slowly destructive.
Erodes deeply.	Extends laterally and superficially.	Very slowly and in all directions.
No general dyscrasia.	Marked general dyscrasia.	Strumous dyscrasia well marked.
No fever.	Fever.	No fever.

An epiglottic form of the disease is sometimes spoken of as a distinct form or stage of development. This can hardly be regarded as constituting a separate stage; but when the epiglottis becomes involved in the morbid process the symptoms are all, in a marked way, aggravated. The morbid process which attacks the epiglottis is the same as that attacking other portions of the larynx, but from its exposed situation, its mobility, and from the fact that every bolus of food swallowed passes over it, it is easy to understand that when it is attacked all the subjective symptoms must be aggravated in a notable degree, and, furthermore, how it is that the morbid process may run a more rapid course or be less amenable to treatment.

Symptoms.—As the disease develops, the following subjective symptoms become more or less prominent, viz., pain, cough, difficult and painful deglutition, hoarseness, or aphonia. In the first stage the symptoms are not prominent—there may be more or less irritation about the throat, with a sense of prickling and some little discomfort in swallowing, due to pressure on the nervous filaments distributed to the diseased part. As the disease progresses, however, we have the severe and oftentimes exquisite pain due to the pressure to which the parts are subjected in the act of deglutition. If the epiglottis is involved the pain in swallowing may be so acute as to absolutely deter the sufferer from the attempt. If there has been much destruction, the food is often regurgitated. Cough is always present as a symptom of the pulmonary disease, but is markedly aggravated in the later stages of the laryngeal complication. Hoarseness or loss of voice is present according to the location of the disease. If the cords are ulcerated, or if their approximation is interfered with, there will necessarily be notable hoarseness or aphonia, and yet the disease may run its whole course with no very marked impairment of the voice.

Complications.—Necrosis of one or more of the laryngeal cartilages is a not infrequent occurrence in this disease. This is not to be considered as part of the tubercular process, but rather as an adventitious feature of the disease. As the ulcerative process destroys the mucous membrane and perichondrium, necrosis of cartilage necessarily follows, and this, breaking loose from its attachments, is coughed up and voided. Œdema of the glottis is another occasional complication. The explanation of this

occurrence may be found in the fact that, as Heinze[16] shows, the tubercular deposit attacks and destroys the coats of the veins, while the outer and inner coats, only, of the arteries are destroyed. We thus have the conditions favorable to the development of œdema. When it does occur, it is the arytenoid and ventricular bends which are generally involved, and of these the point of selection is where the morbid process has progressed farthest. The epiglottis is very rarely the seat of œdema. When it occurs, it becomes a most distressing and intractable symptom, rarely yielding to treatment, but demanding tracheotomy. Paralysis of the abductors is often reported as occurring in phthisis of the larynx; it is very doubtful if genuine paralysis ever occurs in this disease. The tubercular process is very slow to attack the laryngeal muscles, as shown by Holmes,[21] and what has been called paralysis is really a destruction of the crico-arytenoid joint by invasion of the disease, whereby its mobility is destroyed. This may involve one or both joints, and may leave them motionless in any position. If they are anchylosed in a state of abduction, of course, the symptoms are not grave, but if the fixation occurs with the cords approximated the complication is a most serious one. If one cartilage alone is involved, the breathing space is notably, if not seriously, encroached upon. If both cartilages are fixed in adduction, we have the same condition which constitutes the gravity of genuine bilateral paralysis of the abductors. Why the fixation should occur in such a position as to produce dyspnœa is not easy of explanation. Anchylosis is by no means uncommon in laryngeal phthisis, but bilateral anchylosis leaving the cords in a state of adduction is happily very rare. The symptoms of this accident come in rather suddenly, and demand rapid relief by tracheotomy.

TREATMENT.—In former days caustics figured prominently as a local application to laryngeal ulcer, as to all forms of ulcerative disease. The first effect was exquisite pain, followed by a few hours of relief, but the ultimate result was harm, rather than good. Most writers are united now in regarding as the best treatment for this distressing disease that which is the mildest and least irritating. A better rule, perhaps, to lay down would be, never to make any application to a phthisical larynx which causes pain. A systematic method of treatment on this plan would involve four steps, as follows:

1. The thorough cleansing of the parts, preparatory for the more special application.
2. The application of a mild, unirritating astringent, to control secretion and reduce congestion of the mucous membrane.
3. The application of an anodyne, both to relieve pain, and as a valuable remedial agent in this disease.
4. The application of iodoform, as possessing specific properties in controlling ulcerative action.

The first indication may be best carried out by using a solution of borax, or even common salt, but perhaps the best cleansing solution we have is that which is known as Dobell's solution. The formula is as follows:

℞.	Acidi carbolic	gr. iv.
	Sodæ bicarb	gr. xv.
	Sodæ biborat	gr. xx.
	Glycerinæ	ʒ vj.
	Aquæ	ad ℥ vj.
M.		

This is best applied with the compressed-air apparatus and Sass's spray-tubes, a slight jet being thrown in and repeated at short intervals. The application should be regulated according to the condition of the patient, and should cause no irritation. In the absence of the compressed-air apparatus, the small hand-ball atomizer known as the Magic may be employed. Following this, an astringent should be used. One of the following, in the order of preference, will be found useful: Tannin, gr. x. to ℥ j.; zinci sulphat., gr. iv. to ℥ j.; argenti nitrat., gr. j. to ℥ j. The selection should be governed by the effect. The next step is the application of morphia. This should be used in solution rather than in powder. Morphia seems to not only relieve pain in the larynx, but to exercise a certain controlling action on the progress of laryngeal phthisis. In using it, however, it is always to be borne in mind that a systemic effect is produced by an application to the fauces as quickly as when the drug is introduced into the stomach, and care must therefore be exercised in its use. Keeping this in mind, about ten minims of an eight-grain solution may be thrown upon the diseased surface. If there is any difficulty in making the morphine application, it may be combined with the iodoform, which is to be applied next.

In applying iodoform, care must be exercised to evenly distribute a very thin layer over the ulcerated surface. This is best done with Robinson's powder-blower, using the finely powdered iodoform always.

If the morphia has not been applied in solution, it may be used as follows:

℞.	Morphiæ	gr. x.
	Tannin	ʒ j.
	Pulv. amyl	ʒ jss.
	Iodoform	ʒ ijss.
M.		

The above system of treatment is for the stage of ulceration; for the earlier stage the same plan may be carried out, with the exception of the iodoform. The applications must be made every day, and if patience and care be exercised it will be found that what has been heretofore regarded as an incurable disease may be very markedly relieved in all cases; and that many patients may be entirely cured of this most distressing complication of pulmonary disease.

In addition to the above plan there is one remedy which a patient with laryngeal phthisis must never be without, and that is cocaine. The painful symptoms attendant upon the disease, especially the painful deglutition, are so harassing that they react in no small way upon the patient's general condition. The cocaine, locally applied, will procure freedom from pain for about fifteen minutes—long enough to enable the patient to eat and drink with ease, an aid to recovery the value of which is not to be underestimated. Every patient should keep a small Delano atomizer, with a four per cent. solution of cocaine, and make the application as needed.

The constitutional treatment of the disease is the same as that of pulmonary consumption, and need not be entered upon here. There are no constitutional remedies which possess any specific properties in throat consumption.

Francke H. Bosworth.

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[2] Dissertatio de Phthisi Laryngea. Montpellier, 1790.
[3] Recherches sur la Phthisie Laryngée. Paris, 1802.
[4] Recherches sur la Phthisie. Paris, 1825.
[5] Traité de la Phthisie Laryngée. Paris, 1827.
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[17] Pathologische Anatomie des Larynx und der Trachea. Berlin, 1880.
[18] Diseases of the Throat, vol. i., art. Laryngeal Phthisis. London, 1880.
[19] Prager Vierteljahrsschrift, 1856, Bd. xiii.
[20] London Lancet, February 27, 1875.
[21] Ibid., August 25, 1883, p. 323.
[22] New York Medical Record, May 17, 1879, p. 424.

LARYNX, SARCOMA OF THE. Primary sarcoma of the larynx is a rare disease, and occurs oftener as the intrinsic than as the extrinsic variety. Butlin, in his exhaustive and systematic treatise, to which the reader is referred for fuller details, has collected only twenty-three cases of primary sarcoma of the larynx.

The distinction established by Krishaber of intrinsic and extrinsic tumors, as applied to the larynx, also has significance in sarcomatous disease of this organ. Spindle-celled, round-celled, giant-celled, and mixed-celled, as well as the compound tumors, fibro- myxo- and lympho-sarcoma, are recorded as occurring primarily in the

larynx. The spindle- and round-celled growths are encountered most commonly; the latter oftener than the former, according to the writer's investigation.

Sarcoma ordinarily attacks robust persons between the ages of twenty-five and fifty years, as is shown by the accompanying table prepared by Butlin:

	Patients.		Patients.
7 years	1	51 to 60 years	4
24 to 30 years	3	61 to 70 years	1
31 to 40 years	6	74 years	1
41 to 50 years	5	Uncertain	2

About eighty per cent. of those attacked are males. Profession and occupation exercise no marked influence in causing the disease, although exposure to cold, the abuse of alcohol and tobacco, as well as violent use of the vocal organ, may act as inviting causes.

Some contend that hereditary influence, traumatism, and the degeneration of papillomata are causes of sarcoma, but the writer ventures to express his candid disbelief in the existence of sound clinical proof to sustain such opinions. In short, the origin of primary sarcoma within the larynx is quite as obscure as is its source in general. The vocal and ventricular bands of the left side are the favorite points of origin of these growths in intrinsic sarcoma; the epiglottis in extrinsic sarcoma. These tumors rarely attain dimensions larger than an English walnut, usually are single and of smooth appearance, though at times nodulated or dendritic.

Symptoms.—These are similar in most particulars to those of carcinoma of the larynx, although, as a rule, milder in degree and more gradual in development. Phonation, respiration, and deglutition are interfered with in a degree varying with the location of the primary lesion, its size, mode of attachment, and stage of progress.

Hoarseness may exist for years prior to the development of the disease, but is a constant and important symptom. The voice is at first uneven, irregular, and finally shrill, but is rarely entirely and permanently extinguished. The degree of dysphonia may bear no relation to the dimensions of the intra-laryngeal tumor, great vocal changes resulting from the smallest swellings, even in the earliest stage of the disease. The infiltration of sarcoma soon interferes with the mobility of the intra-laryngeal muscles, and dysphonia results. It may be here stated that in benign neoplasms of equal size the movements of the vocal bands are not thus impaired.

Embarrassed respiration, dependent upon tumefaction of laryngeal tissues and consequent stenosis, always occurs. At first respiration is slightly impeded, the patient noticing the impediment upon making slight muscular exertion, but ultimately the laryngeal dyspnœa threatens life and requires the opening of the trachea. The patient finds it often impossible to assume the recumbent posture, and loses sleep and strength. In rare instances the subjective symptoms are so slight that a sarcomatous growth may attain dimensions sufficient to cause death from suffocation before the patient applies for medical advice. A striking instance of this kind is reported by Dr. Louis Jurist, the patient, a gardener, sixty-five years of age, dying forty-eight hours after his first examination, and twenty-four hours after refusing to have a tracheotomy performed.

Deglutition is interfered with in extrinsic sarcomata, particularly if the epiglottis is first invaded. It becomes necessary at times to sustain the patient by means of food introduced through an œsophageal tube, as swallowing is intolerable. Dysphagia may be absent or slight in intrinsic sarcomata.

Pain is by no means a constant accompaniment of sarcoma, although at times it is very severe. Pressure over the laryngeal region may elicit a tenderness. The pain radiates from the larynx to the ear, the fibres of the superior laryngeal nerve conducting the irritation through the auricular branch of the pneumogastric.

The *cough* is primarily of a dry, barking, irritative nature, but later it becomes loose. The expectoration becomes fetid, occasionally containing fragments of detached growth and blood-clots.

Hæmorrhage occasionally happens during the ulcerative period, and may be copious.

The flow of *saliva* is nearly always increased.

Diagnosis.—Sarcoma may be mistaken for benign or other malignant growths, for syphilis and tuberculosis; hence the differential diagnosis is often difficult.

Sarcoma is generally single, consisting of irregular masses of a smooth or nodulated aspect, having a broad, hard base. Its surface is occasionally dendritic, and the adjacent mucous membrane may be either anæmic or of a deeper red than normal. There is nothing in the laryngoscopic appearances of sarcoma which would warrant its differentiation from carcinoma, and the diagnosis must be established from other symptoms.

The *lymphatic glands* are not involved in sarcoma, and Butlin regards this as an important clinical fact.

When possible, a small fragment of the suspected sarcoma should be extracted by cutting-forceps and subjected to thorough histological examination, which enables us to differentiate sarcoma from other malignant growths, as well as from papillomata.

Great caution should be exercised in its differentiation from *syphilis*—the previous history or the coincidence of other syphilitic manifestations will assist in the diagnosis. There is no characteristic difference in the appearance of the sarcomatous ulcer as distinguished from that of syphilis; the former is, however, generally solitary and confined to one side of the larynx. A mixed antisyphilitic treatment may serve to clear up the diagnosis.

The diagnosis of sarcoma from *tuberculosis* is not so difficult, the age of the patient, the presence of the physical signs of pulmonary tuberculosis, and the anæmia of the laryngeal mucous membrane all assist in defining the nature of the malady under treatment.

Prognosis.—Always fatal, by apnœa or asthenia, in cases in which there is no radical or surgical treatment.

Much may, however, be done in the direction of prolonging life and palliating symptoms, both by medical treatment and tracheotomy. That an early laryngectomy has been followed by good results in primary laryngeal sarcoma is undoubted, but the future will decide the exact merits of the operation. In those cases in which the disease is extensive and of long duration, little can be expected in the direction of a radical cure by any operation; but when the disease is intrinsic, unilateral, and there is but slight infiltration, recurrence is not apt to take place after complete extirpation of the sarcoma. The prospects of cure are, *cæteris paribus,* assuredly far brighter in laryngectomy for sarcoma than in laryngectomy for carcinoma.

Bottini operated upon a male patient, twenty-four years of age, for sarcoma, on February 6, 1875, completely extirpating the larynx. This patient held the position of mail-carrier between Miazzina and Trabaro, in Italy, in 1878, and was living eight years after the operation. One of Foulis' cases lived seventeen and a half months after laryngectomy, Caselli's case two years, F. Lange's seven months, and Arpad Gerster's one year. The duration of life after unilateral laryngectomy for primary sarcoma of the larynx is as follows: Gerster's case lived one year, and died of pleurisy; there was no recurrence. Küster's case is reported as cured, but definite information is inaccessible to the writer. Excellent statistical tables of partial and complete laryngectomies have been prepared by M. Mackenzie, Foulis, Blum, Burow, Hahn, Baratoux, and Cohen. The number of recorded laryngectomies (partial and complete) at this writing is about one hundred and twenty-five.

Course and Termination.—Sarcoma, as a primary disease affecting the larynx, is generally slow in its course, and the malady is usually of from one to two years' standing when the patients seek medical aid. The termination, if there has been no surgical interference, is generally from suffocative apnœa, resulting from laryngeal stenosis; but, in the tracheotomized subject, death most frequently results from exhaustion or pyæmia. Extensive perichondritis, secondary abscesses, and destruction of the cartilaginous structure of the larynx are liable to take place during the ulcerative period of the disease.

The destruction and disintegration of the soft tissues and cartilaginous framework of the organ may be so extensive as to result in the formation of fistulous communications between the air- and food-passages, as well as in the expectoration of necrosed cartilages.

TREATMENT.—The treatment of primary sarcoma of the larynx is extremely unsatisfactory. It may be divided into *palliative* and *radical measures.*

The *palliative treatment* includes, in addition to proper systemic medication, the topical treatment of the larynx through the natural passages and the early performance of tracheotomy.

The *systemic management* of malignant disease is fully considered in another portion of this HANDBOOK, and the necessary topical measures have been already discussed in the article on Larynx, Carcinoma of.

Tracheotomy should be done early in the course of sarcoma—on the first symptoms of dyspnœa occurring, and before the strength of the patient is reduced from insufficient oxygenation. Always, as in carcinoma, the tracheotomy should be made as far from the seat of disease as possible, and life may be thereby prolonged from one to four years.

Radical treatment comprises intralaryngeal extirpation, thyrotomy, subhyoidean pharyngotomy, and partial or total extirpation of the larynx.

Mackenzie, Navratil, and Tuerck report cases of primary sarcoma of the larynx radically cured by intralaryngeal operation; but in the writer's opinion there is great doubt about the propriety of relying upon such a procedure in growths possessing the infiltrating tendencies of sarcomata. Again, the tumor is not always either well defined or circumscribed. Butlin questions the accuracy of the above cures. He further says, in most instances it is necessary to do more than remove the seat of attachment of the sarcoma, and that a tolerably wide area of the surrounding parts, even when these present a perfectly healthy aspect, must be removed.

Thyrotomy has not been attended with favorable results, and the weight of opinion, including Bruns', is decidedly opposed to its performance. It might be successful where the disease was limited to one vocal band, if a thyrotomy were performed, the band removed, and the surrounding tissues carefully cauterized (see article Tracheotomy).

Subhyoidean pharyngotomy is only to be resorted to when the epiglottis is the seat of the sarcoma, and it therefore has a limited scope of usefulness (see article Tracheotomy).

Total Extirpation.—Upward of twelve total extirpations have been performed for sarcoma of the larynx, and among them is Bottini's famous case, already referred to in this article.

In the writer's judgment, the future usefulness of this operation will be chiefly limited to the treatment of disease of a sarcomatous nature, and then at an early stage of its existence. A small commencing sarcoma, circumscribed, slightly infiltrated, and occurring in an otherwise vigorous patient, would certainly offer every chance of a radical cure if subjected to complete extirpation. Increased experience and reliable statistics are urgently needed to settle the propriety, not to say the justifiability, of complete laryngectomy, and the near future bids fair to furnish the same.

Cohen says: "Taking for granted, as we are bound to do, that death was imminent in the above cases [those of Bottini, Caselli, and others] when the extirpation was resorted to, we have a considerable prolongation of life in every instance, and a remarkable prolongation in two."

As far as our limited statistics go, therefore, the operation of extirpation of the larynx, in hopeless cases of sarcoma, is worthy of the serious consideration of the surgeon.

Consult articles Larynx, Carcinoma of, and Laryngectomy for further information regarding this operation.

Partial Extirpation.—A very small number of partial laryngectomies are recorded in medical literature, too few to furnish a basis upon which to found any conclusions of practical value. Hahn has claimed that partial excision for carcinoma was followed by as few recurrences as was total excision. But while this may be true of carcinoma, the characteristic tendency of sarcoma to infiltrate renders the operation of doubtful utility (consult article on Laryngectomy).

NOTE.—For the literature of primary sarcoma of the larynx, and illustrations of the same, consult article "Larynx, Carcinoma of."

Ethelbert Carroll Morgan.

LARYNX, STENOSIS OF THE (Stricture of the Larynx, Contraction of the Larynx). Stenosis of the larynx may be defined as that condition of the organ in which its calibre is diminished to such an extent as to interfere with respiration and endanger life. It may result from causes within the larynx or external to it.

Before the introduction of the laryngoscope little was known of this condition. Here and there in medical literature some cases of contraction of the larynx are reported, occasionally treated intelligently, as in Liston's case in 1828, where the obstructed larynx was dilated after a tracheotomy. Bouchut also, in 1858, and Horace Green, about the same time, taught that with the larynx constricted by œdema or croup, life could be preserved by the introduction of a tube; but such remedial measures were looked upon with disfavor by the authorities of the day, and it was reserved for later observers to define the causes which produce this condition, to demonstrate its location and appearance, and to devise means for its relief.

Among the first to operate for stenosis by the aid of the laryngoscope were Marduel in 1863, and Delore in 1864. Since then Stoerck, Schroetter, Mackenzie, Tuerck, Weinlechner, Elsberg, Koch, Hering, and many others have contributed to the literature of the subject, and have added to the knowledge of its method of treatment.

Stenosis of the larynx may be classed, according to its anatomical seat, as supra-glottic, glottic, or infra-glottic, as proposed by Tuerck, or it may be studied according to the cause producing it.

The causes producing stenosis are:

1. Cicatrices following the healing of ulcers, or the formation of bands abnormally uniting different parts of the larynx. This condition we find as the result of constitutional disease, as syphilis, phthisis, and glanders, after wounds of the larynx, and following burns and scalds.
2. Inflammation, acute or chronic, the result of which is to produce obstruction of the larynx. Croup, diphtheria, œdema, perichondritis, and chronic stenosing inflammation are included under this head.
3. Neoplasms, where the obstruction is caused by the presence of growths, benign or malignant.
4. Neuroses, causing spasms or paralysis.
5. Compression of the larynx from external causes.

It is evident that, in order to intelligently treat this condition, its cause must be ascertained. Of course, in all cases where asphyxia is impending operative interference is demanded; but the method of operating, and the measures to be adopted after the emergency has passed, must depend entirely upon a knowledge of the cause producing the obstruction.

The laryngoscopic appearance of a stenosed larynx naturally varies with the character of the obstructing element. In œdema, from whatever cause, we have a smooth, shining swelling, differing in color according as it is produced by acute inflammation, tuberculosis, or Bright's disease. In syphilis we have a ragged, deformed, irregular larynx, sometimes filled with vegetations, and sometimes obstructed by membranous bands and adhesions; in cancer we find ulcerated masses, sanious and vegetating; in perichondritis the deformed condition of the larynx and the presence of abscess point to the nature of the disease, while the appearances of polypi and of spasm or paralysis are at once apparent on examination.

The symptoms of stenosis are those of obstructed respiration. At first there is but slight interference with breathing; there is a hissing sound in inspiration which gradually becomes stridulous, and in some cases is characteristic. Fauvel claims to recognize cancer of the larynx by the peculiar reedy sound of the respiration. Later on appear symptoms of extreme dyspnœa, which

are most marked during sleep. This characteristic is common to all laryngeal stenoses, and is explained by the fact that the patient, during his waking hours, calls into action the dilating muscles of the glottis, which during sleep are withdrawn from the control of the will (Krishaber and Lepine). As the dyspnœa increases, the face becomes cyanosed, the signs of asphyxia appear, and tracheotomy is inevitable. The voice is not necessarily affected, though usually it is modified as the disease advances, gradually becoming weaker until it is finally extinguished. In cases where pediculated growths occur in the larynx, the voice, at first interfered with, becomes clear as the tumor makes its way past the vocal cords.

The diagnosis of laryngo-stenosis is not difficult. The dyspnœa and stridulous respiration indicate it at once, but the nature and seat of the obstruction can only be made known by the laryngoscope. The adhesions, contraction, or tumors which cause the stenosis are immediately seen, and the character of the disease revealed. The progress of the stenosis aids in the diagnosis. Temporary obstructions come on rapidly, while permanent ones may require months or years to bring about aphonia or serious embarrassment of respiration. The dyspnœa occurring in the course of scarlet fever would indicate the formation of false membrane; in the course of phthisis one would suspect œdema or ulcerations; while in syphilis one would naturally be led to conclude, even before examination, that the difficulty in respiration was the result of cicatricial contraction or of the presence of a gummy tumor.

The prognosis of laryngo-stenosis is favorable as regards life, provided an artificial opening can be made below the seat of obstruction. Since the introduction of improved methods of treatment the chances of ultimate cure by systematic dilatation have increased, though the tendency to reproduction of the stenosis is very great. As yet the number and proportion of cases cured by mechanical means have not been large, but there is every reason to hope that, as the result of a wider experience in the use of means already known, the number of successful cases will be increased.

In order to thoroughly understand the nature of the lesions producing laryngeal stenosis, it will be necessary to rapidly pass in review their various causes.

Cicatrices.—First in order of importance are the deformities resulting from the reparation of injuries caused by constitutional diseases, viz., syphilis, phthisis, and glanders, and the cicatricial contractions following wounds of the larynx, burns, and scalds.

Syphilis.—Stenosis of the larynx in syphilis is usually a manifestation of the tertiary stage. Cases have been observed where ulcerations of the secondary stage have been the seat of irregular granulations, which have increased to such a size as to obstruct respiration; but these are very rare, the changes in the larynx being brought about usually by the gummatous tumor, the superficial, and the deep ulcer of the tertiary stage. The superficial specific ulcer occurs in the pharynx as well as in the larynx. It easily penetrates the epithelium of the mucous membrane, and cicatrizes as a flat, fibrous, corrugated or stellate disk, incapable of producing contraction, though when located at the opening of the glottis it may cause adhesion of the adjacent surfaces, and, if ulceration of the pharynx be present at the same time, adhesion of the pharyngeal to the laryngeal surface may occur. The deep ulcerating syphilide, the gummy syphilide of Fournier, is the lesion which is characteristic of the later stages of laryngeal syphilis. It occurs many years after infection, and produces the gravest lesions. It destroys the mucous, submucous, and muscular tissues, and, penetrating more deeply, gives rise to perichondritis, destroying the cartilages. It usually attacks the epiglottis first, thickening it and then destroying it by progressive ulceration, and then attacks the larynx, though the reverse sometimes occurs. It is to the cicatrization of this form of ulcer that the contraction and deformity of the larynx resulting in stenosis are due. Where other cartilages than the epiglottis are attacked they are destroyed in their coverings, and are discharged into the cavity of the larynx, rarely making their way to the external surface. The result of the perichondritis is to cause submucous fibrinous infiltration, which sometimes becomes organized and is transformed into a dense fibrous tissue, giving rise to a chronic œdema, and causing deformity and contraction. Frequently hypertrophies occur, which are usually seen on the inter-arytenoid fold, the inner posterior surface of the larynx, or on the vocal cords.

Gummy tumors occur less frequently than ulceration. They are of varying size, smooth and round, of a yellowish tint, and covered with pus or mucus. They are generally found on the epiglottis and ventricular bands, though they may occur in any part of the larynx. It is to the breaking down of these tumors that some authors ascribe the deep ulceration of the larynx, resting this opinion upon the resemblance between the deep ulcerations of the larynx and the ulcerating gummy tumors of the pharynx.

The cicatrization of the loss of tissue caused by the deep ulcerative syphilide causes the most serious results in the way of adhesions and contractions, which may involve every portion of the larynx and trachea. A case is reported by Heinze,[1] where bands of adhesion ran from the pharyngeal wall to the epiglottis and back of the tongue, forming a funnel-shaped cavity with an opening of about a centimetre in width, easily closed by the tip of the little finger. Not infrequently the glottic orifice is obstructed by a membranous band stretched between the vocal cords, as reported by Elsberg, Navratil, and others; while numerous cases have been observed of adhesion of the ventricular bands to each other, of the ventricular band to the vocal cord below, of the vocal cords to each other, and of the inner surfaces of the arytenoid cartilages, rendering the vocal cords immovable.

The cicatrization of the deep ulcers, and of the loss of tissue caused by the necrosing cartilages, often produces most serious deformities, the parts being distorted and welded together in such a way as to be totally unrecognizable. Where there has been much destruction of the soft parts the resulting contraction is often very great. The neoplasms formed in the course of destructive syphilis frequently obstruct the larynx. A case is reported by Tauber,[2] where a neoplasm causing stenosis occurred in a patient whose primary infection took place forty-five years previously. The thickening and hypertrophy of the lips of the glottis, which is one of the results of the syphilitic morbid process, often plays an important part in the production of stenosis.

Congenital syphilis may give rise to stenosis of the larynx. In a case reported by Fränkel,[3] a child, two months old, manifested symptoms of syphilis, and three weeks later died of laryngeal stenosis. A post-mortem examination showed necrosis of the cricoid and arytenoid cartilages, and an abscess breaking through into the cavity of the larynx. J. N. Mackenzie[4] describes a form of congenital syphilis in which interstitial laryngeal inflammation causes a gradual deposit of fibrous material within the larynx and results in stenosis.

The diagnosis of syphilitic ulcers is not always easy. Von Ziemssen declares that there is nothing pathognomonic in their appearance, while Mackenzie[5] says that they can be easily distinguished from cancer and phthisis, the only affections in which error may occur. The ulcers in syphilis are apt to be single, rapid in development, irregular in shape, and with an inflammatory border. The ulcers of phthisis are numerous, slow in progress, round, and with a paler surrounding tissue, and when there is infiltration of the ary-epiglottic fold its peculiar pyriform shape is pathognomonic. When the epiglottis is ulcerated, as it may be in either disease, it is the upper surface which is most frequently affected in syphilis, while in phthisis it is the lower one. The swelling in the vicinity of the ulceration is firmer than the similar condition in tuberculosis, and there is not so abundant a secretion of pus and mucus. In cancer the rate of development of the ulcer is slower than in syphilis, and more rapid than in phthisis. It is preceded by the formation of a growth, and the surrounding membrane is acutely inflamed. Besides this we have the antecedent manifestations of syph-

ilis; where these are wanting, and the nature of the case is doubtful, the results of antisyphilitic treatment will set the matter at rest.

Phthisis.—Tubercular disease of the larynx may cause stenosis in several ways. There may be œdema caused by submucous infiltration, or resulting from caries of the cartilages. There may be paralysis of the vocal cords due to the pressure of interstitial deposit, the stenosis varying with the degree of swelling and the amount of fixation of the cords, or the paralysis may result from compression of the recurrent laryngeal nerve. Granulations may spring up from the bases of tubercular ulcerations, which increase in size until they produce dyspnœa, and which, when they occur on the vocal cords, may, through adhesive inflammation, cause the formation of a web, such as is found in syphilis. Stenosis may also occur from the deformity resulting from destruction of the cartilages, and from tumors in the larynx composed of aggregations of miliary tubercle in various stages.

There is nothing characteristic at first in the symptoms of this disease, which are the usual ones of chronic laryngitis; dysphonia and dysphagia being present later on in a great proportion of the cases. Shortness of breath is very common, but laryngeal dyspnœa is rare. Examination with the laryngoscope shows a markedly anæmic condition of the larynx. In very many cases there is infiltration of the ary-epiglottic folds, which appear as two large pyriform tumors, largest at the posterior middle line and becoming smaller as they approach the epiglottis, and which is almost pathognomonic of the disease. The inter-arytenoid fold is obscured by this infiltration, which also interferes with the action of the arytenoid cartilages and so prevents approximation of the vocal cords. Irregular granulations appear in the inter-arytenoid space, on the inner surface of the arytenoid cartilages, and in the various parts of the larynx, sometimes being sufficiently large to impede respiration. The inter-arytenoid fold and the whole interior of the larynx is bathed in pus. The vocal cords are congested and thickened, and frequently studded with spots of ecchymosis. The epiglottis is thickened and frequently destroyed by ulceration, and the ventricular bands are swollen and ulcerated. As the disease progresses, the mucous membrane of the vocal cords and of the larynx is destroyed by ulceration, and perichondritis and destruction of the cartilages ensue; the parts become so swollen as to be unrecognizable, adhesion takes place between various parts, and the whole appearance of the deformed and irregular larynx is that of disintegration and destruction.

In the progress of laryngeal phthisis there are two stages, the stage of deposit and the stage of ulceration. The first stage is nearly always accompanied by œdema, the epithelium being rarely altered, even when there is considerable infiltration. The deposit is composed of tubercle; it is found both in the mucous and submucous tissue, and its source is from within, though some observers have ascribed it to irritation from unhealthy sputa.

In the ulcerative stage we find three forms of ulcer. Sometimes the whole extent of the larynx is covered with little erosions, due to epithelial desquamation of the mucous membrane, and usually found near the glandular openings so numerous in the larynx. At other times the ulceration is sharper and deeper; there is suppurative periadenitis with necrosis and elimination of the gland, accompanied by loss of substance more or less extensive. The mucous membrane is then detached and thickened, the edges of the ulcer are indurated and irregular, and the bottom filled with detritus and bloody pus. Later on the subjacent parts are invaded by suppuration, the muscles destroyed, and the cartilages necrosed and rendered carious.

In the third variety gray granulations appear under the epithelium of the mucous membrane; they atrophy and disintegrate, producing a crater-like ulcer; the ulcers of the neighboring granulations coalesce and form a superficial ulcer with scalloped edges; later on infiltration occurs, then inflammatory irritation and suppuration, and the appearance is the same as in the ulcer with bloody base described above.

The whole tendency of tubercular ulceration is to destruction; there is no tendency to repair, though autopsies have discovered a few cases of cicatrized phthisical laryngeal ulcers. When the cartilages are attacked, abscesses often form which seriously interfere with respiration. When caries of the cricoid cartilage occurs we are very likely to have attacks of suffocation, which may require instant tracheotomy.

The disease most likely to be confounded with laryngeal phthisis is syphilis, from which it may be differentiated by the symptoms detailed above.

Laryngeal phthisis has sometimes been observed before any disease of the lung is discovered, but all cases exhibit pulmonary lesions before death.

The progress of laryngeal phthisis is invariably fatal, the duration of the disease being from a few months to six or eight years; the majority of patients, however, rarely live beyond a few years.

Glanders.—When glanders attacks the human subject, serious interference with respiration often occurs, the result of infiltration of the mucous membrane of the larynx, which takes place simultaneously with the development of tubercles and ulcers over the whole respiratory tract. When the infiltration is extensive, secondary œdema of the mucous membrane gives rise to severe dyspnœa. If recovery takes place the contraction of the cicatrices of the ulcers causes a permanent stenosis.

Wounds.—Stenosis of the larynx occurs as the result of incised or gunshot wounds. Wounds made by a cutting instrument frequently result in the formation of a membranous web, and sometimes abnormal union of the parts takes place. Fragments of cartilage may adhere together, deforming the larynx, and cases are reported where in one instance the skin of the neck became adherent to the posterior wall of the larynx, and in another to the anterior wall of the pharynx.[6] After gunshot wounds respiration may be interfered with as the result of consequent œdema or paralysis.

Fracture of the larynx may be the cause of stenosis through effusion of blood into the submucous tissue, and the deformity resulting from the displaced cartilages may give rise to permanent narrowing. Henocque[7] reports a case where its fracture, produced by a carriage wheel, caused an incurable stenosis.

The injuries caused by scalds of the larynx, by burns, and the swallowing of caustic fluids, also result in contraction and stenosis.

2. Inflammations.—In inflammation of the larynx, both acute and chronic, narrowing of its calibre occurs either from œdema, from the exudation of false membrane, as in croup and diphtheria, from the deposit of organized material, as in chronic stenosing inflammation (chorditis vocalis inferior hypertrophica), or from the results of perichondritis.

Œdema is found as a symptom of acute disease either above or below the vocal cords; it may be produced in the course of chronic laryngitis resulting from constitutional causes, by perichondritis of whatever origin, and by abscesses, injuries, and wounds of the larynx. It sometimes occurs in the progress of Bright's disease, and has been encountered in all the exanthemata generally coming on during convalescence. It is the result of an infiltration into the mucous membrane or into the submucous connective tissue, which may be either serous, sero-sanguineous, or sero-purulent; its first result is to impede respiration and then to permanently obstruct it. If relief is not afforded, either by operative measures or by the subsidence of the swelling, death occurs in a period varying from a few hours to some days. The immediate cause of the effusion is impediment to the free venous circulation in the larynx resulting from mechanical obstruction, or from paralysis of the walls of the vessels. The symptoms are those of obstructed respiration. When the œdema depends on acute disease the paroxysms of dyspnœa are violent, abrupt, and of frequent occurrence, and sometimes the patient is suffocated before aid can be afforded. In chronic disease the progress is more

deliberate, the paroxysms occurring at longer intervals which gradually become more frequent, until death takes place, unless tracheotomy is resorted to.

The appearance of œdema is characteristic. The ary-epiglottic folds are seen as pale-yellowish or red globular swellings, translucent, and in general appearance not unlike an œdematous prepuce (Solis-Cohen); only a small chink is left for the passage of air, which becomes narrower during inspiration; the ventricular band is involved, and the vocal cords are invisible. During inspiration the current of air forces the swellings together, while during expiration they are sometimes separated, affording a view of the vocal cords. Hæmorrhagic œdema is not always the result of traumatism; it has been observed in hæmorrhagic small-pox, and as the result of salivation following mercurial inunction.

For the stenosis accompanying *croup* and *diphtheria* we refer the reader to the articles on these diseases.

Perichondritis.—Primary inflammation of the perichondrium of the larynx is rare; it is generally the result of inflammatory or destructive disease of the mucous membrane, such as we find in syphilis, tubercle, or cancer. In Europe many cases occur as a result of typhoid fever, which is there one of the more common causes of stenosis,[8] while in this country such consequences are rare.

When the inflammation of the cartilage is acute, there is swelling followed by purulent infiltration, which dissects the perichondrium from its cartilage and gives rise to necrosis; while the great inflammatory œdema of the first stage tends to produce laryngeal stenosis.

When the inflammation is less acute and goes on to suppuration, we find the abscess projecting into the cavity of the larynx, the cartilages become necrosed, while the perichondrium is totally destroyed. Finally the abscess is evacuated, generally through the mucous membrane, and the necrosed cartilages are discharged, after which the aperture may be closed by new-formation of connective tissue, the result of which, along with the loss of substance, is to so modify the condition of the larynx as to seriously interfere with its calibre. It rarely happens that this termination occurs; as a rule the necrosed cartilage maintains a suppuration causing a callous thickening of the tissue. The abscess may discharge externally as well as internally, and sometimes the increased volume of the cartilage itself closes the cavity of the larynx. It is not always easy to diagnose laryngeal perichondritis at its outset. Pain, increased by pressure on the larynx, by swallowing, and speaking; cough, hoarseness, and swelling of the lymphatic glands of the neck—all of these coming on in the course of any of the diseases which may cause perichondritis, especially if stenosis occurs, point to inflammation of the cartilages. The swelling of the abscess causes obstruction of the gravest character, and not infrequently tracheotomy must be performed without delay. All of the cartilages of the larynx may be affected, the arytenoids usually in phthisis, their destruction and elimination being often accomplished without any considerable disturbance of respiration. It is otherwise with inflammation affecting the cricoid. Here the symptoms are those of stenosis of the highest grade, caused by the protuberance of the abscess from the posterior wall. The stenosis is sometimes still further aggravated by the median position of the vocal cords caused by spasm,[9] or by paralysis from the destruction of the posterior crico-arytenoid muscles, and by the deformity resulting from the sinking in of the soft parts following the loss of cartilage. In thyroid perichondritis the stenosis is caused by the bulging inward of the abscess, and the œdema of the surrounding parts. As a rule, the prognosis of perichondritis of the larynx is unfavorable. When life is not destroyed by the causative disease, the exhausting results of the destructive process cause death. When traumatism or syphilis, and in some cases when typhoid fever is the exciting cause of the inflammation, the morbid process may be arrested even after tracheotomy has been performed, though contraction of the canal usually goes on, producing a stenosis which treatment may palliate and occasionally cure.

Chronic Stenosing Inflammation.—There is a chronic inflammation of the subglottic region which is not an infrequent cause of stenosis of the larynx. It is comparatively rare in this country, few cases having been reported, but is more common in Europe. The disease was first described—though cases had been previously observed—by Gerhardt, in 1873, under the name of chorditis vocalis inferior hypertrophica, a designation which is not entirely correct, as the disease may invade any portion of the larynx. Since then it has been more fully studied by Schroetter, and cases have been reported by Burow, Marian, Ganghofner, Chiari, Scheff, and others. The disease, if seated in the larynx, shows itself first by hoarseness; if, however, as sometimes happens, it is tracheal, then dyspnœa is the first symptom; there is probably a history of inflammation of the throat at some previous time; then dyspnœa appears and, as soon as the thickening is of sufficient volume, suffocative attacks occur, often attended by complete aphonia. The usual seat of the disease is below the vocal cords, where it is seen by the laryngeal mirror as a gray or red, smooth, shining swelling—though in a case observed by Scheff[10] the ventricular bands were also thickened. The nature of the affection is in doubt—its immediate cause is inflammation of the mucous membrane, while the patients are usually of strumous constitution. Stoerck describes a disease producing similar results, which he calls chronic blennorrhœa of the mucous membrane of the nose, larynx, and trachea, which, commencing in the nares, slowly extends downward into the pharynx and larynx, giving rise to inflammation, infiltration of the mucous membrane, ulceration, and finally cicatrization, the larynx below the cords being the part most seriously affected. When cicatrization takes place it results in a firm, white, glistening membrane, often completely encircling the larynx in its lower portion, and diminishing its calibre by progressive contraction. In exceptionally severe cases cicatricial adhesion of the ventricular bands and of the arytenoids increases the amount of stenosis. A case of this disease was observed by me in which the patient suffered from severe suffocative attacks. She had been under treatment for asthma, and was looked upon as an incurable case. Examination with the laryngoscope, however, showed stenosis of the larynx; two folds of membrane were seen, one on either side of the larynx, nearly encircling it at about the level of the cricoid cartilage, and leaving an aperture of the size of a goose-quill; the breathing was stridulous, and could be heard in the adjoining room; the dyspnœa at times was so great that tracheotomy seemed inevitable. The stricture, however, was dilated by expanding a laryngeal forceps within it, followed up by the use of Schroetter's tubes, and the lumen of the larynx was restored to nearly its normal size. The progress of the disease has heretofore been unfavorable, in that tracheotomy, up to this time, has always been unavoidable. Now its timely recognition by the laryngoscope permits the institution of proper treatment at an early stage, and systematic dilatation gives better promise of cure than in stenosis resulting from any other cause.

3. Neoplasms.—Growths of the larynx are a frequent cause of stenosis. They may be either benign or malignant, the number observed of the former largely predominating. They appear at all ages, and comprise nearly every variety of morbid growth known to pathologists. Of the non-malignant forms the papilloma is most commonly encountered. Next in order of frequency come the fibromata; while occasionally we meet with myxomata, cystomata, angiomata, lipomata, and ecchondroses, and still more rarely adenomata. The symptoms of laryngeal growths vary with their nature and size; usually there is hoarseness, sometimes there is dyspnœa, while if the growth is large, or if so situated, even if small, as to obstruct the glottis, croupy cough and paroxysms of dyspnœa are almost certain to be present. These signs, though of importance, are of little value compared to the information derived from the use of the laryngoscope, which reveals the morbid condition in all its relations and furnishes sufficient evidence for accurate diagnosis. The

characters of the various laryngeal growths will be found described under their proper headings elsewhere.

The prognosis of benign growths of the larynx is favorable in a majority of cases; they can usually be removed through the mouth, but in cases where endolaryngeal methods prove unsuccessful the operation through external opening can be resorted to. Sometimes a papilloma is transformed into epithelioma as the result of irritation following repeated attempts at removal, and adenomata are said to be liable to the same degeneration.

Before the introduction of the laryngoscope primitive cancer of the larynx was thought to be a rare affection. Occasionally cases of consecutive cancer were observed, but as a rule the larynx was thought to possess a certain immunity from the disease. Cancer of the larynx, whatever its nature, is always primary. It never develops as the result of cancer in a distant organ, though it may arise by extension of the disease from a neighboring part, as the œsophagus, tongue, or tonsils. It generally occurs while the patient is in the best of health, rarely before forty years of age, and is found more frequently in males than in females. It is not of frequent occurrence. Fauvel, in 380 cases of laryngeal growths, met with but 37 cancers in fifteen years.

Cancers of the larynx present the same histological features as those of other organs, and usually are epithelial (epithelioma) or encephaloid. Some authors, notably Isambert,[11] divide them according to the anatomical seat rather than their histological character, and describe them as extrinsic or laryngo-pharyngeal, intra-laryngeal (polypiform and schirrous), and sub-glottic or tracheal. This division is made, as it is often impossible to obtain during life a specimen of the growth for microscopical examination, and in the event of the patient's death an autopsy is rarely obtainable. Of the varieties of laryngeal cancer which have been observed the majority are epithelial, all observers meeting with them in the largest proportion, Fauvel alone finding encephaloid predominating. Mackenzie reports 53 cases, of which 45 were epithelioma, 2 schirrous, and 6 encephaloid. Ziemssen, in 68 cases, has 57 epithelioma, 9 encephaloid, and 2 villous. Schroetter, in 20 cases, has 17 epithelioma and 3 encephaloid, while Fauvel, in 37 cases, found 19 encephaloid, 16 epithelioma, and 2 doubtful.

Encephaloid cancer begins as a small undefined tumor, covered with red, smooth mucous membrane. It progresses rapidly in size and becomes of a whitish-rose color, while the surface is seen to be irregular, mammillated, and with spots of ecchymosis. It takes on a fungous appearance, and soon completely obstructs the larynx, though before reaching this point it becomes ulcerated. This ulceration always takes place on the most prominent portions of the tumor. Vegetations spring from the centre of the ulcer, by which they may be distinguished from the vegetations of syphilitic ulcers, which grow from the circumference.[12] In primitive encephaloid cancer the surrounding parts generally escape. When, however, the disease originates in the œsophagus, there is considerable œdema of the arytenoid and ary-epiglottic folds. The inter-arytenoidean mucous membrane becomes thickened and is the seat of swelling. In the last stage of encephaloid cancer chondritis and necrosis of the cartilages take place, and their complete destruction ensues.

Epithelial cancer is slower in progress, and like encephaloid is difficult to diagnosticate at first. It appears as a large, uneven tumor, very much resembling a papilloma. It increases gradually without the vegetating appearance of the preceding variety. The surface soon ulcerates, and is covered with mucus and pus. The ulceration has no tendency to heal, and becomes gradually deeper. It is gray, often bleeds, and is covered with small clots. The destruction of the parts first affected takes place, and a hard œdema replaces them. The cartilages may be attacked, and abscesses form which open externally. The submaxillary and cervical ganglions harden, and the anterior part of the neck becomes indurated and hypertrophied, giving a peculiar sensation of hardness to the touch, like that of a "crustacean carapace."[13] The tracheal and bronchial glands also become indurated and hypertrophied, and cause stenosis and dyspnœa. Every part of the larynx may be attacked by the disease. It often originates in the ventricular band, the left side being apparently affected more frequently than the right. Its cause is unknown. Exposure to cold, unusual exercise of the voice, traumatism, habitation in damp places or inhalation of irritating vapors, excessive use of tobacco and liquor, and the gouty diathesis have all been cited as factors in the production of the disease.

The subjective symptoms of laryngeal cancer are pain, loss of voice, dyspnœa, and dysphagia. The pain at first is dull, then lancinating, but is rarely intense; when ulceration is established it radiates to the ear, forehead, and orbit. The pain in the ear Ziemssen considers a characteristic symptom. Hoarseness occurs early in the disease—in fact, is sometimes the first symptom—progressing more or less rapidly according to the part of the larynx attacked, finally resulting in complete aphonia, though the patient by violent effort is able to phonate hoarsely. This peculiarity differentiates carcinoma of the larynx from tubercular phthisis, where the voice is completely lost in spite of all efforts. Dyspnœa comes on at a later period. At first it is present only when the patient exerts himself, later on it is permanent. The respiration is rough and harsh, of a peculiar reedy character, which Fauvel asserts to be pathognomonic. As the glottis becomes obstructed the dyspnœa increases, suffocative attacks occur with spasms, which become more frequent until death takes place by asphyxia. The respiration is affected by the site and size of the tumor, by the paralysis of the vocal cords caused by pressure of an enlarged lymphatic on the recurrent nerve, or by the immobility of one of the arytenoids. Dysphagia is present when ulcerations are seated on the epiglottis or arytenoid eminences. It sometimes is as intense as in laryngeal phthisis, and the patient is in as great danger of death from inanition as from dyspnœa.

The laryngoscopic appearances vary with the site and form of the disease. There is first observed a simple congestion. Later a dark-red tumor, smooth at first, with a large, progressively increasing base, is seen. The surface of the tumor soon becomes ragged, nodulated, and vascular, and ulcerations occur with vegetations. As the ulceration progresses, the whole of the upper part of the larynx becomes œdematous, red, hard, and shining, and frequently the parts are so involved as to become unrecognizable.

In epithelial cancer the principal feature is ulceration. The vegetations never assume the proportions of the encephaloid variety, and consequently never become sufficiently large to produce complete obstruction of the glottis. It is œdema of the surrounding parts which causes suffocation.

As the different parts of the larynx are involved new tumors form, but only one-half of the larynx is affected, and this usually is the left. When the epiglottis is attacked by epithelioma it is frequently destroyed, often without any swelling. The disease sometimes communicates to the surrounding parts by contiguity. Mora[13] describes a case where the thyroid gland became involved in the progress of the disease.

The diagnosis is at first obscure, the appearances being those of catarrhal inflammation; the tumor, with its consecutive ulceration, making its appearance afterward. When the laryngeal cancer is an extension from surrounding tissues, there is little difficulty, but in other cases it is not always easy to distinguish it from syphilitic or tubercular ulceration. In the first case recourse to antisyphilitic treatment will often prove a sufficient test. Fauvel subjects all his cancer patients to this treatment, in spite of their denial of any previous infection. The stenosis requiring operative procedures is the result of the hypertrophies, vegetations, and the size of the tumor. The prognosis is always fatal, the patient living from fifteen months to four years after the inception of the disease. Death results from either asphyxia, hæmorrhage, exhaustion, or pyæmia.

4. Neuroses.—The functional affections giving rise

to stenosis of the larynx are spasm of the constricting and paralysis of the dilating muscles of the glottis, as a result of which the vocal cords are retained in the middle line and interfere with respiration. Spasm may be temporary or permanent. The condition of temporary spasm is common in children, occurring as laryngismus stridulus or spasmodic croup, and is occasionally observed in adults as a result of hysteria or of direct irritation of the larynx. When it is permanent it results from compression of the recurrent laryngeal nerves, or from myopathic changes brought on by cold, or from injury to the throat while swallowing. Paralysis is sometimes a factor in this condition, but not to the extent it was formerly supposed.

The symptoms of stenosis arising from impaired innervation are those of severe dyspnœa; the voice is normal and expiration is free, but there is great inspiratory difficulty, increased on the slightest exertion, and accompanied by great stridor during sleep. The vocal cords are seen in the laryngeal mirror to be fixed in the median line; they are nearly in contact, with an opening of a line or more, the opening of the glottis forming an acute isosceles triangle; on inspiration they rather diminish the size of the opening, which in expiration is slightly enlarged.

The cause of the condition of the larynx described above has heretofore been wholly ascribed to paralysis of the posterior crico-arytenoid (the dilator) muscles, causing occlusion of the glottis by their inability to counteract the more powerful action of the adductors; but more recently the work of Krause, Hooper, Gougenheim, and Solis-Cohen has tended to discredit this view, and to ascribe the condition to a continued spasm of all the constrictor muscles, and not to a paralysis of the dilators; the resulting atrophy of the dilator muscle being ascribed to its mechanical rather than to its paretic immobility. There is in a view of the cords an appearance of tension rather than the opposite; while it is not rare to find, as the first result of pressure of the recurrent nerves, a paralysis of the adductors, with the vocal cords in the cadaveric position, with no symptoms of dyspnœa—which, however, comes on later. In the cases where the immobility of the vocal cords is accompanied by caries of the cartilage, and where no compression or alteration of the recurrent nerve is observed, Gougenheim [14] ascribes the condition to mechanical causes, viz., loosening of the mucous membrane and neighboring infiltration of the opening of the glottis. He does not deny the existence of paralysis of the adductors, but believes spasm to be the greatest and most serious complication of laryngeal disease. Besides compression of the recurrent nerve, other causes of paralysis are atrophy or degeneration of the muscles, and degeneration of the roots of the pneumogastric and spinal accessory nerves. The remote causes are catarrhal inflammation, tuberculosis, syphilis, cerebral lesion, hysteria, and excessive use of tobacco.

Bilateral paralysis of the posterior crico-arytenoid muscles has been observed to occur during pregnancy without any assignable lesion. Aysaguer [15] reports a case of this kind where, in the course of a pregnancy, dyspnœa came on, increasing gradually in severity until tracheotomy became necessary. At the end of a month, being the fifth month of pregnancy, the respiration was restored and the cannula removed. Toward the end of the seventh month the difficulty in respiration returned. Electricity and dilatation by Schroetter's tubes were tried in vain, and tracheotomy was again performed. A fortnight after delivery the patient could breathe without the cannula, and after that no laryngeal trouble was observed. In this case there were no traces of albumen in the urine—no history of syphilis or hysteria—the condition seemed to be one depending entirely on pregnancy.

The prognosis is favorable in the temporary spasmodic affections, in the permanent ones it is fatal unless tracheotomy is performed.

5. Compression.—When stenosis of the larynx results from external causes it is due to the compression exercised by aneurism, abscess, morbid growths, goitre, or enlarged scrofulous glands in the vicinity of the larynx, or from a foreign body in the œsophagus. Beger [16] reports a case where, stenosis of the larynx occurring, tracheotomy was performed, but the patient died eleven days afterward. An autopsy showed the larynx and trachea compressed by an abscess, the result of caries of four of the thoracic vertebræ.

Besides the causes of stenosis enumerated above, it may result from fibroid deposit in the tissue of the larynx, [17] and from strumous hypertrophy of the epiglottis and laryngeal structures. [18] Granulations sprouting from the wound made in tracheotomy may cause a stenosis which prevents the removal of the cannula.

Treatment.—The treatment of stenosis of the larynx varies with the nature of the disease and the character of the obstruction. The first object is to relieve the impediment to respiration. The next to restore the larynx to its normal condition. When the obstruction is the result of an acute affection, as œdema, the exudation of croup or diphtheria, abscess, or the consequences of inflammation, either idiopathic or the result of mechanical or chemical causes, we make use of the general methods indicated for such cases, and when these fail to relieve, resort to scarification, intubation, or tracheotomy. When, on the other hand, the obstruction is of a chronic character, as in the stenosis occurring after perichondritis, the lesions of phthisis and syphilis, inflammatory or membranous contraction, or chronic stenosing laryngitis, we endeavor to remove it by mechanical treatment, systematically dilating the larynx by instruments specially devised for the purpose. It is preferable to effect this dilatation through the mouth, without recourse to previous tracheotomy; but in cases where the emergency does not permit of this, tracheotomy must be performed and the dilatation practised afterward.

In the stenosis produced by neoplasms mechanical dilatation is not indicated. In these cases it is necessary to extirpate the growth either by endolaryngeal methods or by removal through an external opening. If the operation is performed through the mouth, cauterization, crushing, cutting, or evulsion of the tumors by forceps may be practised, or they may be rubbed off by a sponge after the method of Voltolini, or the wire loop or galvano-cautery may be used. If these methods fail, the growth must be removed through an opening made in the thyro-hyoid membrane, crico-thyroid membrane, or the thyroid cartilage, or total or partial laryngectomy must be performed. In œdema and in abscess, scarification or puncture with the aid of the laryngoscope is to be practised. When the stenosis is the result of spasm, or paralysis of the abductor muscles from whatever cause, if general or local treatment fail to relieve it, there is no resource but in tracheotomy. When bands occlude the larynx they can be divided by incision or galvano-cautery, and care must be taken to avoid bleeding. In a case of Heinze [1] (*loc. cit.*) the hæmorrhage, after division of the bands by the galvano-cautery, was so great as to necessitate the ligation of the carotid artery.

Mechanical dilatation of the larynx for the cure of stenosis is a method of very modern date. Catheterization of the larynx was proposed by Desault in 1793, and Bouchut, in 1858, took up again the idea for the relief of dyspnœa in croup, under the name of tubage of the larynx. He used short, cylindrical tubes attached to a hollow introductor, a thread being attached for the purpose of withdrawal; they proved very irritating, and lost favor owing to the report of Trousseau to the Academy of Medicine of Paris. He condemned them as "beautiful in theory but difficult and wrong in practice." Horace Green, in this country, advocated the same method of treatment.

In 1871 Weinlechner, of Vienna, took up Bouchut's idea, under another form, using hard-rubber tubes, and in his experiments followed in the same track; but Schroetter [19] first systematically demonstrated the methods of mechanical dilatation of the larynx. The instruments used by him consist of a graduated series of hard-rubber tubes, varying from twenty-three to twenty-five centimetres in length, curved like the ordinary laryngeal sound, perforated at the end, and with two oval, fenestrated openings at the side.

They are twelve in number, and increase in thickness according to the following scale: No. 1 is 8 mm. thick from before backward, and 6 mm. transversely; No. 12 is 20 mm. from before backward, and 16 mm. across, so that the tubes increase in thickness with each number one millimetre antero-posteriorly, and not quite one millimetre transversely. The tubes are slightly conical at the point. The buccal extremity is curved downward, so as to prevent the patient from coughing in the face of the operator. The introduction of the tube is effected under the guidance of the laryngeal mirror. It should be held by the thumb and first and second fingers, in the manner of a pen, then passed into the larynx in the middle line

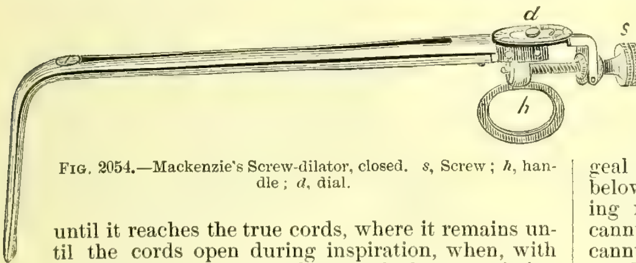

FIG. 2054.—Mackenzie's Screw-dilator, closed. *s*, Screw; *h*, handle; *d*, dial.

until it reaches the true cords, where it remains until the cords open during inspiration, when, with careful force, it is pushed through the constriction until the fenestrated extremity is clear of it. This is all that should be accomplished at the first attempt, the introduction being prolonged as the parts grow more tolerant.

O'Dwyer[20] calls attention to a method of tubage of the larynx. He makes use of a series of self-retaining tubes made of gilded metal, and varying in size from an inch and three-fourths to three inches in length, increasing in size from either extremity to the middle; the upper portion is expanded with a curved flange posteriorly and laterally, and there is an aperture in the flange for the introduction of a thread, by which to remove the tube in case of its malposition. The tube is introduced by means of an instrument specially constructed for the purpose. It is directed into the larynx by the forefinger of the operator, which also elevates the epiglottis, and when it is ascertained to be in the larynx the thread attached is withdrawn. The tube is extracted by an instrument also specially devised. Dr. O'Dwyer uses the tubes in cases demanding tracheotomy, and likewise proposes their use in chronic stenosis, a case of which treated in this way he has reported. (See article Larynx, Intubation of.)

Catheterization of the larynx for acute disease is not always easy of performance. In children, especially, it is often very difficult even for an experienced operator with good assistants, so that in many cases it is preferable to perform tracheotomy. In adults the larynx is frequently so irritable that the instrument can be borne only for a few seconds at first, though later on it acquires more tolerance. In chronic cases the patient can be taught to introduce the tube himself. As a rule, a tube should never be introduced except with the aid of the laryngeal mirror, but in urgent cases it may be dispensed with, using the forefinger as a guide. Attention has

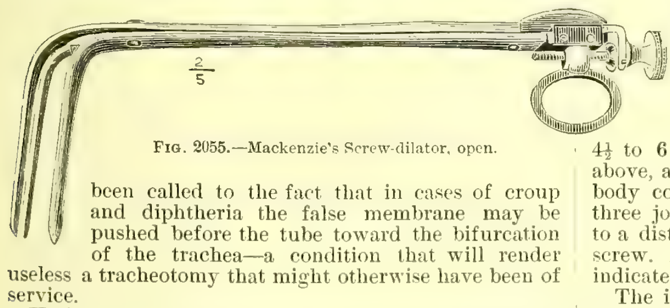

FIG. 2055.—Mackenzie's Screw-dilator, open.

been called to the fact that in cases of croup and diphtheria the false membrane may be pushed before the tube toward the bifurcation of the trachea—a condition that will render useless a tracheotomy that might otherwise have been of service.

Hering, in a memoir on "The Results of Mechanical Treatment of Strictures of the Larynx," read before the International Congress of London, 1881, has collected a number of observations where catheterization of the larynx was employed in stenosis of an acute and chronic character. He found in 8 reported cases of catheterization of the larynx, for acute stenosis threatening suffocation, 4 successful cases, 2 of œdema of the glottis, and 2 of paralysis. In 3 cases (laryngeal phthisis and perichondritis) tracheotomy was retarded, and in 1 case of hyperplastic laryngitis, in a child eighteen months of age, emphysema occurred. In 47 cases of chronic stenosis treated by this method he found 27 cures.

When the stenosis is of such a nature that it cannot be relieved by the methods described above, it becomes necessary to perform tracheotomy, and to make use of systematic dilatation, either through the tracheal opening or through the mouth.

Dilatation through the tracheal opening was practised before the time of laryngoscopy. As long ago as 1827, Mr. Liston dilated from below a stricture of the larynx, at first no wider than a knitting-needle, until it could receive an œsophageal bougie. Since the introduction of the laryngeal mirror various devices for dilating strictures from below have been constructed. Tracheal tubes with dilating mechanism projecting through a fenestrum in the cannula; T-shaped cannulæ; and others with a second cannula projecting up from the lower one, have been devised, but they have only been used in special cases, and have not come into general use.

For mechanical dilatation through the mouth, after tracheotomy, different appliances have been constructed, such as the dilators of Mackenzie and Navratil, metal sounds and tubes, the hard-rubber tubes and metal bougies of Schroetter, and the cutting dilator of Whistler. The screw dilator of Mackenzie consists of three

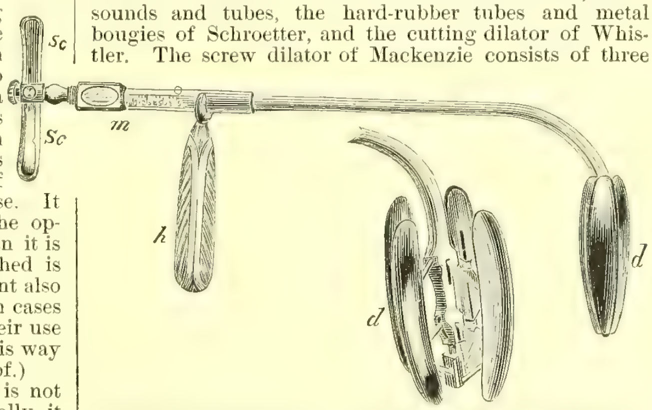

FIG. 2056.—Navratil's Dilator. *d*, *d*, Dilator proper, closed and opened; *Sc*, screw; *h*, handle; *m*, measuring scale.

blades, which when united form a solid instrument, easily introduced into the larynx. When the instrument has been passed into the constriction, a screw at its proximal extremity enables the operator to open the blade and thus effect distention. A dial placed near the screw shows the degree to which the instrument has been expanded (see Figs. 2054 and 2055).

The instrument of Navratil is a silver tube containing a steel rod, terminating at the distal extremity in an olive-shaped body, rather pointed below and broad above, the dilator proper; and at the proximal end in a screw. Between the two is a handle, which the patient holds after the introduction of the instrument into the mouth. The olive-shaped dilator varies in length from 4½ to 6 ctm., and its diameter from 12 mm. to 8 mm. above, and from 5 mm. to 2 mm. below. The olivary body consists of four segments, each segment having three joints, and can be made to extend symmetrically to a distance of from 20 mm. to 30 mm. by turning the screw. A scale on the instrument, anterior to the handle, indicates the amount of dilatation that has taken place.

The instrument of Whistler is particularly serviceable for dividing webs and membranous formations. It consists of an almond-shaped dilator in which is a concealed blade. The blade is reversible, so that it may divide a

stricture at either anterior or posterior commissure of the larynx, and can be pushed forward when required by a lever attached to the handle. When the instrument is passed into the larynx any existing web is put on the stretch and thus rendered tense for division.

The method of Schroetter for dilatation of the larynx makes use both of the hard-rubber tubes described above

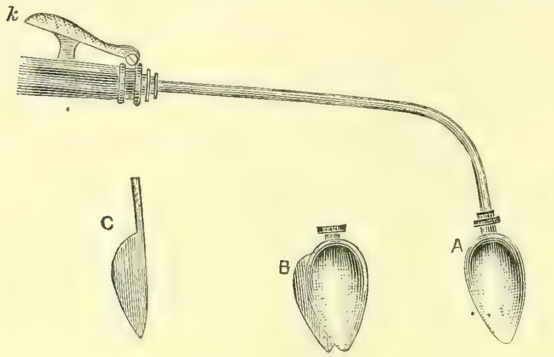

FIG. 2057.—Whistler's Dilator. *A*, almond-shaped dilator with the blade concealed; *B* dilator with blade projecting; *C*, blade removed from covering; *k* lever.

and of the laryngeal dilating plug. It gave, when first described, a new impulse to investigations in this method of treatment, and since then a number of successes from its employment have been reported. The process consists in the placing, after tracheotomy, of a metallic (tin) plug in the strictured part and retaining it *in situ* by fixing it to the tracheal cannula, increasing the size of the plug gradually until the larynx has attained a sufficient calibre. The method is as follows: A tolerance to instruments is established by the introduction of elastic catheters into the larynx. This occupies from three to eight days. As soon as the object is attained the cannula is removed and a catheter inserted into the constriction, where it remains until it becomes necessary to replace the tracheal cannula (five to thirty minutes). As soon as a No. 15 catheter can be introduced the third stage commences. Graduated dilators of hard rubber or pure tin are introduced by means of a hollow staff through which passes a cord, one end of which is attached to the handle

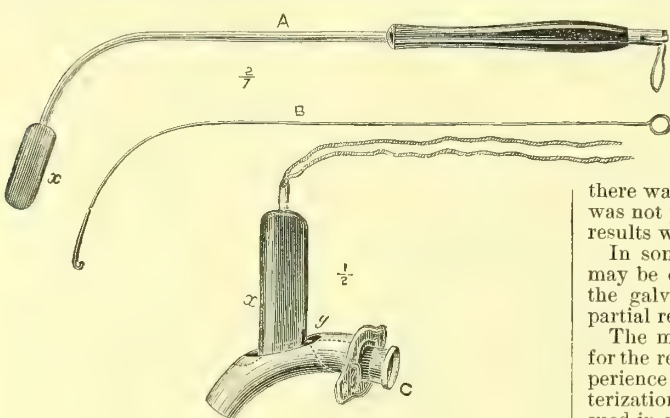

FIG. 2058.—Schroetter's Dilator. *A*, instrument ready for use; *x*, metallic plug; *B*, silver rod for drawing tumor through tube; *C*, inner tube of tracheal cannula with projection; *y*, canal in plug for reception of cannula.

and one end to the plug. These plugs are of the shape of the normal orifice of the open glottis, and with rounded corners; they are twenty-four in number, 4 ctm. in length, and are graduated in diameter from 6 to 16 mm. A brass rod passes through the centre of each, with an eye above for fixing a thread, and below is an oblique canal for fixing it in position by means of a projection in the inner tube of a tracheal cannula. As soon as the plug is fastened the staff is detached and withdrawn, and the thread drawn out of the mouth and attached to the band of the cannula.

These bougies are allowed to remain night and day, and are only withdrawn to be cleaned or when larger ones are introduced. When the dilatation is complete

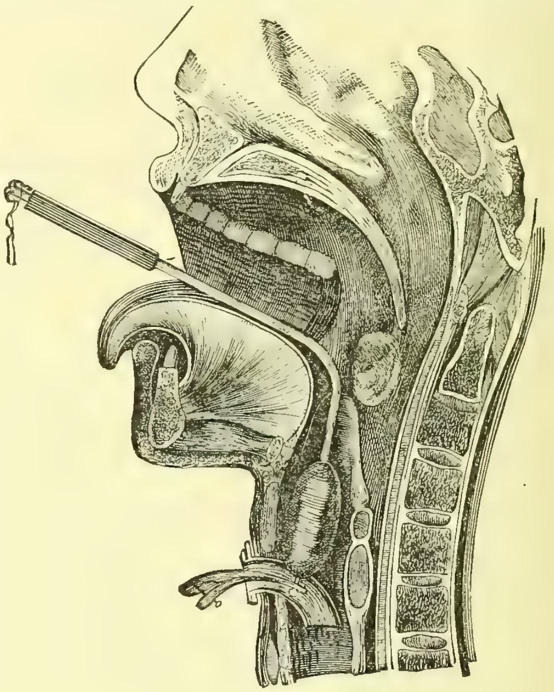

FIG. 2059.—Schroetter's Method of Dilating Stenosis of the Larynx. (Labus.)

the external wound is closed and retraction is prevented by the retention daily, for from fifteen to thirty minutes, of the curved tubes of hard rubber. The period of time necessary to effect a cure by this method varies from six months to two years or more. All of the cases so treated have not been cured, though a large proportion, while unable to dispense with the tracheal tube, have been rendered more comfortable.

Hering, in his table of cases of stenosis treated by Schroetter's method (*loc. cit.*), gives thirty-six cases, in eight of which there was a complete cure with removal of the cannula; in ten there was a complete dilatation of the larynx, although it was not possible to dispense with the tube, and negative results were obtained in eighteen cases.

In some cases of stenosis where dilatation fails, a cure may be effected by removal of the obstructing cause by the galvano-cautery or scissors, and where this fails a partial resection of the larynx can be performed.

The methods described above are those now practised for the relief of stenosis both chronic and acute. The experience gathered up to this time seems to show that catheterization of the larynx is not the best method to be pursued in cases of stenosis threatening life; that in chronic stenosis we must wait until the morbid process has ceased; and when cicatricial bands, adhesions, or granulations exist in the larynx, they must be removed before mechanical dilatation is begun; and, most important of all, the greatest patience and perseverance must be exercised on the part of the operator as well as of the patient.

Morris J. Asch.

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[5] Dis. Throat and Nose. Philadelphia, 1880.

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[20] N. Y. Med. Jour., August 8, 1885.

LARYNX, TRACHEA, AND BRONCHI, SYPHILIS OF THE. HISTORICAL SKETCH.—It is not the purpose of the present article to discuss the antiquity of the venereal complaint, but simply to briefly review the evidence of its ancient origin as far as it relates to affections of the nose and throat. As some of the weightiest arguments in favor of the remote existence of syphilis rest upon the supposed early recognition of specific disease of the upper respiratory apparatus, it may be interesting to examine the reasons alleged for this assumption, which has been defended with so much talent and erudition.

It has been maintained by some that certain passages in the ancient records of Chinese and Hindu medicine render it probable that syphilitic affections of the nose and throat have been recognized from the earliest times.[1] The evidence deducible from the researches of Dabry is, however, as Verneuil[2] has pointed out, inconclusive in view of their many chronological inaccuracies, while there is no sufficient reason for the belief that the disease described in the Ayur Véda is the affection which we now recognize as syphilis.

Both Hippocrates[3] and Galen[4] allude to falling in and depression of the nose from recession of the palate bones, and they and their followers refer to destructive ulceration of the larynx, trachea, and nose. Aretæus,[5] in his famous and much-discussed description of the disease called *uva*, asserts that the palate bone is sometimes laid bare, and that the ulcerative process spreads over to the fauces and even the epiglottis; but these isolated observations furnish obviously slender data upon which to base the antiquity of the venereal complaint.

The attention paid to, and the frequency with which the disease called by the Greeks *ozæna* is encountered in the writings of the ancients, are at first sight naturally suggestive of their acquaintance with syphilitic affections of the nasal passages; but, if we reflect upon the sense in which this term was employed by the large majority of physicians and grammarians of those times, we shall be obliged to confess that it forms an uncertain element in the chain of evidence which links the nasal syphilis of to-day with the ozæna of the Greek physicians.

By many of the ancient medical writers ozæna and polypus are used as convertible terms, and the cure of the two affections is considered under the same head.

In this sense, too (*i.e.*, as synonymous with polypus), the term is used by Pliny; and even among the later Latin grammarians the appellation *ozænosus* was applied to those who suffered from nasal polypi. It is exceedingly probable, then, that the term ozæna did not carry with it the same significance which attaches to its use at the present day. The ancients have left but scanty record of the measures they adopted in cleansing the nasal passages, and indeed, if we consider their notions concerning the pathology of nasal discharges, it would not be surprising if they neglected that important process altogether. A form of instrument, the rhinenchytes, for injecting the nasal cavities, is mentioned by Aurelian[6] and Scribonius Largus,[7] but it is highly probable that the important hygienic measure of systematic cleansing and disinfection was neglected, and that the secretion was allowed to accumulate and decompose within the nostrils—a condition which we know favors the development of a peculiar odor even in simple catarrhal inflammation of these cavities. It is, moreover, very probable that the hypertrophic, and consequently the atrophic, form of rhinitis were common affections among the citizens of ancient Greece and Rome. Finally, as the term ozæna, especially when used in the sense of a stench from the nostrils, serves to express a number of different pathological states, and in the light of our present knowledge concerning atrophic rhinitis, it is illogical to maintain that the ancients were acquainted with the nasal form of syphilis because of the frequent allusion to ozæna in their medical writings.

The foul mouth, hoarse voice, and snoring respiration of the cunnilingus, fellator and irrumator[8] have been thought to indicate syphilitic affections of the throat, but, as I have suggested elsewhere, they were doubtless the symptoms of a catarrhal process acquired in the discharge of their filthy occupations.

Reiskes thus describes the cinædus or sodomite: "In naribus et in palato vitium, a qua clare non potuerint eloqui, sed, ῥέγχειν, stertere et rhoncissare debuerint."[9] The value of this passage in evidence, it seems to me, turns upon the rendering of the word *vitium* (and not, as Rosenbaum[10] and others maintain, upon the verb ῥέγχειν), which may mean anything from a simple inflammatory condition to destruction by ulceration; and it may be with equal justice contended that the affection described by Reiskes may be referred to the advanced forms of hypertrophic naso-pharyngeal catarrh. At all events, there is no possible reason why we should lay the affection of the sodomite at the doors of syphilis.

Equally uncertain is the evidence adduced by the same writer[11] from the disease of the armpits among the Lesbians, which destroyed their noses and voices, and was supposed by Dio Crysostom, who drew attention to it, to have been the angry visitation of the goddess Aphrodite.

If now we turn to the passages which have been taken from the satirical writers of antiquity, the same uncertainty is found. The following are the only ones, it seems to me, worthy of the slightest consideration. The first is taken from Martial; a certain Festus, after he found that a dire disease had invaded his fauces, and crept into his countenance, committed suicide.

> "Indignas premeret cum tabida fauces
> Inque ipsos vultus saperet atra lues."[12]

The second is also from Martial, and refers to the debauchee and sodomite:

> "Qui recitat lana fauces et colla revinctus
> Hic se posse loqui, posse tacere negat."[13]

Now, it is perfectly obvious that the disease from which Festus was supposed to suffer may have been a cancerous or other malignant affection; and in the case of the debauchee it is manifestly absurd to infer the existence of syphilis from what was most probably a simple sore throat.

In the fifteenth century there lived an obscure poet, by name Pacificus Maximus, who, in spite of his apparently dissolute tendencies, as reflected in a volume of wanton poems published by him in 1489, managed to eke out a lascivious existence of exactly one hundred years.* Among his poems is the following invocation of Priapus, which possesses a certain historical value:

> "Tuque meum si non properas sanare Priapum,
> Decidet heu! non hoc nobile robur erit.
> Ante meis oculis orbatus priver, et ante
> Abscissus fœdo nasus ab ore cadat!
> Non me respiciet, nec me vollet ulla puella,
> In me etiam mittet tristia spata puer,
> Lætior heu! toto me non erat alter in orbe!
> Si cadet hic, non me tristior alter erit.
> Me miserum! Sordes quas marcidus ore remittet!
> Ulcera quæ fœdo marcidus ore gerit!
> Aspice me miserum, precor, O! per poma, per hortos,
> Per caput hoc sacrum, per rigidamque trabem,
> Hinc ego commendo tota tibi menta, Priape,
> Fac valeat, sic sit sanus ut ante fuit." †

In connection with the early origin of the venereal complaint I would like to call attention to the following passages, which I discovered accidentally while engaged in an historical research foreign to the subject now

* Born 1400, died 1500.

† Attention was first called to this poem by Sanchez, in the Journal de Vandermonde for October, 1759, tom. ix.

under review. The sonnet is one by Sulpicius Lupereus Servastus, Junior,* and runs as follows :

" Atqui sunt, quod propter honestum rumpere fœdus,
Audeat inlicite pallida avaritia.
Romani sermonis egens, ridendaque verba
Frangit ad horrificos turbida lingua sonos.
Sed tamen ex vultu adpetitur spes grata nepotum.
Saltem istud nostri forsan bonoris habent.
Ambusti torris species, exesaque seclo
Abduntur priscis corpora de tumulis
Perplexi crines, frons improba, tempora pressa,
Extantes mala deficiente genæ
Simatque jacent pando sinuamine nares.
Territat os nudum, cæsaque labra tremunt.
Defossum in ventrem propulso pondere tergum
Frangitur, et vacuo crure tument genua.
Discolor in manibus species, ac turpius illud,
Quod cutis obscure pallet in invidiam." [14]

Leaving now the question of the ancient recognition of the throat and nasal lesions of syphilis, and coming down to the close of the fifteenth century, when the affection is generally supposed to have been discovered, we find that the earlier writers on the lues venerea looked upon "softening" of the uvula, ulceration of the pharynx, tonsils, and fauces, perforation of the palate, catarrhal and destructive disease of the nasal passages, and a hoarse and raucous character of the voice as diagnostic signs of the disease.[15] Among them Frascatorius,[16] in his celebrated poem on syphilis, speaks of affections of the voice and obstruction in the pharynx, and Alexander Trajanus Petronius[17] (1566) refers to liquids taken by the mouth returning thereby, and to chronic hoarseness (*vox rauca perseverans*) as symptoms of syphilitic infection. Both Maynardi[18] and Fallopius mention difficult breathing from disease of the larynx and trachea, and tinnitus and other symptoms referable to disease of the ear were observed, among others, by Botallus, Tomitanus, and Petronius.

While these writers were doubtless thoroughly conversant with the ravages produced by syphilis in the nose and pharynx, and with affections of the voice and respiration, nothing definite was known concerning the pathological changes in the larynx until about the middle of the seventeenth century, when Marcus Aurelius Severinus[19] found in the body of a girl, dead of syphilis, the epiglottis completely destroyed by ulceration. This writer[20] seems also to have been familiar with ulceration of the trachea, bronchi, and œsophagus.† In 1678 Gunther Christopher Schelhammer[21] adverted to dryness of the larynx from ulceration of the uvula, and in the early part of the following century Vercollonius[22] gave a systematic account of syphilitic affections of the tonsils, pharynx, larynx, trachea, and œsophagus. Later on the subject of throat syphilis, from a clinical standpoint, was treated of in detail by Boerhaave,[23] Astruc,[24] Plenck,[25] Benjamin Bell,[26] John Hunter,[27] and Swediaur,[28] while Morgagni[29] directed attention to the anatomical appearances of the affection. Among the writers of the eighteenth century Raulin[30] seems to have been acquainted with syphilitic ulceration as it affects the larynx, trachea, and œsophagus.‡

At the beginning of the present century Thomann[31] drew attention to syphilis of the windpipe, and Altenhofer[32] announced, in a very valuable paper based on extensive experience, that tracheal phthisis is often the result of malignant or neglected syphilitic throat ulceration.

The impulse given to the pursuit of pathological anatomy by the colossal labors of Morgagni led, among other things, to the study of ulceration of the upper air-passages and to the publication of a number of special treatises on the subject,[33] which culminated in the classical mémoire of Trousseau and Belloc.[34] These observers, as well as those who preceded them, included syphilis, tuberculosis, and other chronic laryngeal affections under the generic term "phthisis laryngea," and this confusion practically reigned until the introduction of the laryngoscope, and the pathway to differential diagnosis was opened by the laryngoscopic studies of Tuerck.[35]

Syphilis of the Larynx.—Statistics differ widely as to the frequency with which syphilis attacks the larynx. While the elementary character of the present work precludes a critical examination of the sources of error discoverable in the antagonistic reports of different observers, it may be said, in general, that reconciliation of diverging opinions upon this subject can only be accomplished by taking the life-histories of the cases upon which the statistical evidence is based. Were this method universally adopted, we believe that few syphilitics would be found who had not, at some period or other of the disease, suffered from some form of laryngeal affection.

The delicate structure of the larynx, the irritation to which it is exposed in the natural discharge of function, or in the unnatural exercise of the same from disease of adjacent and communicating organs, as the nose and pharynx, the common invasion of its structures in other forms of acute and chronic blood-poisoning, and its frequent exposure to a host of other unfavorable influences from direct or reflected irritation, furnish, *à priori*, grounds for regarding this organ as a frequent seat of the manifestations of constitutional and hereditary syphilis. The impairment of nutrition induced in its structures by the circulation within their substance of a vitiated fluid, and the consequent vulnerability of its mucous membrane to the causes that determine catarrhal conditions, predispose, among other things, to the phases of so-called secondary inflammation, while its wealth in fibrous tissue and fibro-cartilage doubtless invites invasion by the tertiary processes of the disease.

While it is therefore probably true that the majority of cases of constitutional or hereditary syphilis, if untreated or neglected, will sooner or later develop some phase of laryngeal disorder, it is equally certain that the eruption of the disease in the larynx can be prevented or modified by early therapeutic interference. As the virulence of syphilitic lesions in general is modified by the employment of the more advanced and rational methods for its cure, so the destructive affections of the larynx are less frequently met with now than in the time when the therapeutics of the disease were less perfectly understood, and when the exhibition of mercury to salivation was the catholicon of the profession.

Certain it is, that the proportion of the more destructive forms of laryngeal syphilis is small, compared with their constancy and the terrible ravages to which they gave rise, as described by the writers of the fifteenth and sixteenth centuries. While, therefore, it is safe to affirm that the proportion of cases of laryngeal disease in syphilis has been notably diminished by the rational use of mercury, and especially by the tonic treatment of the disease, as formulated by Keyes,[36] the injudicious use of that drug, on the other hand, may be looked upon as having contributed in the past in no small degree to the determination of the disease to the throat. For when we recall the extensive ulceration of the pharynx and larynx sometimes produced by mercurials, and the free way in which the latter were often administered,[37] it is easy to conceive of the disastrous influence of their incautious administration upon structures peculiarly obnoxious to the ulcerative forms of syphilis.

The time elapsing between inoculation and invasion of the larynx varies greatly. Lewin,[38] who has given this

* Nothing is known concerning the age at which this member of the Sulpicii lived, the only trace of his literary existence being preserved in the above.

† Severinus's observations were made in the post-mortem room of a large hospital for venereal complaints, and must be regarded as the first pathological researches in the direction of syphilitic affections of the larynx.

‡ In the sixteenth century Schenck, of Grafenberg (Observat. medicæ de capite humano ; hoc est exempla capitis morborum, etc., obs. cccxlix., p. 397, Basiliæ, 1584) spoke of the "gula ex ulcere Gallico exesa procidens devorata," and also of perforation and loss of the palate (ob. cccxlvii., from Paré). In 1778 Andrew Duncan (Medical Cases, etc., p. 176 *et seq.*, Edinburgh, 1778) called attention to dysphagia resulting from increased sensibility of the pharynx from pre-existing syphilitic sore throat ; and Zeviani (quoted by Voigtel, Handbuch d. path. Anat., Bd. ii., Halle, 1804) placed on record a case in which a syphilitic ulcer of the windpipe communicated with the œsophagus. I would also call attention to the fact that Dolæus (Encyclopædia chirurgica rationalis, etc., ii., cap. v., p. 276, Francofurt. ad Mœnum, 1703), in his chapter on strictures of the œsophagus, observes, "aliquando angustia hæc fieri solet a caruncula gulæ ex ulcere venereo aborta." These cases of œsophageal syphilis may be added to those collected from the older literature of the subject by Astruc, Van Swieten, and Lieutaud.

particular attention, asserts that the minimum period is from two and a half to three months, while in the well-known case of Türck, the laryngeal affection developed thirty years after infection.[39]

The rarity of primary inoculation of the pharynx and tonsils precludes the framing of any definite conclusions concerning the rapidity of subsequent laryngeal invasion, nor has any relationship been established between the severity of the respiratory lesions and the size of the primary sore. Reasoning by analogy, however, it might be said that an early invasion of the larynx may be looked for in primary disease of the tonsils, and that the destructive tendency may vary with the character of the initial lesion.

The laryngeal lesions of syphilis are superficial and deep. Superficial changes usually appear early during the secondary stage of the disease, while the deeper, destructive lesions occur later, in the period of tertiary phenomena. The laryngeal inflammation is therefore, as a rule, associated with the corresponding external phenomena of these periods.* This relationship between the laryngeal and cutaneous lesions is, however, by no means invariable, especially as regards the superficial lesions, and even deep ulceration may be met with at an early period of the disease.

It sometimes happens that laryngeal inflammation and ulceration appear many years after the constitutional malady has run its course, and lesions of the pharyngo-laryngeal tract are occasionally encountered without antecedent cutaneous or visceral changes. In several cases seen by me, it was from the appearance of ulceration in the larynx that the patients and their attendant first became aware of the previous existence of the initial lesion. This remarkable tendency of syphilitic lesions to make their appearance in some portion of the upper respiratory tract long after the affection has apparently run its course, or without antecedent cutaneous and visceral phenomena, is especially worthy of note, and also the fact of their isolation, under these circumstances, in the nose, pharynx, larynx, or trachea, without disease of adjacent or communicating organs. Syphilis of the larynx is generally consecutive to inflammatory changes in the pharynx or nasal passages, but occasionally occurs as an independent affection. In rare instances it is the result of extension from the trachea. The age at which the disease appears will depend, of course, upon the time of infection, and, as men are more exposed to the exciting causes of inflammatory affections of the larynx, it is more frequently met with in the male sex.

The experience of the writer as regards the relative frequency of secondary and tertiary lesions is in favor of the more common occurrence of the former, if the simple catarrhal affections of that period be included under the head of true syphilitic phenomena.

Varieties.—The lesions of laryngeal syphilis are pathologically separable into two main groups, corresponding to the secondary and tertiary periods of the constitutional affection. In addition to these, there is a class of case which cannot be assigned to either extreme, and which belong to what Whistler[40] has aptly termed the "intermediate" period.

I. *Lesions of the Secondary Period.*—In this stage the mucous membrane and submucous tissues are the structures involved, and the appearances consist either in transient or permanent hyperæmia, or in well-defined catarrhal inflammation. The former presents nothing characteristic, the latter is differentiated from simple inflammation by the less pronounced character of the hyperæmia, and by the tendency to multiple superficial ulceration. There is, however, nothing absolutely characteristic in the anatomical appearances of this form of syphilis. The mucous membrane is, as a rule, paler than normal, sometimes even almost white, and the presence of minute ulcers, especially in number, and associated with similar appearances in the pharynx, is of value in the anatomical diagnosis of syphilis.

In the laryngoscopic image the existence of a brownish-red, mottled appearance of the vocal cords, especially if the condition be symmetrical, together with erosions or superficial ulceration of the edges of the vocal cords, on the free border and posterior surface of the epiglottis or ventricular bands, should lead to a suspicion of the specific nature of the inflammation.

While these appearances are strong presumptive evidence in favor of the existence of syphilis, it were more prudent to look for other phenomena and historical data before giving a decided opinion. The ulcers of this period are either follicular in origin or result from the breaking down of the more superficial portions of the mucous membrane. These minute losses of substance often coalesce to form a large ulcer with well-defined, elevated walls, and grayish-mottled base, which, in healing, leaves a small, somewhat depressed cicatrix. This latter from a clinical standpoint offers weighty evidence in favor of syphilis.

Whether ulceration of the laryngeal mucous membrane ever results from inoculation by the pharyngeal secretion cannot be affirmed with any degree of positiveness.

Mucous patches and condylomata. The utmost confusion prevails concerning the occurrence and frequency of mucous patches in the larynx. While their existence in this organ is strenuously denied by some who have specially investigated the subject, the very opposite opinion is entertained by equally competent observers. In a large number of patients with laryngeal syphilis that have come under the observation of the writer, he recalls but one case concerning the nature of which there could be little doubt.* The failure to detect the presence of mucous patches in the larynx may be due, as Morell Mackenzie[41] observes, to their fleeting character; while, on the other hand, it is highly probable that many of the so-called mucous patches described by writers are in reality nothing more than papillomatous excrescences or small ulcerating gummata.

The laryngeal mucous patch, so-called, appears in the mirror as a grayish-red or whitish-yellow elevation, rounded or oval in contour, and surrounded by an inflammatory areola. This may disappear completely or disintegration and ulceration may ensue. Small papillary hyperplasiæ not infrequently occur in the neighborhood of existing ulcerations or on the confines of an old cicatrix, which should, however, not be confounded, as has been done, with the true condylomata.

II. *Lesions of the Intermediate Period.*—These have been well described by Whistler. The anatomical peculiarity of this stage resides in a chronic diffuse laryngitis, characterized by its constant tendency to relapse, and by the existence of ragged ulceration of the vocal cords. These ulcers, in fact, represent, so to speak, a transition stage from the superficial destruction of the secondary to the deeper and more malignant ulceration of the tertiary period.

The ulceration of both the secondary and intermediate periods occasionally extends to the fibro-cartilaginous structures, but the latter complication is much more frequently due to ulceration of tertiary development.

III. *Lesions of the Tertiary Period.*—In this stage all the structures of the larynx may be involved, singly or in combination. The proclivity of syphilis to attack those cartilages only that are invested with perichondrium applies with especial force to the cartilaginous structures of this organ. The characteristic lesions of this period are gummata, deep ulceration, and fibroid degeneration.

1. *Gummata* appear as solitary or multiple tumors of varying size and shape, and of smooth, regular contour, which may proceed from any of the laryngeal structures,

* M. Dance has attempted to show that roseola, and even the tubercular and papular syphilide occur in the larynx simultaneously with their eruption upon the external surface (Eruptions du larynx survenantes dans la periode secondaire de la syphilis, Paris, 1864). These observations have never been confirmed.

* The subject was a woman suffering from secondary syphilis. On the left vocal cord, about its centre, was a small, oval, yellowish-white patch, smooth in contour, and slightly elevated above the surface of the cord. Its long diameter was parallel with the free border of the cord, and its base surrounded by a scarlet inflammatory areola. The laryngeal membrane was slightly erythematous. Three days afterward both patch and areola had disappeared.

but which are usually found in the submucous tissue of the free border and posterior surface of the epiglottis and the interarytenoid space. They are occasionally met with in the subglottic region, on the ventricular bands and vocal cords. They vary in size from that of a mustard-seed to a tumor that calls for tracheotomy.

The color of the mucous membrane covering the gumma is at first intensely red, and occasionally small vessels are developed in its vicinity. Gradually, under the increased pressure of the submucous deposit, it becomes pale, thin, and transparent, so that the peculiar yellow or whitish-yellow color of the gummatous infiltration is distinctly visible. Necrosis of the anæmic membrane soon follows, and an ulcer results which rapidly invades the submucous tissues, forming a more or less crater-like excavation, not infrequently involving the perichondrium and underlying cartilage. In small gummata absorption of the infiltration may be secured by the exhibition of antisyphilitic remedies, even after considerable thinning of the mucous membrane has taken place.

In histological structure the laryngeal gumma does not differ from similar products in other parts of the body.

An isolated case is on record where giant cells were found in the gummatous infiltration of the larynx,[42] but this is probably an exceptional and accidental occurrence.

Well-defined gummatous tumors of the larynx are comparatively rarely met with as compared with diffuse syphilitic infiltration.

2. *Fibroid Degeneration.*—In the later stages of tertiary syphilis there is in a certain proportion of cases a decided tendency to the gradual development of fibroid tissue in the structures of the larynx, which tends to diminish the lumen of the organ, not only by contraction of the new-formed tissue, but also by the production of large, dense fibroid tumors, which are often mistaken for and described as gummy tumors, but which pathologically have nothing in common with them. These fibroid utmors appear as hard, nodular masses occupying the epiglottis, ary-epiglottic folds, and other portions of the vestibule and subglottic region. Sometimes the greater portion of the organ is converted into a dense hypertrophic mass. Acute ulceration occurs, and is fraught with great danger from accompanying œdema, and each succeeding attack of ulceration favors a greater deposit of fibrous tissue and increases proportionately the gravity of the case. In this variety of laryngeal syphilis, which Whistler has especially insisted upon, no retrograde metamorphosis takes place; its processes are essentially progressive, and the calibre of the larynx becomes diminished sooner or later by an irregular nodular mass—half hypertrophied tissue, half cicatricial bands—which does not subside under internal or local treatment, and which, if extensive, demands tracheotomy.

These fibroid tumors may be differentiated from gummata by their pale grayish or whitish appearance, by the surrounding anæmia of the mucous membrane, and by the absence of the peculiar yellowish submucous discoloration of the latter. The hard, dense sensation communicated to the probe contrasts, too, forcibly with the soft elastic feel of the gummy growth.

This class of cases is only seen in hospital or dispensary practice, and presents a long history of neglected laryngeal trouble with gradually increasing obstruction to respiration. These tumors are more common than is generally supposed, and probably constitute a large proportion of the specimens which are labelled "gummata" in anatomical museums and collections.

Sections of the growths show under the microscope thickening of the mucous membrane, a round-cell infiltration of the submucous tissues, and abundant meshes and wavy bands of fibrous tissue, which in contracting obliterate more or less completely the vessels and glandular elements of the parts. Whether this fibrous tissue starts from the perichondrium or submucous layer, or both, or what relation it bears to the fibroid hyperplasiæ which are found after the cicatrization of ulcers, has not as yet been made out, but it is not improbable that this hypertrophic syphilitic laryngitis may be due to the combined action of these different factors.

3. *Tertiary Ulceration.*—Ulcers of the tertiary period result from atrophy of the mucous membrane, through the pressure of the underlying infiltration and the consequent purulent degeneration of the latter, and in this way excavations are formed, of more or less circular outline, with a deep base of grayish or lardaceous appearance and with elevated, clearly defined, and often bloodshot walls, surrounded by a scarlet zone of inflammation, and covered with a foul, dirty yellowish secretion, which imparts to the breath a peculiar and somewhat characteristic odor.

Of varying sizes, the tertiary ulcer may be multiple, and occur in any portion of the larynx and subglottic space; but it is generally solitary and occupies by preference the lingual surface and free edge of the epiglottis. It may be said, in general, that ulceration of the upper part of the larynx is much more common than ulceration of the cords and subcordal region. The ulcerative process not infrequently extends along the ary-epiglottic fold to the ventricular band, or from the latter to the ventricles. The epiglottis may present a crenated appearance, like the comb of a cock, or a punched-out aspect; or it may be depressed in various other ways. Occasionally it is perforated. It may be reduced to a mere rudiment, or finally be completely destroyed.

Syphilitic ulceration of the larynx heals by peripheral cicatrization, as has been well described by Virchow. Around the borders of the ulcer dense, callous connective tissue makes its appearance, which is characterized by excessive peripheral growth, as in the cicatrix following a burn. The resulting scar varies in appearance, according to the size and situation of the original ulcer. On the ventricular bands and free surface of the epiglottis, it is generally star-shaped, while in other situations firm, fibrous bands are formed which connect them with, or bind them down upon, adjacent structures.

As the ulcers heal, there spring up at the periphery of the cicatrices small papillary or fibroid hyperplasiæ, and thus, later on, small areas are found decked with growths, which mark the site of past ulceration.

The deformities which result from the cicatrization of large ulcers are quite characteristic. The epiglottis may be bound down to the base of the tongue, to the lateral and even posterior pharyngeal wall, adhesions may form between its free edges and the ary-epiglottic fold, between the latter and the ventricular bands and pyriform sinuses, and between the free edges of the ventricular bands; or the whole interior of the larynx may be converted into a contracted cicatricial channel in which all trace of the original anatomy of the parts is lost. Occasionally the larynx as a whole is displaced, or individual parts are thrown into unnatural positions by the contraction of the new-formed tissue. When ulceration occurs on surfaces that are brought in contact in the natural exercise of function, as for example, the vocal cords, membranous formations composed of cicatricial tissue are occasionally developed between the opposing ulcerative surfaces, thus forming a web between them—a condition which has been especially well described by Elsberg.[43]

If cicatrization be not promoted, the ulcers rapidly descend to the perichondrium, purulent inflammation of that structure is established and the cartilage laid bare.

Perichondritis and necrosis of the cartilages may also develop as a primary affection—possibly, though rarely, as a metastatic (septic) inflammation of the fibro-cartilaginous tissue. The cartilage thus becomes surrounded by a purulent infiltration which takes place beneath and in the meshes of the perichondrium, caries occurs and the necrotic portions are expelled as a granular detritus or as well-formed sequestra. Sometimes an entire cartilage is expelled in the effort to expectorate. While expulsion of necrotic cartilage usually takes place by the mouth, it occasionally happens that the necrosed plate falls into the trachea and causes death. The entire epiglottis has also been found in the stomach.

The presence of necrotic cartilage in the larynx, apart from other dangers to which it may give rise, aggravates the existing local disease, increases suppuration, and may

even lead, if not artificially extracted, to metastatic abscesses in various parts of the body, to pyæmia, and death.

If perichondritis do not result fatally, recovery takes place, at the expense of the functions of the larynx, with permanent anchylosis, with consequent paralytic affections and diminution in the calibre of the larynx, or fistulous tracks may be established between the cartilage and interior of the larynx, or may connect the former with the external surface.

A remote danger from tertiary laryngeal ulceration is death from hæmorrhage, as in the classical case of Türck,[44] where the laryngeal artery was opened, and in the one mentioned by Rokitansky,[45] where sudden death occurred from perforation of the aorta.

In all forms of tertiary syphilis of the larynx and in the deeper ulceration of the secondary and intermediate periods there is a tendency to acute and chronic œdema. The former occurs suddenly, and is sometimes the immediate cause of death; the latter develops slowly, and, in some instances, without danger to life, while in others it causes progressive dyspnœa, which may terminate fatally by sudden increase of the serous infiltration.

Symptoms and Complications.—It is manifest from the above that the symptoms and complications of laryngeal syphilis are of the most varying nature, and may consist in very slight modification of the vocal and respiratory functions or in their complete destruction; and even, secondarily, abrogation of the process of deglutition.

Diagnosis.—The distinctive points of difference between the diffuse laryngitis of the secondary period and simple catarrhal inflammation have been already given. The older writers laid great stress upon a peculiar raucous character of the voice as diagnostic, and the *vox rauca syphilitica* was placed among the pathognomonic symptoms of the disease. This quality of the voice is, however, met with when the vocal cords are congested, thickened, or abraded from simple inflammation, and cannot, therefore, be looked upon as characteristic of syphilitic laryngitis; though it may be of value in differentiating the latter from tubercular inflammation.

In the earlier laryngeal affections of tuberculosis the pronounced pallor of the mucous membrane of the pharynx, larynx, and nasal passages, the tendency to swelling and congestion of the posterior and inferior portions of the larynx, together with a hyperæsthetic condition of the upper air-passages, and especially the pharynx, and the slow development and persistence of the ulcers (generally on the vocal processes) will lead to an examination of the lungs, where evidences of commencing consolidation are generally to be found upon careful examination. In doubtful cases, where such evidence is wanting at the apices, the writer has repeatedly discovered signs of a localized bronchitis between the scapulæ, and the diagnosis has been verified by the subsequent development of the case.

Tertiary syphilitic ulceration of the larynx, and that which occurs in the intermediate period, may be confounded with that of tuberculosis and carcinoma.

From tuberculosis it may be differentiated by attention to the following points: Syphilitic ulcers are usually single, develop rapidly, and are preceded or accompanied by localized unilateral swelling of the mucous membrane or by gummatous growths. Tubercular ulcers, on the other hand, are generally multiple, are slow in development, and are preceded, as a rule, by a peculiar lustreless, opaque thickening of the membrane (tubercular infiltration). This may, in turn, be distinguished from the œdema which complicates syphilis, in that the latter is commonly unilateral, or confined to the parts principally affected, is glistening, more or less translucent, and does not partake of the opaque, dull color of tubercular deposit. When the latter leads to the peculiar pyriform swelling of the ary-epiglottic folds or to the turban-shaped epiglottis (*vide* article on Larynx, Phthisis of) it furnishes pathognomonic proof of tuberculosis. Syphilitic ulcers are larger, as a rule, than tubercular ulcers, and their favorite seats are the anterior surface and free edge of the epiglottis, while tubercular ulceration is most frequently encountered in the lower and posterior portions of the larynx and on the ventricular bands. When tuberculosis attacks the epiglottis it is generally the lower and posterior surface that is involved, and it may be said, in general, that the tendency of syphilitic ulceration is to develop from above downward, that of tuberculosis from below upward. Bilateral ulceration of the larynx, and especially of opposing surfaces, other things being equal, is in favor of tuberculosis.

Deformity always results when any of the laryngeal structures, as, for example, the epiglottis, is perforated from syphilitic ulceration, while the perforating ulcer of tuberculosis has little or no effect upon the natural shape and position of the cartilage. The syphilitic ulcer is deep, cleanly cut, with well-defined shelving walls (*vide supra*), is surrounded by an inflammatory areola, and rapidly invades the submucous tissues; the tubercular ulcer is surrounded by an anæmic mucous membrane, is more shallow, presents a characteristic worm-eaten appearance, and tends to spread laterally in an irregular or serpiginous manner.

The secretion from tubercular ulceration is usually very profuse, accumulates with great rapidity, and gives to the breath a peculiar sweetish odor that is quite characteristic. Microscopic examination, moreover, will generally detect the presence of Koch's bacillus, which may be looked upon as possessing a certain crucial diagnostic value. In syphilis, on the other hand, the secretion is by no means as great, nor does it accumulate with the rapidity observed in tuberculosis. Syphilitic ulceration, especially if the pharynx be involved, gives to the breath, moreover, a peculiar fetid odor, which may be regarded as diagnostic.

Hæmorrhage from the larynx is not uncommon in tuberculosis, and is rare in syphilis. Syphiiitic ulceration tends to heal by peripheral cicatrization; it is doubtful whether extensive tubercular ulceration ever heals. The presence of cicatrices in the larynx is *prima facie* evidence of syphilis, and when these assume their characteristic form there can be little doubt concerning the diagnosis.

Small fibrous outgrowths in the neighborhood of ulcers or cicatrices are additional evidence in favor of syphilis, while papillary hyperplasiæ, occurring in the interarytenoid fold, and especially when they appear in the early stages or precede well-marked changes in the larynx, should awaken suspicion of tuberculosis.[46] While, moreover, small granular or papillary hyperplasias are sometimes found covering the base of tubercular ulceration,* no growth ever arises from that of a syphilitic ulcer or from the resulting cicatrix. Papillary hyperplasiæ are not uncommon in syphilis, but generally mark the seat of past ulceration, as indicated by the presence of a cicatrix or other evidence of pre-existing localized destruction. The papillomatous excrescences of tuberculosis tend in time to ulcerate and break down, those of syphilis rarely, if ever, ulcerate.

Syphilitic ulceration is, as a rule, not painful, nor is the larynx tender to pressure, except when the deeper structures are involved. Deglutition is also accomplished with ease, except in active ulceration of the epiglottis, when the pain is sometimes severe. In tubercular ulceration, on the other hand, especially when the food comes in contact with the ulcerated surface, swallowing is intensely painful and sometimes impossible.

In tuberculosis the respiration is always more or less embarrassed and the voice is enfeebled and veiled from insufficiency of the expiratory forces, while in syphilis, unless the vocal cords be involved, the phonetic quality of the voice is not necessarily impaired. In the differential diagnosis between tuberculosis and syphilis, the so-called *vox rauca* may be accepted as a conclusive sign of the latter.

The presence of cicatrices or active ulceration in the

* The gummata of syphilis may possibly be confounded with tubercular tumors of the larynx, that rare form of tuberculosis first described by the writer of this article in 1882 (N. Y. Archives of Medicine, October, 1882), and of which other cases have been since recorded by Schnitzler (Wiener Med. Presse, Nos. 44 and 46, 1883), and Percy Kidd (Clin. Soc. Trans., London, vol. xvii., p. 154, and St. Bartholomew's Hosp. Rep., vol. xxi.).

pharynx, on the palate, or in the nasal cavities carries with it weighty evidence in favor of syphilis, the condition of these structures in advanced tuberculosis being commonly that of anæmia associated with more or less catarrhal disease.

By attention to the above differential points between the two diseases a mistake can rarely occur. It must, however, be admitted that cases arise in which an appeal to the historical narrative of the case, the physical examination of the lungs and other organs, and even treatment may be necessary before giving a positive opinion. It should be remembered, too, that syphilis and tuberculosis are occasionally combined in the larynx, and that such a condition can only be recognized by the eye of a skilled observer.

The deformities which result from tertiary syphilis may be said to be practically characteristic; but it is well to call attention to the fact that certain essential fevers, *e.g.*, typhoid, small-pox, etc., and diphtheria, occasionally give rise to ulceration of the nasal passages, pharynx and larynx, with perforation of the septum, ozœna, loss of the palate, epiglottis, etc., which present all the gross appearances of syphilis, and which can only be differentiated from the destruction of that disease by the history of the case. This is especially worthy of remembrance, lest, in the after-life of the individual, the previous existence of syphilis be too readily assumed from a perforation of the septum or the loss of the uvula or palate.

Much more difficult is the differentiation of syphilis and cancerous ulceration occurring in the larynx. The chief points to take into consideration here are the following: Cancer is a disease which occurs usually after the fiftieth year of life, which develops less rapidly than syphilis, and most commonly originates from the space between the vocal cord and ventricular bands (except when it descends from the pharynx), as a more or less clearly defined nodular growth, which subsequently ulcerates and is converted into a deep ulcer with bloodshot walls, whose base becomes covered later with fungous, bleeding granulations. Associated with this, or preceding its development, are usually evidences of œsophageal obstruction, with pain on swallowing, pressure, or manipulation with the bougie.

Lancinating pain in the larynx, when at rest, radiating to the ear of the affected side is often present, although it cannot be considered characteristic, as it may occur in any ulcerative disease of the larynx. As the ulcerative process of cancer advances, extensive hæmorrhages not infrequently take place, an uncommon occurrence even in extensive syphilitic ulceration.

The secretion of cancer is profuse, ichorous, and differs materially in odor from the peculiar sickening stench of the discharge produced by syphilitic ulceration. Examination under the microscope will occasionally determine the nature of the case.

Cervical glandular enlargement is uncommon in laryngeal cancer, but is not infrequently associated with tertiary syphilis of the larynx.

While the above may serve as reliable guides to diagnosis, every experienced specialist can recall cases where the latter could only be determined by resort to the sovereign test of treatment. Indeed in any case in which the slightest doubt exists, it is the part of prudence in this, as in other problems of diagnosis, to give the patient the benefit of the doubt.

Prognosis, Complications, Sequels.—The treatment of syphilitic affections of the larynx is generally very satisfactory, unless the cartilages and their envelopes be attacked. Even then a cure may be effected, if the necrotic cartilage be removed. In deep-seated destruction a cure can only be obtained with permanent injury to function.

The complications and dangers to life from tertiary syphilis have been already alluded to in treating of the pathology of the disease. The possibility of the sudden occurrence of œdema, even in the ulcerative laryngitis of the intermediate period, should never be lost sight of, and the danger of the latter increases, in every stage, as the perichondrium is approached.

It is generally possible to produce complete cicatrization of tertiary ulceration, but when the latter is extensive, such an event is only accomplished with considerable deformity or contraction of the larynx. Ulceration occurring in the subglottic region and in the neighborhood of the crico-arytenoid joint is more dangerous to life than when the epiglottis and ventricular bands are attacked. The entire epiglottis may be destroyed without serious impairment of the laryngeal functions and without impediment to deglutition.

In fibroid degeneration, when extensive hypertrophy has taken place, no good has as yet come from constitutional or local treatment, and the patient drifts sooner or later to tracheotomy. Perhaps some good could be accomplished by the use of acids, electric cautery, and other destructive measures, with or without a preliminary tracheotomy in this apparently hopeless class of case.

If properly treated, the prognosis in simple syphilitic catarrh, with or without ulceration, is good, and a permanent cure can often be accomplished. In other cases relapses of the ulcerative process occur from time to time. In both the prognosis is influenced by the previous timely treatment of the constitutional disease. Finally, all syphilitic lesions of the larynx are rendered less amenable to treatment by the predisposition to or coexistence of serious organic disease, as for example, tuberculosis.

Treatment.—The treatment of laryngeal syphilis is both constitutional and local. While there is, perhaps, no disease of the larynx that calls for more careful local methods of cure than syphilis, and in which the prognosis depends so much upon the early laryngoscopic recognition and appropriate topical treatment of its manifestations, the successful accomplishment of the latter is nearly always assisted by and often dependent upon the exhibition of constitutional remedies. Especially is this true of the tertiary lesions of the disease. To neglect general antisyphilitic medication when an ulcer is approaching the perichondrium, or when the destruction of important parts is menaced, is, to say the least, an unsafe and injudicious experiment.

The development and permanency of secondary laryngeal lesions is also influenced, in a great measure, by the early adoption of constitutional measures, for the latter not only assist in the removal of the infiltration, but, in some instances, act as a safeguard against true inflammatory disease.

The different methods of administration of antisyphilitic remedies will be given in the article on Syphilis. The writer can recommend the tonic use of mercury, as formulated by Keyes, in the treatment of syphilitic affections of the larynx. The most direct way of producing both the local and general effects of the drug is by mercurial fumigation or vapor-baths.

The local treatment of the diffuse laryngitis of secondary syphilis does not differ materially from that of simple catarrhal laryngitis (*vide supra*). Should ulceration occur, iodoform may be freely used. In the deeper form of ulceration this drug is of inestimable service, and is in the writer's experience superior to iodine and the nitrate of silver. Sprays of the bichloride of mercury, or the local application of the yellow oxide in cosmoline, vaseline, or like substance are also of considerable value. Before applying these remedies, the ulcerated surface should be thoroughly cleansed by means of a detergent and disinfectant spray, for, otherwise, much of the good effect will be lost.

Papillomatous growths may be dissipated by the local application of alcohol or chromic acid, or, if extensive, may be removed at once with the forceps. Membranous webs may be successfully divided with the galvano-cautery (Elsberg) or by cutting dilators, the best of which is that devised by Whistler, to the excellent results obtainable by which the writer of the present article can testify.

Whether any good can be accomplished by the division of adhesions must be determined by the peculiarities of the individual case. Except when function can be restored, or serious dyspnœa or dysphagia mitigated by the operation, it is better, as a rule, to let them severely alone.

Serious interference with respiration from any compli-

cation calls for tracheotomy, and the early performance of the latter is especially to be advised when the larynx has undergone the fibroid degeneration described above. Systematic dilatation of the larynx, as described under the heading Larynx, Stenosis of, is sometimes of value, but, as a rule, little can be expected of this line of treatment beyond temporary improvement, while it is much inferior to the cutting operation.

Loosened necrotic plates of cartilage, in view of the dangerous complications to which they may give rise, should be removed, if practicable, by endo-laryngeal operation or from without, by exsection.

Syphilis of the Trachea and Bronchi.—The individual portions of the respiratory apparatus possess a decidedly varying disposition to the localization of syphilitic lesions. When the notable frequency with which the nose and larynx are involved during the course of constitutional syphilis is contrasted with the comparative rarity of affections of the trachea and bronchi, it may be with safety said that the lesions of syphilis are more frequently found in the upper than in the lower segments of the respiratory system.

Syphilis of the trachea is of relatively rare occurrence, though not as uncommon as statistics would lead us to believe. Many cases of tracheal syphilis are doubtless overlooked, and especially is this true of those isolated inflammatory and ulcerative conditions which are found in the lower portion and at the bifurcation of the windpipe. In a large proportion of cases, the tracheal affection is secondary to, and consists simply in the extension downward of, infiltration and ulceration of the larynx; it occasionally involves the whole length of the trachea, and even the bronchi in its destructive action.

Much less common is the existence of syphilis of the trachea without associated or pre-existent lesions of the larynx and pharynx, or at least, which is not the result of extension, but which occurs as an independent affection. When the syphilitic disease is thus isolated, it is usually in the lower third of the trachea, from which it extends into the bronchi, or the latter may themselves be the seat of isolated syphilitic lesions.

Isolated syphilis of the upper third is much less commonly met with, and may occur alone or in combination with lesions of the lower trachea and bronchi. Usually both bronchi are affected. When one alone is involved, it is more frequently the right. Only two cases are on record of isolated syphilis of the windpipe in its entire length,[47] while the isolation of the disease in the middle third is so rare that the possibility of its existence in this locality has been denied. This condition has, however, been found and described by the writer[48] of this article, who, at the time of publication, could find but two similar cases in literature (Charnal,[49] Beger[50]), to which a fourth has quite recently been added by Felix Semon.[51]

Pathological Anatomy.—The changes met with in the trachea are identical with those found in the larynx during the secondary and tertiary period, with certain differences of appearance due to peculiarity of anatomical structure.

Mucous patches in the trachea are liable to be overlooked. M. Mackenzie[53] states that he has found them five times. Seidel[54] describes as a mucous patch a pale-red excrescence, the size of a pea, which was associated with condylomata in other parts of the body, and which disappeared without local treatment. Diffuse superficial inflammation, with or without ulceration, fibroid degeneration, gummatous growths, deep ulceration involving the perichondrium and cartilages, leading to peritracheal abscesses, exfoliation of necrotic tissues with subsequent fistulous communication with the exterior, membranous formations and stricture from the cicatrization of ulcers are all observed, either alone or combined in the course of constitutional syphilis.

The ulceration generally descends from the larynx along the inner surface of the tube, presenting a more or less irregular spiral form or peculiarly forked appearance. In other cases, the long diameter of the ulcer is at right angles to that of the trachea, which it surrounds in a circular manner. Usually single, the ulcers vary in size, sometimes extending the whole length of the tube, and even to the first division of the bronchi.

The stenosis which follows the contraction of the cicatricial tissue may affect the tube as a whole, whose lumen it sometimes obliterates almost completely, or the obstruction may be confined to its individual segments. The most common seat of obstruction is the lower third.

The stricture which results from the cicatrization of a tracheal ulcer is of two kinds—excentric and concentric. The former is produced by irregularities or deformities of the tube from the healing of longitudinal or imperfectly annular ulceration, or as the result of perichondritis. In annular or concentric stricture there is often dilatation of the trachea above and below the constriction, forming, so to speak, an hour-glass appearance. The cicatrices do not differ materially from those found in the larynx. They either present a peculiar net-like form or resemble the scars found in the œsophagus from corrosions (Förster). In the writer's case the cicatrix presented a remarkable resemblance to a sheaf of wheat.

Prognosis.—The prognosis of tracheal syphilis is, other things being equal, much less favorable than when the disease attacks the larynx, and it becomes graver as the bifurcation into the bronchi is approached. Extensive ulceration, especially when occurring in the lower third, or when it involves the bronchi, is generally fatal, while in obstruction in the upper third life may be prolonged by resort to tracheotomy or to systematic dilatation. In addition to the usual dangers from stenosis, perichondritis, etc., death has been known to occur from hæmorrhage, due to perforation of the ulcer into the aorta[55] and into the pulmonary artery.[56] In other cases the ulcer has perforated into the mediastinum[57] and into the œsophagus.[58]

Symptoms.—Syphilis of the trachea may run its course without the production of any symptoms during life, or it may give rise to those of the most alarming and dangerous forms of stenosis.

Congenital Syphilis of the Larynx, Trachea, and Bronchi.— Isolated cases of laryngeal lesions in congenital syphilis are to be found scattered here and there through medical periodicals, but systematic writers have either entirely ignored the subject, or referred to a few recorded cases as pathological curiosities. The universal sentiment of authority has, until quite recently, been decidedly adverse to the frequent dangerous implication of the larynx, and the changes in the voice* are referred to the intervention of fortuitous catarrh.

In the *American Journal of the Medical Sciences* for October, 1880, I called attention to the frequency with which the throat is involved in congenital syphilis, and gave a systematic description of the lesions found in the pharyngo-bronchial tract and œsophagus during the course of that disease.[59] In opposition to the then generally received doctrine, I ventured to maintain, as the result of careful investigation of the subject, that, so far from being rare, as was generally supposed, laryngeal affections in congenital syphilis are among the most common and characteristic of its pathological phenomena, and that the invasion of the larynx may be looked for with the same confidence in the congenital as in the ac-

* As early as 1837, Dr. Abraham Colles, of Dublin, called attention to a hoarse cry as a symptom of congenital syphilis and referred to the fact that when the voice became hoarse, the affection of the anus might be shortly expected (Pract. Observ. on the Venereal Disease, etc., Lond., 1837, p. 269.). Rosen, a distinguished Swedish physician is cited by Mahon and Lamauve (Recherch. important sur l'existence, la nature et la communication des mal. syph., etc., p. 371, Paris. 1804), as mentioning a hoarseness occurring without manifest cause, and difficult deglutition as symptomatic of congenital syphilis; but on referring to the English translation of Rosen's work, I find that the sentence relates, not to the inherited syphilis of the child, but to the acquired disease in the nurse (The Dis. of Children and their Remedies, by Nicolas Rosen von Rosenstein, trans. from the Swedish edition of 1771, by Dr. Andrew Sparrman, p. 332, London, 1776). Long before Colles wrote, Josef Jacob Plenck, in speaking of the signs of inherited syphilis, observes that not infrequently the fauces and labial commissures become exulcerated—a condition indicated by a rough voice, nocturnal cries, sleepless nights, etc. "Non raro fauces et commissuræ labiorum simul eroduntur. Index vox rauca, clamores nocturni, noctes insomnes, deglutitio difficilis, tabes, mors" (Doctrina de morbis venereis, p. 149, Viennæ, 1779). This writer also refers to ulceration of the fauces in "latent" syphilis.

quired form of the disease. Further experience and the study of cures since recorded by others have only served to strengthen the positions taken in the paper referred to, for an elaborate discussion of which I must refer to the original, from which also the following account is taken.

The laryngeal lesions of congenital syphilis are constant and characteristic and play an important rôle in the pathological evolution of the disease. Often among the first events of its clinical history, they may rapidly terminate in death, or stealthily advance, inducing progressive morbid changes, which, at first controllable and evanescent, may ultimately become inveterate. And thus the laryngeal inflammation may outlive the series of phenomena which mark the progress of the malady, witnessing their inception, course, and disappearance, itself alone rebellious to the approaches of the treatment by which they have been controlled or dissipated.

The larynx may be involved at any, but usually at an early epoch. Laryngitis may even arise during intrauterine life. The most common period of invasion, however, is within the first six months after birth. Out of 76 cases of laryngitis, 53 occurred within the first year; and of these 43 within the first six months, 17 within the first month, and four within the first week of life. Age, therefore, seems to exercise a predisposing influence upon the eruption of the disease in the larynx. This applies not only to the superficial changes, but also to the more malignant forms of laryngeal destruction.

The laryngeal affection is met with more frequently in the female than in the male sex, in the proportion of three to two. It develops at all periods of the year, without regard to season, although it is naturally aggravated by those atmospheric changes that determine catarrhal conditions.

Imperfect nutrition and forced neglect of hygienic laws sufficiently explain its prevalence among the children of the poor.

The classification of the laryngeal lesions of congenital syphilis into secondary and tertiary will not obtain as in the case of acquired disease. Their pathological evolution is not governed by the same laws that regulate the eruption of syphilis in the adult larynx, nor can we predicate, in any given case, the order in which they will appear. In some, not a few, the deeper destructive forms are the first indication of laryngeal mischief.

In congenital syphilis we may distinguish two principal varieties of laryngeal inflammation. In the one, the changes are limited to the mucous membrane, and, it may be the submucosa; its march is essentially slow, and there is little tendency to invasion of the deeper structures. The other is characterized by deep ulceration of an extremely acute nature, which, especially in early life, rapidly involves the cartilages and their envelopes, and constitutes the most frightful form of the disease. In addition to these, there is a third form, in which a gradual deposit of dense, fibrous material takes place within the tissues of the larynx, and leads to contraction of its lumen.

These pathological facts justify a classification based upon the anatomical seat of inflammation. The laryngeal lesions may, accordingly, be classified as *superficial, deep*, and *interstitial.*

Chronic superficial laryngitis is the condition most frequently met with. It is limited to the mucous membrane and submucosa; is essentially chronic; runs a definite course; gives rise to well-defined changes in the larynx, and may be divided into three stages. The first, or stage of hyperæmia, presents nothing diagnostic; the redness is generally diffuse, but sometimes is confined to special areas. It is commonly associated with congestion of the trachea, coryza, and erythema of the fauces and pharynx. Gradually, however, a condition of hypertrophy is developed in the laryngeal membrane, which becomes swollen, thickened, and infiltrated, constituting the second stage or that of infiltration and hypertrophy. If the larynx be examined now, its membrane will be seen to be deeply injected, and often slightly translucent from chronic inflammatory œdema. The epiglottis, ventricular bands, and arytenoids have a swollen, rounded appearance, while the vocal cords are thickened and reddened, and their excursive mobility is impaired. Swelling of the mucous glands sometimes occurs, but the secretion is generally scanty. These changes are occasionally limited to one side of the larynx. Thus, one-half of the epiglottis, its corresponding ary-epiglottic fold and ventricular band may be swollen and thickened, while the opposite side of the larynx is in a state of simple congestion. If the throat be neglected, minute ulcers form by the liquefaction of the superficial portions of the mucous membrane, which partake at first more of the nature of erosions, but which, in long-standing cases, involve the whole thickness of the membrane, and sometimes reach the cartilage. Arrived at this period or stage of ulceration, the affection becomes stubbornly rebellious to treatment. Under antisyphilitic medication the ulcers heal, it is true, and temporary relief is afforded; but sooner or later fresh ones appear in other parts, thickening and hypertrophy become progressive, and secondary changes may be induced in the lungs, either by direct extension through the trachea and bronchi, or as the result of a diminution in the calibre of the larynx itself. As cicatrization of the ulcers takes place, small papillary or polypoid hyperplasiæ arise around the edges of the cicatrix. When small, they impart (post mortem) to the finger a rough granular sensation. They are more common in the child than in the adult, and the same may be said of the ulcerations which precede them.

Such is the common history of this form of laryngitis. Commencing in early childhood as an ordinary catarrh, for which it is often mistaken, it gradually, but surely asserts its specific nature. To it is due the characteristic cry and other symptoms referable to the larynx, so common in the early stages of congenital syphilis. The changes which have been described require time for their completion, months and even years elapsing before they reach their full development.

From the fact that hoarseness and other laryngeal symptoms sometimes coexisted with mucous patches on the palate and in the pharynx, it was assumed by Diday[60] that they were due to the presence of similar lesions within the larynx, in the neighborhood of the ary-epiglottic folds. Czermak[61] and Türck[62] have each reported cases where they were seen with the laryngoscope; and one is referred to in the *Gazette des Hôpitaux*,[63] in which they were found in front of the arytenoids. The patches described by Czermak and Türck are, however, evidently examples of true ulceration, and the account of the laryngeal appearances in the child from the Hôpital Necker is too meagre to be of any value in establishing the existence of mucous patches in the larynx of the congenital syphilitic.

The deep, destructive, ulcerative laryngitis corresponds in physical characters pretty closely to the tertiary inflammation of acquired syphilis. It may follow the superficial form, but generally occurs independently of it. It is sometimes among the first symptoms of infection, and is then most destructive.

As a rule, deep pharyngeal ulceration precedes, or coexists with, this form of laryngitis, but deep ulceration of the larynx occurs, too, without the slightest evidence of pre-existing pharyngeal lesions.

Laryngeal ulceration does not commonly follow the pharyngeal destruction of so-called latent syphilis. The palato-pharyngeal ulceration found in tardy congenital syphilis, has little tendency to invade the larynx; its future theatre of action is the naso-pharynx and nose.

The first stage of this form of laryngitis consists either in a deposit of gummatous material in, or a round-cell infiltration of, the structures which subsequently become the seats of ulceration. The resulting ulcers have the same appearances as those found in the tertiary period of constitutional syphilis, and lead to similar deformity and stenosis. They are single or multiple, symmetrical, or confined to one side of the larynx. Their most frequent seat is the epiglottis; they are often situated in the ventricles; less frequently on the upper and under surface of the vocal cords, ventricular bands, ary-epiglottic folds, and plica meso-arytenoidea. They are also observed in the subglottic cavity.

There is a remarkable tendency in the laryngeal ulceration of congenital syphilis to destruction of the deeper tissues—the cartilages and their envelopes—and this predisposition is most marked in those in whom the throat is attacked at an early stage of the disease. There seems to be an inherent virulence in the process, which finds in the imperfectly developed laryngeal structures an appropriate field for the display of its destructive power. Chondritis, caries, and necrosis are found in over two-thirds of the recorded cases, at all ages. Of these, over three-fifths occurred within the first year of life.

Chronic interstitial laryngitis is intermediate between the two forms of inflammation already described, and is rarer than either; but it is of considerable practical importance, in view of its insidious tendency to stenosis. It consists essentially in a gradual deposit of a fibroid material in the tissues of the larynx, which leads inevitably to serious interference with respiration. But few cases of this condition have been recorded; it is possible, however, that it may be looked for at a period when other interstitial changes, notably keratitis, commonly develop.

Lesions of the Trachea and Bronchi.—The trachea is the seat, though much less frequently, of the three forms of syphilitic inflammation described as occurring in the larynx. Apart from superficial changes, well pronounced tracheitis and deep ulceration are relatively rare. The condition most commonly found is congestion, generally streaked or confined to certain areas, with moderate swelling of the mucous membrane. In two cases examined post mortem there were numerous small ulcers confined to the upper third of the trachea. Small granular hyperplasiæ existed in their vicinity. Ulceration and cicatrices have also been observed by Hüttenbrunner,[64] Woronchin,[65] and Sturges,[66] and a case of stenosis has been recorded by Steiner.[67]

Symptoms of Congenital Laryngeal Syphilis.—*Voice and Cry.* The cry in the infant and the voice in the older child exhibit all degrees of phonetic impairment, from slight huskiness to the toneless whisper of absolute aphonia. At first the cry has a shrill, piping tone, that has been compared by West and Zeissl to the sound of a child's toy trumpet. This sometimes degenerates into a peculiar squeak. Soon it assumes a characteristic vibratory twang, difficult to describe, but not unlike the vocal resonance which is heard just above the level of a pleuritic effusion. This is probably due to the sonorous vibrations of the thickened mucous membrane, which, at a stage when infiltration has not advanced to consolidation, is loose and admits of being thrown into exaggerated vibration by the current of expired air. Later the voice becomes harsh, cracked, and finally completely lost. It is surprising, however, to what extent the larynx may be involved without impairment of the voice.

Cough is frequently present, and is often a very distressing symptom. It is paroxysmal, suffocative, intermittent, raucous, and often followed by vomiting. The impairment of phonetic quality may be of diagnostic value in those cases in which corresponding changes in the voice are absent. The paroxysms may be excited by crying, or attempted deglutition, but are generally worse at night, leading to attacks of dyspnœa, which threaten suffocation. There is not much expectoration, except in the deep ulcerative form, when it is very profuse and muco-purulent, filling the larynx, and interfering with laryngoscopic examination. The amount of secretion may be taken as an approximate measure of the extent to which the destructive process has advanced.

Respiration is seriously embarrassed, the rhythm hurried, and often interrupted. Attacks of dyspnœa are brought on by coughing and suckling, and are worse at night, leading to orthopnœa, cyanosis, and convulsions. Sometimes the breathing has a *bronchial* sound, and is stridulous and stertorous, according to the amount of obstruction. The respiratory distress is, as a rule, commensurate with the amount of laryngeal stenosis; but secondary changes in the trachea, bronchi, and lungs are sometimes important factors in its production. It is also modified by the degree of nasal obstruction from coryza.

Deglutition is difficult, and sometimes painful and impossible. It is caused by pharyngo-laryngeal swelling and ulceration; but we may assume that, in some cases, it is due to lesions of the œsophagus itself. Laryngismus occurs quite frequently, and is sometimes the immediate cause of death. In a case reported by Thomas Barlow,[68] it was associated with disease of the meninges of the brain.

In many cases no definite relationship seems to exist between the laryngeal and cutaneous lesions of congenital syphilis. It is also an interesting fact that, while the external lesions yield readily to antisyphilitic medication, the laryngeal often have a tendency to persist. The larynx seems to be the last organ to surrender to therapeutic influence. Among the secondary complications in the lungs are congestion, atelectasis, emphysema, bronchitis, pleurisy, and pneumonia. The latter is often the immediate cause of death. But the condition which commands most serious attention is the sudden and fatal laryngeal œdema, which occurs without warning, and from which the patient dies before assistance can be obtained.

Diagnosis.—The laryngeal affection in its first stage may be mistaken for simple laryngitis, and when associated with chronic bronchial irritation or pulmonary inflammation may be confounded with tubercular laryngitis. But the greatest difficulty will arise in its discrimination from laryngeal growths. Here, if laryngoscopic examination be impossible, the diagnosis may be involved in doubt.

Rapid cicatrization of laryngeal ulceration under the iodide of potassium practically settles the question of syphilis; but the diagnosis can be made, in the majority of instances, without invoking this aid. When ulceration attacks the denser structures, the action of the iodide may be slow. Here, if nutrition be stimulated by tonic treatment, and especially by cod-liver oil, the processes of repair will be accelerated. But this obviously does not warrant the conclusion that the destruction is not syphilitic. The power of cod-liver oil over the phenomena of congenital syphilis is the same as that which it exercises in other wasting diseases, an influence which is often overlooked. The assumption, therefore, that an ulcer which heals under this drug, either alone or combined with the iodide of potassium, is necessarily scrofulous, diverts the mind from a rational interpretation of the case.

The *prognosis* will be influenced greatly by the age of the patient; the earlier the throat is attacked, the more serious the results. Pharyngo-laryngeal ulceration occurring within the first year is almost invariably fatal. Deep ulceration of the larynx, in view of its destructive tendency, offers a grave prognosis at any period. The prognosis in chronic superficial laryngitis is more favorable as regards life, though the tendency to laryngeal œdema and spasm should not be lost sight of. This form of laryngeal syphilis is exceedingly persistent and intolerant of treatment. It is often the *primum vivens* and the *ultimum moriens* of the disease. As Vidus Vidius said of syphilis, "it makes many truces, but never peace." In all forms of laryngeal syphilis, death may take place from acute œdema. The prognosis will depend, furthermore, upon the gravity of the general infection and the secondary complications in the lungs.

Treatment.—In acute laryngeal syphilis the treatment should consist in mercurial inunction over the thyroid cartilage, the inhalation of calomel or iodate of zinc in the form of vapor, and the internal administration of potassium iodide. The aggregate daily dose of the latter should be large, and the drug pushed rapidly to the verge of iodism. Should the dangerous symptoms not yield within forty-eight hours, the question of tracheotomy should be considered.

In the more chronic forms, mercury in tonic doses, combined with iodide of potassium, should be exhibited, the local treatment consisting in the use of topical applications and inhalations. As a topical application to the ulcers, great reliance may be placed upon iodoform, or the vapor of the iodate of zinc may be used.

The Effect of Certain Acute Morbid Processes upon the Throat Affections of Syphilis, Congenital and Acquired.—In a paper read before the American Laryngological Association in 1884,[69] I contributed some observations on the manifestations of congenital syphilis in the throat and their behavior under the influence of certain acute diseases, from which the following extract is taken:

In the paper on congenital throat syphilis to which reference has already been made in the preceding article,[70] the following conclusions were reached in regard to deep destructive ulceration of the oro-pharyngeal cavities:

1. That deep ulceration may invade the palate, pharynx, and naso-pharynx at any period of life from the first week up to the age of puberty. Thus, of thirty cases analyzed with reference to the period of invasion, fourteen occurred within the first year, and ten within the first six months of life, the remainder occurring at periods more or less advanced toward puberty. 2. When the eruption of inherited syphilis is apparently delayed until the latter period, that lesions of the palate and pharynx are found with a peculiar constancy, and often first attract attention to the existence of a diathesis of which they are the sole pathological expression. 3. That females are attacked more frequently than males. Thus, out of 69 cases of pharyngeal ulceration, 41 occurred in the former sex. 4. That ulceration may occur in any situation; but its most frequent seat is the palate, for which it exhibits the closest elective affinity. 5. That, when situated at the posterior portion of the hard palate, the tendency is to involve the soft palate and velum, and thence to invade the naso-pharynx and nose; while, situated more anteriorly, it seeks a more direct pathway to the latter, which is established by perforation of the bone. 6. That the next most common seats of ulceration in order of frequency are the fauces, naso-pharynx, posterior pharyngeal wall, nasal fossa and septum, tongue, and gums. 7. That ulceration, especially that of the palate, shows a disposition to centrality of position, together with a special tendency to caries and necrosis of the bone, a fact probably explicable by the great vascularity of the periosteum and medullary membrane in youth. 8. That the tendency to necrosis exists at all periods of life, but especially in early youth, when it is more destructive and less amenable to treatment. 9. That while deep pharyngeal ulceration generally precedes or co-exists with similar affections of the larynx, the latter occurs, too, without evidence of pre-existing pharyngeal lesions. 10. That simultaneous or consecutive ulceration of the palate, pharynx, and nose seems to be characteristic of syphilis, or at least occurs more frequently in this than in any other disease.

I bring these facts again into prominence because they differ from commonly accepted views, and because they possess at least a certain value by reason of the method by which they were obtained. I desire also to reiterate what was said in connection with the confusion of these lesions with so-called "scrofulous" ulceration. Without entering into a discussion of the subject, suffice it to say that there is no just ground for belief in an ulcerative scrofulide of the throat. It needs only the most superficial review of the writings of those who maintain its separate existence to show the utter confusion which prevails, as the result of erroneous views handed down among the traditions of an obsolete pathology.

It is obviously a point of great practical importance that this fact should be recognized, and especially in view of the rapidly destructive tendency of inherited syphilitic ulceration in the oro-pharyngeal cavities and larynx.

The throat ulceration of congenital syphilis not only exhibits a special tendency to rapid invasion of the deeper tissues; it often possesses an inherent virulence which places it apparently beyond the reach of therapeutic control. This is markedly true of the ulceration which occurs in the earlier years of life. Cases are now and then encountered in which the ulcers stubbornly refuse to cicatrize, or do so sluggishly and imperfectly, healing at one point and becoming simultaneously active at others. *Under such circumstances, when remedial measures are apparently of little or no avail, they sometimes cicatrize, as if by magic, on the accession of an acute disease.* It is to this that I wish to direct particular attention.

The clinical study of the cases upon the analysis of which the report referred to was based disclosed certain striking facts in connection with the influence of some of the ordinary infectious diseases of childhood upon the progress of the inherited syphilitic affection. From the historical narrative furnished by this particular group of cases, it would appear (1) *that, while congenital syphilis affords no absolute protection against certain acute infectious diseases, its existence in the individual seems often, other things being equal, to mitigate their severity and exert a favorable influence on their course;* (2) *that certain acute diseases, accompanied by an exanthem, favor the dissipation, at least temporarily, of the throat and other manifestations of the disease;* (3) *that while at no period of the disease is the child exempt from these affections, they are more liable to be contracted during the period of latency—that curious interval of apparent health in congenital syphilis which Cazenave has poetically called the sleep of the virus.*

These remarks are limited to scarlet fever, measles, and chicken-pox, but they could doubtless be extended to embrace others of the exanthemata.

They do not apply, for obvious reasons, in the case of excessive virulence of the syphilitic cachexia or malignant epidemic influence of the intercurrent disease.

Of special interest is the effect produced by acute febrile disease upon the throat lesions of congenital syphilis. *Chronic inflammatory conditions and ulceration of the larynx, pharynx, and nasal passages, are often influenced in a remarkable manner through the presence in the individual of an intercurrent febrile affection. This is, moreover, eminently true of those acute blood diseases with special tendency to local manifestations in the throat, such as scarlet fever, measles, diphtheria, etc. According to personal experience, scarlet fever and measles exert, as a rule, a favorable influence on the course of the throat affection, their supervention being of itself sufficient to cause its complete disappearance. The poisons of the two diseases in their circulation in these regions appear to be mutually destructive, and the throat escapes by virtue of such reciprocal antagonism.* The cure here may be permanent, or relapses of the inflammatory or ulcerative process may follow the removal of the antagonistic influence of the intercurrent disease.*

These remarks do not apply to diphtheria. When this affection supervenes during the existence of lesions in the throat, the patients rapidly succumb to the disease. The existence of syphilis in the child apparently increases the tendency to membranous formation; indeed, in some instances, apart from the presence of the diphtheritic process, there seems to be a *special tendency to fibrinous formation in the nose and retro-nasal space.*

The influence of acute disease upon the manifestations of constitutional syphilis is a subject which has received some attention at the hands of syphilographers, especially certain of the French school; but very little is known as yet beyond the empirical fact that the lesions of that disease, and especially the cutaneous syphilides, are often modified by the introduction into the blood of the virus of an intercurrent febrile affection. This modification may consist either in the permanent or temporary dissipation of existing syphilitic lesions, or in the exaggeration or intensification of the morbid process. Thus, for example, various syphilitic affections, such as skin eruptions, exostoses, etc., have been observed to disappear during the course of erysipelas,[71] acute rheumatism,[72] cholerine,[73] variola,[74] febrile furunculosis,[75] etc. Lasègue[76] has recorded a case of ulceration of the pharynx and tonsils which disappeared during an attack of erysipelas, while in a similar one observed by Martellière[77] a fatal result ensued from that disease. The dissipation of syphilitic eruptions has also occurred during pregnancy,[78] and as the result of vaccination,[79] and there is a case on record where the latter apparently exerted a curative influence in caries of the pharyngeal vault.[80]

* It is quite possible that this may also be true of other mucous surfaces of the body.

Larynx.

The remarkable power of erysipelas over the cutaneous syphilides has suggested its artificial production as a therapeutic agent in these affections,[81] while their behavior under the operation of the vaccine virus led to the now almost forgotten practice of Lukonski.[82] It has, finally, even been proposed by an enthusiastic pupil of M. Hardy to inoculate the poison of small-pox in cases of syphilis which have resisted all other methods of treatment.[83]

It is sufficiently evident, then, that a reciprocal antagonism exists between the poison of syphilis and that of a number of acute diseases. By what pathological law this is brought about is, in the present state of our knowledge of the mutual relations of disease, a matter of pure speculation.

This remarkable influence of the febrile state upon syphilitic inflammation and ulceration of the nasal passages and throat is also, in a measure, true of simple inflammatory conditions of these cavities. It were foreign to the purpose of the present article to elaborate this latter and cognate subject, and I shall, therefore, simply offer for consideration the fact that *simple catarrhal inflammation of these regions occasionally disappears completely, and is permanently cured during the course of an acute febrile disease.* Whether this occur as a phenomenon of so-called "substitution," or as the result of a profound impression made upon the nutrition of the parts by virtue of which abnormal secretion is arrested and the inflamed tract placed in a condition favorable to resolution, can only be determined by the accumulation of more exact scientific data concerning the reciprocal antagonism of pathological processes.

Without, then, attempting any special explanation or generalization, I present the foregoing observations from my clinical experience as a contribution to the study of an interesting but imperfectly understood subject.

John Noland Mackenzie.

[1] For a full statement of this argument, see Lancereaux's treatise on Syphilis. New Syd. Soc. Trans., 1868, vol. i., pp. 8 to 10. Quotations taken from Captain Dabry's book, La Médecine chez les Chinois, Paris, 1863, and from Hessler's translation of the Ayur Veda.

[2] See Lancereaux. [3] Epid. 6, sec. 1. [4] Isag., cap. 20.

[5] De causis acut. morborum, lib. i., cap. viii.

[6] De Chron. Morb., lib. ii., cap. 4; lib. iii., cap. 2.

[7] De Compositionibus Medicamentorum, comp. vii.

[8] See especially Martial, I., 66, 79; VI., 41; IV., 41; XI., 30; VI., 55; XI., 92, 61; VII., 33, etc. [9] Observ. Miscellan., Leid., 1745. def. p. 28.

[10] Die Geschichte der Lustseuche im Alterthume, Halle, 1845.

[11] Orationes ex recensione. Lipsiæ, 1784, vol. ii., orat. 33. See also Rosenbaum, op. cit., p. 158. [12] Lib. I., 78. [13] Lib. IV., 41.

[14] Sulpicius Lupercus Servastus, Junior, in Anthologia veterum latinorum Epigrammatorum et poëtarum, Lib. I., p. 515, *et seq.*, Ed. Burmann, Amstelodami, 1759.

[15] See Nic. Leonicini, De Epidemia, etc., in Aphrodisiac. sive de lue venerea, ab Aloysio Luisino, Lugd. Bat., 1728; Nic. Massa, De morbo gallico, cap. vii., et quarti tract., cap. iv. (Aphr., pp. 46 and 96–97); Jacob. Cataneus, De morb. gall., cap. iv. (Aphr., p. 148); Pet. Maynardi, De morb. gall. tract., i., c. 4, Fernelius, De lue venerea caput (Aphr., pp. 613–614); Victorius, de morb. gall., liber, cap. iii., alludes to flattening of nose and caries of nasal bones, ozœna, polypus (hypertrophic catarrh), etc.; Marchelli, De morb. gall. tract. (Aphr., p. 732); Fallopius, De morb. gall. tract., cap. xxiii. (Aphr., p. 781), and cap. xciii. (p. 824); Botallus, Luis venereæ curandæ ratio, cap. iv.; Tomitanus (B.), De morb. gall., lib. i., cap. xxviii. (p. 1047), also lib. ii., cap. i. (p. 1053); Sylvius, De morb. gall. tract. (p. 1109); Paschal, De morb. gall. tract. (p. 1113); Borgarutius, De morb. gall. methodus, cap. vii. p. 1129), *et al.* See also Benevenius (Antonius), De morb. gall. tractatus, in his work De abditis nonnullis ac mirandis morborum et sanationum causis, Florent., 1507; this work is the first essay on pathological anatomy (Library Surgeon-General's Office, Washington).

[16] Hieronymi Frascatorii, Veronensis, Syphilis, sive Morbi gallici, lib. iii., lib. i. (Aphr., p. 187), B. and lib. ii. (Aphr., pp. 191–192), C. (A.D. 1555); see also Frascator, De Syphilide, seu Morb. gall. lucubratio, cap. i. (Aphr., p. 199).

[17] De morbo gallico, lib. ii., cap. xxii. (Aph., pp. 1222 and 1223), and lib. vii., cap. viii. and cap. xix. [18] Loc. cit.

[19] This case is recorded in the Collegium Anatomicum of Severinus, from which it is taken by Bonetus (Sepulchretum, Ludg., 1700, tom. i., p. 766).

[20] See Astruc., De lue venerea, tom. ii., p. 921: Van Swieten, Comm. in Aphor.; Boerhaave, § 1445; and Lieutaud, Hist. Med., tom. ii., lib. iv., obs. 105, Parisiis, 1777; also Lieutaud, Synopsis of Pract. of Med., ed Atlee. Phila., 1816, p. 97.

[21] Diss. inaug. de voce, ejusque affectibus, cap. ii., p. 52, Jenæ, 1678.

[22] De pudendorum morbis., sec. 2, 12, p. 182; 9, 10, 13, p. 183, and 14, p. 184, Lugd. Bat., 1722.

[23] Aphorism. de cognos., et. curand. morbis., § 1445, Lugd. Bat., 1728; also Tract. de lue venerea, Lugd. Bat., 1751.

[24] De morb. ven. libri sex, etc., II., cap. ii., cap. vii., IV., cap. iv. and cap. viii. and xi., § xii. Parisiis, 1736, 1738, and 1755. See also Lond. ed. of 1754, pp. 124 to 159 of Bk. ii., and pp. 9–14, 15, 89–90 of Bk. iv.

[25] Joseph Jacob Plenck: Doctrina de morbis venereis, pp. 93, 94, 97, 99, 100, 143, 147, and 149–151. Viennæ, 1779. This writer seems to have been personally familiar with syphilitic affections of the œsophagus and cicatricial stricture of the pharynx.

[26] A Treatise on Gonorrhœa Virulenta and Lues Venerea, vol. ii., pp. 37 and 43. Dublin, 1793.

[27] Treatise on the Ven. Dis., pt. vi., chap. ii., p. 262, *et seq.* (in Works, with notes by Babington, Phila., 1839). See also Babington's excellent observations, pp. 266 to 268.

[28] Complete Treatise on the Symptoms, Effects, etc., of Syphilis, Phila. ed., 1815, p. 293. Swediaur also alludes to affections of the ear (tinnitus) from compression and corrosion of the Eustachian tubes, p. 294.

[29] De sedibus et causis morborum, Epist. xliv., cap. xv., Lond. ed., 1769.

[30] Traité de la phthisie pulmonaire, par M. Raulin, pp. 13 and 79. Paris, 1784.

[31] J. N. Thomann's Annalen der klinischen Anstalt in dem Julius Hospitale zu Würzburg f. das Jahr 1800, p. 242, Würzb., 1803; see also case in Hufeland's Bibliothek der prakt. Heilkunde, Bd. ii., St. ii., S. 143.

[32] Beobachtungen über die Natur u. Heilung der Syphilis. Russische Sammlung f. Naturwissenschaft u. Heilkunst, I. Bd., St. ii., 2ter Abschnitt, S. 36. Riga u. Leipzig, 1816.

[33] The principal of these are the following: Before the era of pathological anatomy, Richard Morton, Phthisiologia, seu exercitationes de Phthisi, Londini, 1689; after the time of Morgagni, Petit (M. A.), Diss. de Phthisi Laryngea, Monspelii, 1790, October 25th (copies of both these rare tracts may be found in the library of the Surgeon-General's Office); Sauvée, Recherches sur la phthisie laryngée, Paris, 1802; Schönbach, De phthisi laryngea, Wilmæ, 1808; Jos. Sigaud, Recherches sur la phthisie laryngée, Strasburg, 1819; Wm. Sachse, Beiträge zur genaueren Kenntniss u. Unterscheidung der Kehlkopfs- u. Luftröhren-Schwindsucht. Hannover, 1821; Barth, Mém. sur les ulcerations des voies aériennes, Arch. gén. de Méd., 1839, p. 137, et folg.

[34] A Practical Treatise on Laryngeal Phthisis, Chronic Laryngitis, and Diseases of the Voice, trans. fr. the French. Philadelphia, 1839.

[35] Allg. Wiener med. Zeitung, No. 48, 1861; No. 43, 1866; also Klinik der Krankheiten des Kehlkopfes, etc. Wien, 1866.

[36] American Jour. of Med. Sc., January, 1876, also Tonic Treatment of Syphilis, New York, 1876.

[37] See Colson, Journal Hebdom., 1831, p. 36; also Crampton (Trans. Dublin Coll. of Phys., vol. iv., p. 91), where two grains of calomel caused ulceration of the throat and death, and Devergie (Archives gén de méd., tom. ix., p. 468), gangrene of the throat and death; also a case (Broadbent, Mem. of Lond. Med. Soc., vol. v., p. 112) where globules of mercury were found upon the laryngeal cartilages after death.

[38] Die Behandlung der Syphilis mit Sublimat-Injectionen, Berlin, 1869; Ziemssen's Encyclop., Am. ed., vol. vii., p. 862, New York, 1876.

[39] Op. cit., p. 377.

[40] Lectures on Syphilis of the Larynx. London, 1879.

[41] Diseases of Throat and Nose, vol. i., p. 356. London, 1880.

[42] Browicz: Centralblatt f. die Med. Wissenschaft, 1877, s. 346.

[43] Syphilitic Membranoid Occlusion of the Rima Glottidis, New York, 1874. [44] Klinik der Krankheiten des Kehlkopfes, 1866, S. 413.

[45] Path. Anat., Bd. iii., p. 22.

[46] Stoerck: Klinik der Krankheiten des Kehlkopfes, etc., Stuttgart, 1880, s. 282. Major: Trans. Am. Laryng. Assoc., 1883, p. 163.

[47] Zurhelle: Berliner klin. Woch., 1872, No. 35. Wilks: Guy's Hosp. Rep., ix., 1863. [48] Wiener med. Jahrbücher, 1881, I. Heft, p. 75, et seq.

[49] L'Union Médicale, 1859, No. 21.

[50] Deutsch. Arch. f. klin. Med., 1879, S. 608.

[51] London Lancet, vol. i., pp. 905–906, 1882.

[52] Reference omitted after electrotype plate had been made.—Editor.

[53] Diseases of the Throat and Nose, vol. i., p. 531. London, 1880.

[54] Seidel: Jenaer Zeitschr. f. Med., 1866, S. 489. Canstatt, 1866, S. 497.

[55] Rokitansky: Patholog. Anatomie, Bd. iii., p. 22. Wilks: Trans. Path. Soc., vol. xvi., p. 52.

[56] Gerhardt: Arch. f. klin. Med., vol. ii., p. 541. Kelly: Trans. Path. Soc., vol. xxiii., p. 45.

[57] Wallmann: Virchow's Archiv, Bd. xiv., p. 201.

[58] Beger, loc. cit., and Axel Key and Oscar Sandhal, cit. in Schmidt's Jahrbuch., 1870, 147, p. 48.

[59] Congenital Syphilis of the Throat; based on the Study of One Hundred and Fifty Cases.

[60] Syphilis des Nouveaux-nés. New Syd. Trans., p. 64–65.

[61] Der Kehlkopfspiegel. New Syd. Trans., 1861, p. 53.

[62] Klinik, etc., Wien, 1867, 161 Fall, and Atlas, xxii., 4.

[63] Gaz. des Hôp., 1860, No. 51, p. 202.

[64] Jahrbuch für Kinderheilkunde, Bd. v., 1872, p. 338.

[65] Ibid., Bd. viii., 1875, p. 108.

[66] Vide Lond. Lancet, April 10, 1880, p. 566.

[67] Jahrb. f. Kinderheilkunde, Bd. vii., 1865, ii., § 64.

[68] Trans. Path. Soc., London, vol. xxviii., 1876–1877, p. 287.

[69] A Contribution to the Study of Congenital Syphilis, Trans. Am. Laryng. Assoc., 1884, and N. Y. Medical Journal, May 31, 1884.

[70] See article on Congenital Syphilis of the Larynx.

[71] Vide Cazenave and Schedel, Practical Synopsis of Cutan. Dis., etc., p. 353, Phila., 1829; Rayer, Traité des mal. de la peau, Paris, 1835; Lamarche, De l'érysipèle salutaire, Thêse de Paris, 1856, and the excellent articles of Mauriac, Étude clinique sur l'influence d'érysipelas dans la syphilis, Paris, 1873; published also in the Gaz. des Hôpitaux. Nouv. sér., 1873, pp. 305, 321, 346, 385, 410, 443, 466, 506, 546, 569, 594, 601. See also Bidenkap's case (cited by Bäumler, von Ziemssen's Cyclopædia, Am. ed., vol. iii., p. 98, 1875).

[72] Rayer, op. cit., p. 546 (Mauriac); see also Jourjon, Infl. des mal. aiguës sur quelques manifestations cutan. de la syph., Thèse de Paris, 1870. [73] Cazenave: Traité des syphilides, p. 593 (Mauriac).

[74] Gore: Lancet, September 2, 1858.

[75] Diday (quoted by Mauriac, l. c.).

[76] Traité des angines, pp. 110–112.

[77] Sur l'angine syphilitique (cited by Mauriac)

[78] Gilbert: Bull. de l'acad. de méd., 1851, tom. xvii., p. 156.

[79] Vide Revue méd., 1861, tom. i., p. 157, Jeltzinzki.
[80] Jeltzinzki, l. c. : Sur la cure radicale de la syphilis par la vaccination.
[81] Sabatier : Propositions sur l'érysipele considéré principalement comme moyen curatif dans les mal. cutanees, etc., Thése de Paris, 1831.
[82] Jeltzinzki, l. c.
[83] Garrigue : De l'influence des mal. aig. sur les diathèses, Thèse de Paris, 1870.

LAS VEGAS HOT SPRINGS. *Location and Post-office*, Las Vegas Hot Springs, San Miguel County, New Mexico Territory.

ACCESS.—By the Hot Springs Branch of the Atchison, Topeka & Santa Fé Railroad from the town of Las Vegas.

ANALYSIS (Professor J. T. Lovewell).—Water collected and temperature taken January 13, 1882.

The quantity of magnesium carbonate in most of these waters is very small, with indications of a small quantity of potassium and traces of lithium. Carbonic acid is probably in the bubbles arising from most of these springs.

No. of Spring.	Temperatures, Fahr.	Parts of Solid Constituents contained in 100,000 Parts of Water.					
		Sodium chloride.	Sodium sulphate.	Sodium carbonate.	Calcium carbonate.	Silicic acid.	Total solid residue.
2	105.5	27.36	16.82	5.02	4.03	9.97	65.53
3	120	27.38	15.72	3.04	2.01	4.41	54.06
4	92	23.41	14.62	2.55	4.02	7.20	58.33
5	140	28.54	16.96	2.10	3.03	8.88	57.90
6	140	27.86	16.86	3.30	2.00	6.03	56.20
6½	140	28.02	17.98	1.24	1.05	6.60	55.63
7	71	28.63	17.86	2.01	3.02	6.03	55.80
8 and 9	114	27.86	10.80	1.54	2.01	?	54.60
10	117	27.70	15.15	3.20	2.05	5.45	56.40
11 with 10 and 12	124	26.04	17.86	1.52	1.18	6.10	54.83
12	112	26.03	15.70	3.14	5.26	6.80	56.46
13	136	28.03	17.72	1.50	3.01	6.16	57.00
14	92	28.85	18.00	1.03	1.24	6.93	55.40
15	82	27.30	18.61	1.00	1.16	?	55.90
16	112.5	27.36	19.86	2.01	1.05	7.26	57.73
17	112.5	27.86	17.22	0.98	1.06	5.33	53.00
18	96	26.63	17.54	1.08	1.00	?	56.16
19*	....	....	....	....	....	....	....
22 with 20	106	26.87	11.54	1.23	1.55	6.20	54.56
21	86	28.19	14.10	1.16	1.10	?	56.95
22	75	27.36	17.32	1.15	1.08	6.63	57.00
23	123	28.19	12.50	2.33	3.01	6.20	60.20
Cold Sulphur †	....	33.01	18.14	11.20	38.52	1.20	102.06

* Spring overflowed at time of collecting water.
† Sulphuretted hydrogen gas.

THERAPEUTIC PROPERTIES.—The high temperature and mineral ingredients of these springs, together with the excellent accommodations and healthful location, have rapidly brought them into favorable notice as efficient agents in the treatment—by way of baths—of rheumatism, gout, blood-poisoning, cutaneous diseases, nervous exhaustion and its many attendant ills.

These springs are situated at the entrance of the Gallinas Cañon, among the foot-hills, at an elevation of sixty-seven hundred feet above the sea-level. The atmosphere is very dry.

The springs, forty in number, are divided into two classes as to temperature : Those ranging from 120° F. to 140° F., thirty in number, and those ranging from 75° F. to 100° F., ten in number. The water from the first class, of which No. 6 furnishes 30,000 gallons per day, at a temperature of 140° F., is conducted to the bath-house direct, while the water from the other class is collected in tanks to furnish cold water as required. There are two bath-houses, one for water-baths of all descriptions, and the other for mud-baths. There are two hotels built of stone, the "Las Vegas Hot Springs," replacing the Montezuma, destroyed by fire in 1884, contains three hundred rooms, and the "Hot Springs Hotel," lately refurnished, having a capacity for one hundred guests. Both are excellent hostelries. *G. B. F.*

LATERAL CURVATURE OF THE SPINE. SYN. : Scoliosis ; Fr., *Déviation Latérale du Rachis ;* Ger., *Seitliche Rückgratsverkrümmung.* A deformity characterized by a lateral deviation of a portion of the spinal column, accompanied by an apparent rotation of the vertebræ, and, when occurring in the dorsal region, by a displacement, of greater or less extent, of the corresponding ribs. There may be one curve or several, but when multiple one curve is usually primary, the others being compensatory and occasioned in part by the unconscious effort of the patient to maintain an erect posture. The most frequent seat of the primary deformity is in the dorsal region, and the convexity of the curve is usually directed toward the right. The lumbar region is affected primarily in a much smaller proportion of cases. In this situation there is no rule as to the direction of the curve, the convexity looking to the right and to the left in about an equal proportion of cases. Kölliker, of Leipzig, found in a study of 721 cases of true lateral curvature (*Centralblatt f. Chirurgie*, No. 21, 1886), 466 single curves, of which 391 were in the dorsal region ; and of these 208 were with convexity to the right, and 183 to the left. Of 222 double curvatures, 172 were of convexity to the right in the dorsal region and to the left in the lumbar.

Writers usually recognize three degrees or stages of scoliosis, which classification may be retained as affording a convenient ground upon which to base the prognosis. In the first stage the spine becomes straight upon the patient assuming the prone position ; in the second, the curve does not disappear when the subject lies down, but may be nearly or entirely overcome upon suspension of the patient, combined with properly directed pressure by the hands of the surgeon ; in the third degree but little or no correction of the deformity is obtainable by these manœuvres.

Lateral curvature is pre-eminently a disease of early adolescence, though it may be met with at any age from early infancy to middle adult life. It is developed most commonly between the ages of eight and fifteen—at least it is at that time that it usually comes under the eye of the surgeon, though, as the affection is so insidious in its growth and may exist for so long a time before giving rise to any notable deformity of the shoulder—the sign that is usually the first to attract the attention of the mother—the date of its commencement may be put somewhat earlier. Ketch, of New York, has collected the statistics of 229 cases treated at the New York Orthopædic Dispensary (New York *Medical Record*, April 24, 1886). The cases selected were only those where the typical symptom of rotation was present. They were divided into three classes : 1, those in which the deformity was first observed from birth to the twelfth year, or the age of childhood ; 2, those in which the deformity was first observed from the twelfth to the eighteenth year, or the age of puberty ; 3, those where the deformity was first observed from the eighteenth year and upward, or the age of complete development. During the first period there were 120 cases (52.4 per cent.) ; during the second, 94 cases (41 per cent.); during the third, 9 cases (3.9 per cent.). In 6 cases the age was not stated. Of 1,000 cases collected by Eulenburg 78 were first noticed between birth and the sixth year, 216 between the sixth and seventh year, 564 between the seventh and tenth, 107 between the tenth and fourteenth, and 35 over the fourteenth. Of 500 cases of rachitic curvature 454 occurred during the first three years of life.

Girls are affected more frequently than boys in the proportion of between four and five to one. Ketch found the proportion 189 females to 40 males, and Kölliker 577 females to 144 males. The latter noticed the curious fact that in the more severe forms of the curvature the number of males approached that of females, and in the worst cases, triple curvature of the third degree, there were even more males than females affected. Although in ordinary acquired scoliosis the direction of the primary curve, when in the dorsal region, is to the right in a very large percentage of all the cases, the contrary obtains, in the writer's experience, in infantile curvatures, where the convexity points almost invariably to the left.

The predisposing cause of lateral curvature lies, in a large proportion of cases, in a weakness of the muscles and ligaments concerned in maintaining the spinal column

in an erect position. The deformity not infrequently begins during convalescence from some acute illness, usually one of the diseases incidental to childhood, or, it may be, pneumonia or typhoid fever. M. Desprès (*L'Union Médicale*, No. 54, 1883) has recorded an instance of scoliosis developing during convalescence from the latter disease, and the writer has notes of a somewhat similar case. The muscular weakness may be due to any other causes which induce a general debility, such as a constitutional vice, rapid growth, rachitis or other disorders of nutrition. When tight stays are worn the spinal muscles lose their tone and become pale and flabby, and a predisposition to lateral curvature is thus established. The deformity may even arise in those who through indolence sit constantly lolling to one side, although there may be no actual muscular debility. It not infrequently happens that several members of the same family are afflicted with lateral curvature, and in many cases heredity seems to play a prominent part in the etiology of the affection. But it is only the predisposition to the deformity, a constitutional debility, that is inherited, and not the actual deformity itself.

The exciting causes of scoliosis are numerous and varied. Any influence which acts in such a way as to produce a lateral flexion of the vertebral column may, if frequently repeated for a long period of time, give rise to a permanent curve. The mere weight of the head and upper extremities is sufficient to produce a curvature in many cases where there is pre-existing muscular debility. There is normally (at least its existence has been determined in such a large proportion of healthy individuals in whom an examination to this end has been made, that it may be justly termed normal) a slight lateral deviation of the spine to the right in the dorsal region. It is this normal deflection that determines the direction taken by the pathological curve when induced by gravity. It embraces the third, fourth, and fifth, and sometimes one or two more, dorsal vertebræ. It has been explained variously by different writers, but by none in a very satisfactory manner. Some regard it as a consequence of the presence of the aorta at this point, while others look upon it as a result of the more frequent use of the right arm. It certainly is not congenital. Bouvier, who made a very careful study of this physiological curve in a large number of individuals of both sexes and all ages, states that it does not exist prior to the seventh year. It is first noticed at about that age, but for several years its direction seems to be a matter of uncertainty, for he says that, in subjects between eight and sixteen years of age, he found it nearly as frequently directed to the left as to the right. About this time, however, its direction becomes established to the right, and it then increases very gradually with advancing years. The fact of the absence, or the uncertainty in direction, of this physiological curve in early life seems, as suggested by Malgaigne, to have a bearing upon the greater relative frequency of left dorsal curvatures in young children. Possibly, also, the position in which an infant is held or carried by its nurse may determine the direction of the pathological curve in certain cases, in which it becomes established before the child has begun to sit up, though such instances might perhaps be more properly regarded as congenital.

In some few cases it is fair to hold the unnatural attitudes, forced upon children by reason of the faulty construction of the school furniture, accountable for the production of the deformity; but more frequently the awkward position, for which the poor girl is so often chided and punished, is not the cause, but rather a symptom, of the already existing curvature. A difference in the weight habitually borne by the two upper extremities is a not infrequent cause in the production of lateral curvature. The direction of the curve thus produced is determined, not only by the side upon which the extra weight is borne, but also by the degree of power existing in the spinal muscles. When a strong, healthy porter carries a heavy weight on one shoulder, the spinal muscles of the other side contract and bend the spine laterally, so as to furnish a greater support to the weighted shoulder; but when the spinal muscles have lost their power from any cause, they are unable to act as stays, the shoulder sinks under the load, and the spinal column is bowed out to the other side. The same thing is seen in nurses who carry their charges habitually on one or the other arm. A very slight disproportion in the weight borne by the two upper extremities, if of long continuance, may end in the production of lateral curvature. Dubreuil mentions a case in which the deformity followed upon disarticulation of one arm at the shoulder-joint, and the writer has seen one in which the curvature was attributed to the weight of a plaster splint applied for fracture of the arm. In the latter case the patient was a weakly child, and the convexity of the curve was directed away from the side upon which the additional weight was carried. Inequality in the length of the lower extremities, either congenital or acquired, may in time lead to the establishment of a permanent scoliosis. When due to this cause, the primary curve is always in the lumbar or dorso-lumbar region, and its convexity is always toward the side upon which is the shortened limb. True, permanent, so-called rotatory, lateral curvature is but seldom produced as a result of the tilted pelvis from a shortened limb, but that it may, and does, in certain cases, arise from this cause there can, in the writer's mind, be no question of doubt. This point will be explained more fully when considering the pathology of the affection. Another cause of lateral curvature is to be seen in the retraction of the thorax following upon pleurisy—the *narbige Scoliose* of Hueter. This author doubts whether the deformity can arise from the contractions following pleuritic inflammation unless it have been suppurative in character. Other forms of "cicatricial scoliosis" may occur from integumentary contractions after a severe burn, or even, it has been asserted, from the healing of a large pulmonary cavity. The deformity may follow infantile paralysis, affecting the spinal muscles of one side. When this disease attacks the muscles of one leg, it may be indirectly a cause of scoliosis by reason of the atrophy and arrested growth of the affected member. Lastly, rachitis is accountable, directly or indirectly, for a certain number of cases of lateral curvature. There may be a rachitic softening of several contiguous vertebral bodies, or ossification may proceed irregularly, taking place only on one side. Again, in rickets the muscles are often weak and the ligaments lax, and if this condition obtains in the soft parts concerned in maintaining the vertebral column erect, gravity or other causes may readily produce a lateral deviation of the spine. Rachitic deformity in one leg—unilateral knock-knee, for example—may cause a tilting of the pelvis and thus give rise to a curvature in the lumbar region, though, as stated above, such curve is seldom a permanent one, or at most is usually not more than a curvature of the first degree.

The pathology of lateral curvature may perhaps be best studied by considering the various steps in the gradual development of the deformity. As stated above, there is normally a slight curve to the right in the mid-dorsal region. Ordinarily, owing to the firm support afforded to the spine in this region by the muscles and ligaments, as well as by the chest-walls, no marked increase takes place in the curve. Bouvier states that it does grow very slowly larger with advancing years, but its progress is so gradual that it never produces any noticeable deformity, if the individual remain otherwise healthy, but exists only as a constant menace, ready to act whenever circumstances arise favorable to its increase. But if, from any cause, the muscles lose their tone, the efficient support is withdrawn from the spine, and gravity is allowed to act without restraint. As it is exerting a continuous force during the whole time of the patient's waking hours, the inevitable result is an increase of the dorsal deflection. Even at night the evil influences are still active, if the patient sleeps, as she commonly does, because that is the easiest position, on the side of the convexity, with the head raised on pillows so as to favor an increase in the curvature.

The intervertebral discs are the first to yield on the concave side, the curve is thereby slightly increased, and now gravity acts at greater advantage. Still greater

pressure is exerted on the side of the concavity, the vertebral bodies, being elastic, yield a little in this direction, and by so doing squeeze out some of the blood upon which their nutrition depends. The muscles on the convex side of the curve, working as they do, at a constantly increasing disadvantage, offer but slight resistance to the progressive deformity; the ligaments, already weakened, and even in health acting only as stays to check undue lateral flexion, readily yield, and become elongated over the convexity of the curve. The intervertebral discs soon become thinned on the side exposed to pressure, and, in advanced curvatures, may be entirely absorbed. The pulpy centre is meanwhile pushed over toward the side of convexity, where pressure is least. The vertebræ themselves are not slow to follow the discs in undergoing atrophic changes. Pressure and the consequent diminution in blood-supply combine to repress the growth of the concave halves, while, on the other hand, the parts on the side of convexity, being free from pressure, follow the rule in such cases and take on increased growth. In time, the intervertebral discs having entirely disappeared on the inner side of the curve, the bodies rest directly one upon the other, and, finally, synostosis occurs. The articular processes on this side likewise become welded together. When anchylosis has thus taken place, a cure of the lateral curvature becomes impossible. The different segments of the spine have become forged together into a single bone in this portion, and no force which we can employ is able to bend the bar straight.

In the meantime, changes induced by the altered condition of affairs are taking place in the muscles and ligaments. The spinal muscles on the inner side of the curve are in a state of relaxation, and their antagonists being, from the nature of the case, unable to act upon them so as to excite them to the activity necessary for their preservation, they undergo fatty changes, and finally degenerate into fibrous cords incapable of extension. An additional factor, if one were needed, is thus added to the bony anchylosis to render any correction of the deformity impossible. The muscles lying over the convexity of the curve are elongated, and become also in time the seat of fatty degeneration.

These are briefly the most important changes which take place in the bones, muscles, and ligaments of the vertebral column in a case of steadily progressing lateral curvature uncontrolled by treatment. Of course, every case is peculiar to itself in both the persistence and the rapidity of its growth. Even when left to itself every scoliosis will not progress to the extreme degree here presented, but may, under certain circumstances and from various causes, explainable or unexplainable, become arrested at any period of its development. We accordingly meet with, in practice, curvatures, even of many years' standing, of varying degrees, from that which may be regarded merely as a slight exaggeration of the physiological deviation, to a condition in which the whole spine, from the atlas to the sacrum, is so twisted and distorted that it seems a marvel how the viscera of the thorax and abdomen can find room in which to perform their delicate functions necessary to the life of the individual. These changes, which take place in the several parts of the vertebral column are, of course, the same whatever may be the mode of development of the curvature, whether from gravity acting against the weakened muscles, from direct muscular action, as in infantile paralysis, or from inequality in the length of the lower extremities.

The tendency of scoliosis is almost always to increase, though sometimes, as just stated, its progress may, through a favorable conjunction of circumstances, become arrested. The rapidity of its growth is, however, very variable, depending in great measure upon its causation. When the exciting cause is intermittent and exerted only for a comparatively short period of time in the twenty-four hours, it may take years before a permanent curvature, accompanied by changes in the bones and intervertebral disks, is established. In other cases, great and incurable deformity may be produced in an incredibly short period of time. This occurs when the exciting cause is at work constantly, day and night, whatever the position of the patient may be, whether standing, sitting, or reclining, as is exemplified in the curvature due to infantile paralysis.

It has been denied that a true lateral curvature of the second or third degree can be caused by a shortened limb, or, what amounts practically to the same thing, a fixed habit of standing with the weight thrown upon one leg, in French *se hancher*. It is true, the action is here intermittent and exerted only while the patient stands or walks, for, of course, in sitting the pelvis rests on an even plane and the lumbar curve redresses itself. But if we consider the mode of origin of knock-knee, when uncomplicated with rickets and due to functional weakness of the muscles and ligaments, we must admit the probability, to say the least, of like causes producing like effects upon the bones of the spinal column. Statical knock-knee is produced by the weight of the body, in standing or walking, acting upon the weakened stays of the knee-joint. At first the internal lateral and the crucial ligaments yield a little, and the knee is in-deviated while the weight of the body rests upon it; but as soon as the weight is removed from the limb the knee resumes its normal line. Before long, however, the frequently repeated, though intermittent pressing together of the outer joint-surfaces causes absorption, while the relief of the normal pressure upon the inner condyle and tibial facet, in all probability gives occasion to an increased growth of these parts. Now, the plane of the opposed articular surfaces is altered, and a spontaneous reduction of the deformity upon removal of the exciting cause does not take place. This is exactly the way in which a permanent lumbar curvature arises when due to a tilted pelvis. It is not formed all at once, but little by little the bones and disks give way under the frequently repeated pressure, they undergo the changes in form described above, and in time neither the negative action of recumbency nor the positive forces of traction and pressure are able to restore the spine to its normal shape.

From what we have seen of the manner of development of the primary curve in scoliosis, it follows that precisely the same changes occur in the secondary or compensatory curves. When the primary deviation is in the dorsal region there are usually two compensatory curvatures, one above and one below, with convexity directed to the side opposite to that toward which the primary curve looks. Cases have been described in which the spine was flexed laterally throughout its entire extent, forming but one gentle curve—the **C**-shaped curvature—but they are of extremely rare occurrence. The usual form is the multiple, **S**-shaped, or, more properly, sigmoid scoliosis. The primary curve is the largest and most advanced, the compensation being supplied by two smaller curves. The latter, in slight cases, may hardly pass beyond the median line, and may be ignored in the treatment, being considered rather as a return to the normal direction than as true curves. When there are but two curvatures they are usually nearly equal in degree, so that sometimes it is difficult to determine which is the primary one. If compensation be perfect, a plumb-line let fall from the external occipital protuberance will rest in the rima clunium, but it not infrequently happens that the secondary curve is too shallow to equal the deviation formed by the original curvature, and in such case the head falls outside of the median vertical plane of the body, and the scoliosis is called oblique.

There still remains to be considered one most peculiar condition found in permanent curvatures, namely, the so-called rotation. In looking at a specimen of a scoliosed spine, we see that the line of the bodies forms a much deeper curve than that of the spinous processes. The vertebræ involved in the curvature appear to be rotated about a vertical axis, the bodies pointing in the direction of the convexity, while the spines are inclined to the side of the concavity. Various ingenious theories have been advanced to account for this rotation. It has been referred to the result of muscular action by those who favor the muscular theory of the development of scoliosis, the rotation being affected by the various bun-

dles of the multifidus spinæ, lying upon the inner side of the curve, whose action is to approximate the spinous and transverse processes of the contiguous vertebræ. Again, it is said that the posterior portion of the vertebral segments being fixed by the muscular and articular attachments here situated, while the bodies are more free, the rotation is effected by mechanical causes; the anterior portions of the vertebræ being the thicker, when lateral flexion occurs they are forced over to the convex side where pressure is least. It is difficult, however, to account for rotation to any such extreme degree as seems to exist in the more advanced stages of scoliosis by any of the theories hitherto advanced, most of which rest on the idea of a rotation of the vertebra as a whole, and ignore the fact that the individual segments of the spinal column are themselves deformed and twisted. That there is some temporary rotation, especially in the earlier stages, may be true; but this is not all, and the true explanation of the spiral shape which the spinal column assumes is to be looked for in the changes occurring in the separate vertebræ, rather than in a shifting of position of one upon the other.

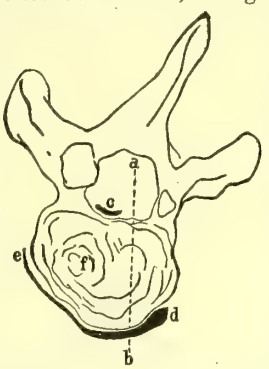

FIG. 2060.—Schematic. Showing the Changes in a Single Vertebral Segment, caused by Unequal Pressure. (Nicoladoni.).

"Rotation" does not occur immediately upon the inception of a lateral spinal flexion, as it ought to do were it produced mechanically, but its development requires time, and often a very considerable time. A symptomatic lumbar curvature, produced by unequal length of the lower extremities, may exist for months or years before it becomes "rotary" or permanent. We have seen that its permanence is owing to the altered shape of the vertebræ involved, and the torsion is due to the same cause. Hueter recognized this vertebral deformity, and endeavored to show that upon it depended the apparent rotation. He looked upon the unequal development of the lateral halves of the vertebral segments, when occurring in the dorsal region, as the cause rather than the consequence of lateral curvature. (Glisson had enunciated very similar views two centuries before.) "Scoliosis," says Hueter, "is a general disease of the dorsal spine and thorax, evidenced by asymmetrical forms of all the parts of the skeleton on the concave and convex sides of the curvature." Engel (*Wiener Medizinische Wochenschrift*, Nos. 62–64, 1868) likewise believed that the unequal development of the two halves of one or more vertebral bodies gives the first impulse to a lateral curvature. This asymmetry of the two vertebral halves has been more recently demonstrated by Nicoladoni, who endeavors to prove from a study of a scoliosed spine, from which the ligaments and diaphragmatic attachments have not been removed, that the convexity of the curve is not occupied by the centres of the vertebral bodies, but by an overgrowth of their outer sides. The turning of the spinous processes to the inner side of the curvature is explained by him in the same manner, since by the abnormal growth of the bodies on the side of convexity the corresponding pedicles and laminæ are forced backward, and the spines are pushed over to the side of concavity. Fig. 2060 represents a vertebra removed from near the apex of the curvature; *c* is the posterior longitudinal ligament; *e*, *d*, the anterior ligament; *f*, the pulpy portion of the intervertebral disk pushed over to the convex side; *ab*, is the line assumed to represent the original centre of the vertebral body. Adolf Lorenz (*Wiener Medizinische Wochenschrift*, Nos. 1, 2, 3, and 4, 1886) opposes Nicoladoni in his view that the rotation is purely apparent, and asserts that there is an actual twist in the vertebra itself in addition to the inequality in the two lateral halves. Fischer also (*Berliner Klinische Wochenschrift*, Nos. 20, 21, 22, 1886) regards the rotation as a torsion. The accompanying illustration (Fig. 2061), shows the spiral direction of the bony trabeculæ of the bodies of the vertebræ in a case of advanced lateral curvature.

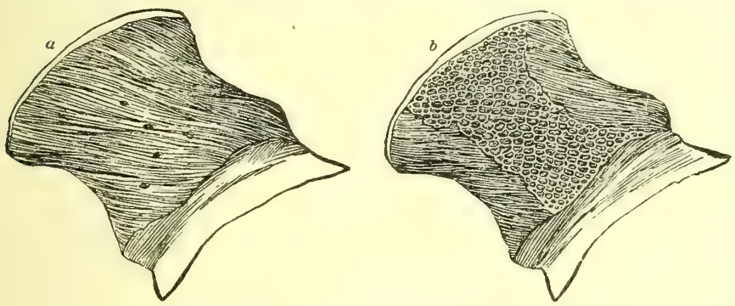

FIG. 2061.—Dorsal Vertebra in well-marked Scoliosis. *a*, The anterior surface of the body, showing the spiral markings; *b*, the same, with outer layer removed, showing the spiral direction of the trabeculæ of the spongy portion. (Fischer.)

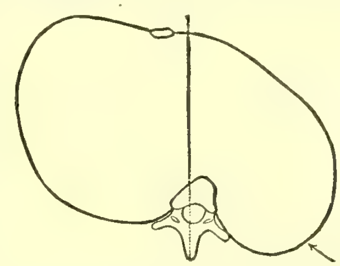

FIG. 2062.—Schematic. Showing a Transverse Section of the Thorax at the Level of the Apex of the Curve.

The deformity in lateral curvature is not, however, confined to the spinal column alone. The ribs are so closely articulated with the dorsal vertebræ that any change of position or of form of the latter must necessarily involve an alteration in the shape of the thoracic parietes. The outgrowth of the convex halves of the vertebral bodies and of the corresponding portions of the arches causes a displacement backward of the transverse processes and costal articulations. The result is that the angles of the ribs become more acute, while, at the same time, the ribs themselves assume a more nearly horizontal direction, and the intercostal spaces are widened. On the concave side an opposite condition prevails. The ribs are approximated and straightened, their angles are almost obliterated, and the bones themselves are more or less atrophied. The ribs sometimes approach each other so closely as to touch, and it is even said that synostosis may occur. The sternum is usually but little, if at all, displaced from the median line, and, consequently the change in shape and direction of the ribs causes a diminution in the capacity of the thorax on both the convex and concave sides (see Fig. 2062). The pelvis is sometimes tilted in an antero-posterior direction as well as laterally, even in cases in which the primary curve is located in the dorsal region, but more frequently this condition is only apparent.

The condition of the cord in lateral curvature has not received sufficient study to enable us to form any definite conclusions as to the amount of injury sustained by it, though from the evidences of trophic disturbances seen upon the side of convexity we might infer that some lesion, presumably from compression, exists in the opposite half of the cord.

The diagnosis of well-marked scoliosis presents little or no difficulty; the lateral deviation of the vertebral column to one or the other side, the prominent angles of the ribs, the unequal height of the shoulders, the projection of the scapula, the prominent hip, are all too evident to escape the notice of even the most careless observer. Fig. 2063 represents the appearance presented in an ordinary case of lateral curvature of moderate degree, with primary curve to the right in the dorsal region, and a smaller compensatory curve of the lumbar spine to the

left. The shoulder upon the side of the convexity of the curve is higher than its fellow ; the scapula is also elevated, and its angle and inner border are prominent. There is a fulness posteriorly of the chest-wall on the convex side, and a corresponding flatness of the opposite side. Shaffer (*The Medical Gazette*, April 2, 1881) has called attention to a sign which is rarely, if ever, absent in curvatures of the upper dorsal region, namely, atrophy of the mammary gland upon the side corresponding to the convexity of the curve. This is present only in those cases in which the curve extends above the fifth dorsal vertebra, and is merely a part of the unilateral atrophic disturbance seen on the side of convexity. Its explanation would seem to be found in a disturbance, due probably to compression, of the trophic centre upon the opposite side of the cord. There is a sinking in of the side just over the crest of the ilium, due to the secondary lumbar curve ; this occurs upon the side of convexity of the dorsal, or concavity of the lumbar curve. The hip thus becomes prominent on this side, and the pelvis presents the appearance of being tilted, though most frequently the appearance is deceptive. In more marked curves (Fig. 2064) all these symptoms are exaggerated ; the difference in height of the two shoulders is more evident, the scapula is more prominent, and the depression above the ilium is deeper. The fulness of the chest posteriorly is very evident, and the ribs are thrown so far backward and the angles are so sharp that a large hump is formed. This has been mistaken for the deformity of Pott's disease, but need never be if it is remembered that the hump in the latter case is formed by the projecting spinous processes, and is situated directly or nearly in the median line, while in lateral curvature it is situated laterally with respect to the spinal column, which may be felt on its inner side. In these formidable cases of lateral curvature there is usually also some lordosis, or anterior curvature of the spine. When the curvature is but slight in extent we have often to rely for diagnosis solely upon the deformity arising from the displacement of the ribs, for the spinous processes, being pushed over so as to point toward the concavity of the curve, may form a nearly straight line, thus concealing the existence of any lateral deviation. In such cases, if the patient be made to stoop forward without flexing the knees, the muscles lying between the spinous and transverse processes of the vertebræ on the side of the convexity will become prominent, while a groove will be formed upon the other side of the spine. Another sign of great importance in doubtful cases, to which Shaffer has called attention, is the diminished lateral flexibility of the spine in the direction of the convexity. His method of examination is as follows : The patient is placed sitting on a stool in front of the surgeon. The latter then supports the ribs with one hand, making the support firm by bracing the elbow against his knee ; then, with the other hand resting against the patient's shoulder or in the axilla, forcible lateral flexion of the spine is made. The process is then reversed to test the flexibility to the other side. If lateral curvature exist, the difference in lateral flexibility will be very apparent, motion being most free in the direction of the concavity. The subjective symptoms of lateral curvature are unimportant. There is usually some pain in the back and sides, though this is by no means constant. Shortness of breath is frequently complained of in cases of extensive curvature, and is due to the diminished capacity of the thorax.

FIG. 2063.—Lateral Curvature of Moderate Degree, Dorsal Curve to the Right. (Staffel.)

The only conditions liable to be mistaken for true scoliosis are Pott's disease of the spine and the hysterical form of lateral curvature. The gibbosity of scoliosis is formed by the prominent angles of the ribs, and is situated to one side of the median line, while in spondylitis it lies usually in the centre of the back and is produced by the prominence of the spinous processes. In lateral curvature, also, the antero-posterior movements, while usually diminished somewhat in extent, are seldom absolutely abolished, as is the case in the region involved in spinal caries. The diagnosis of simulated (neuromimetic) lateral curvature often presents considerable difficulty. It occurs in nervous hysterical patients, but an hysterical state is by no means infrequently met with in the subjects of true scoliosis. In the simulated form the shoulders are of unequal height, but there is no deformity of the ribs—no projecting angles, and no prominent and flaring scapula. The vertebræ are not misshapen, consequently there is no appearance of rotation, and on stooping the muscles are seen to be equally prominent on each side of the spine ; there is no elevation on one side of the spinous processes, and no groove on the other, as there is when the vertebræ are deformed. Again, in hysterical deviations of the spine the direction of the curvature may vary ; at the first examination it may exist with convexity pointing to the right, and at a subsequent examination it may point to the opposite side. In true scoliosis the direction of the curve is constant.

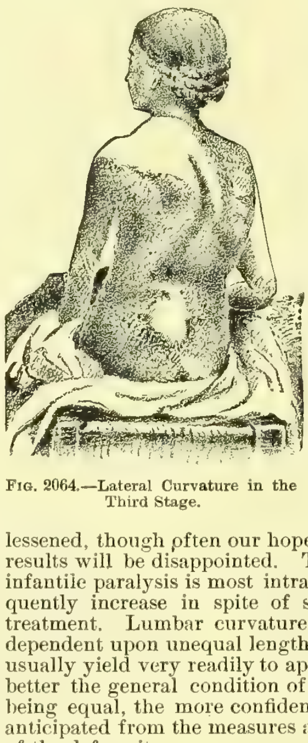

FIG. 2064.—Lateral Curvature in the Third Stage.

The prognosis of lateral curvature varies according to the degree of curvature, the etiology, and the general condition of the patient. If upon recumbency or suspension combined with manual pressure the curve is markedly diminished or obliterated, the hope of obtaining a cure of the deformity may be cautiously held out to the patient. But in scoliosis of the third degree, where the vertebræ have undergone extensive changes in shape, the most that can be promised is that the deformity will not be increased, or that possibly it may be very slightly lessened, though often our hopes of obtaining even these results will be disappointed. The curve associated with infantile paralysis is most intractable, and will not infrequently increase in spite of systematic and persistent treatment. Lumbar curvatures of moderate size, when dependent upon unequal length of the lower extremities, usually yield very readily to appropriate treatment. The better the general condition of the patient, other things being equal, the more confidently may a good result be anticipated from the measures adopted for the correction of the deformity.

In order to obtain any success whatever in the management of this deformity, the treatment should be steadily persevered in without break or intermission. Cures of lateral curvature would be much less of a rarity than they now are, would surgeons only give each case their personal attention, following it up from week to week or month to month, noting the changes as they occur, persevering in the treatment if the deformity is growing less, however slowly, and modifying or changing it altogether if the curve is seen to be constantly increasing. The "fast and loose" style of treatment is as harmful in scoliosis as it is in other deformities, indeed more so ; for when the limbs are misshapen, the knife and the chisel are at hand to repair the damage resulting from careless management in the earlier stages, but with the spine it is otherwise, the damage here is irremedi-

able. The treatment should also be commenced at the earliest possible moment, for it is the rule that the deformity steadily increases, and every month, or even week, that is allowed to pass is just so much valuable time lost. True lateral curvature, unlike some of the deformities occurring in the course of rickets, never undergoes a spontaneous cure, and the hope of such a termination should not be admitted as an excuse for delay.

Our aim in the treatment of scoliosis is not only to restore the spinal column to its normal shape, but also to strengthen the muscles and ligaments so that the upright position may be maintained after a cure is obtained. This can only be accomplished by appropriate exercises, both active and passive, and by the application of a suitable apparatus to maintain the spine in its improved position until the muscles have regained sufficient tone and strength to perform this office unaided. When the primary curve is in the lumbar region—especially if due to inequality in the length of the lower limbs—and is but slight in degree, a mechanical support is not always necessary. The equalizing of the two extremities by the use of a cork sole of the required thickness may suffice to correct the deformity. The patient should also sit upon a firm, wedge-shaped cushion in such a way that the pelvis is raised upon the side corresponding to the convexity of the lumbar deviation. The inclination of the upper surface of this inclined plane should not be too steep, as then a great effort is required to keep from sliding off, and the patient soon becomes tired and defeats our efforts by rejecting the appliance altogether.

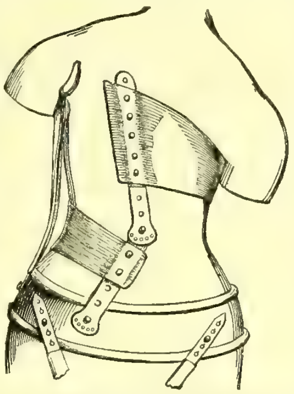

FIG. 2065.—Guérin's Apparatus for Lateral Curvature.

In the treatment of dorsal curvatures a mechanical support is necessary The apparatus employed should be light and well-fitting, so as to incommode the patient as little as possible, yet should be sufficiently strong to answer the purpose intended, viz., to support the body We cannot straighten a scoliosed spine by any brace; the most that can be accomplished is to relieve the weakened and overtaxed muscles and ligaments of a portion of the weight of the head and upper extremities, and to restrain the constant tendency to increase of the deformity. If the attempt is made to force the spinal column into place by apparatus, the constant severe pressure required will speedily cause excoriations of the skin, thereby compelling frequent interruptions in treatment, if not the final abandonment of all therapeutic measures. The brace is to be used merely as an adjuvant to the treatment by exercises and posturing, to hold what has been thereby gained, and to keep the spine from sinking back into its former position in the intervals of the gymnastic exercises. Since, in the event of successful treatment, the spine is constantly, though slowly, growing straighter and the deformity of the thorax lessening, the appliance used should be such that it can be readily modified to correspond to the improved shape of the body. The force employed may be elastic or fixed; the latter is, however, in most cases to be preferred, for the reason that it is more easily controlled. The direction of the force is a matter of prime importance. It should be exerted in the line indicated by the arrow in Fig. 2062, against the prominent ribs, diagonally forward and inward; when the direction is wholly lateral the tendency is to increase the flexion of the ribs at their angles rather than to straighten the curve of the spine. The pressure should also be made in a direction slightly upward. There is one caution to be observed, however, in constructing an apparatus on this principle, namely, to avoid pulling from the opposite shoulder against the prominent ribs. Any appliance so constructed is faulty in principle, and is calculated rather to increase the deformity than to benefit it. The lifting and pushing force should start from below. Various mechanical supports have been devised, some of which answer the indications, while others are worse than useless. The accompanying illustrations (Figs. 2065 and 2066) show a couple of the instruments which have been devised, by which the indications for support in lateral curvature are more or less imperfectly met. An apparatus which is well adapted to fulfil the indications which present themselves has been described and figured by Franz Staffel, in the *Berliner Klinische Wochenschrift*, No. 24, 1886 (Fig. 2067). The lowered shoulder is supported by a crutch, and pressure is made in the proper direction against the convexity of the curve by a pad. The force and direction of the pressure can be regulated by an endless screw. The plaster-of-Paris corset of Sayre furnishes a very efficient support, which is at the same time cheap and easy of application. It should never be worn constantly, but should be cut through in front, and provided with laces so as to admit of easy removal and reapplication. It has the disadvantage of requiring frequent renewal in order to accommodate itself to the change of form resulting from growth and the gradual process of cure. A further objection is that the patient's body is entirely encased in the plaster mould, which to some extent hinders evaporation from the skin and is often a source of discomfort in hot weather.

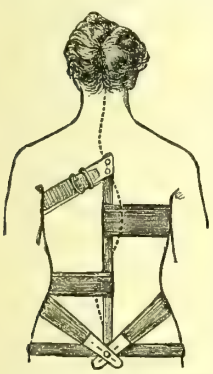

FIG. 2066.—Davis' Apparatus for Lateral Curvature.

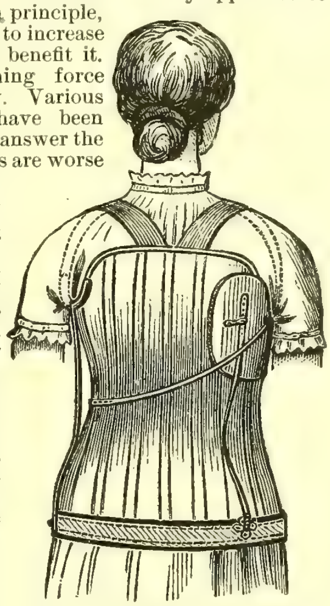

FIG. 2067.—Staffel's Lateral Curvature Apparatus.

A very simple, and in some cases efficient, apparatus has been devised by Fischer (*Centralblatt für Chirurgie*, No. 24, 1885). It consists of two rings of padded webbing, applied like braces to the shoulders, and united posteriorly by a transverse band. From one of these rings, the one on the side of convexity of the dorsal curve, an elastic band passes down, across the chest and abdomen, to another ring encircling the opposite thigh. The action of this apparatus, its proposer claims, is to depress the shoulder and to pull it forward, causing also a rotation of the spine in an opposite direction. The writer has used this traction force, as devised by Fischer, in his own practice, and has found its action very satisfactory in certain cases.

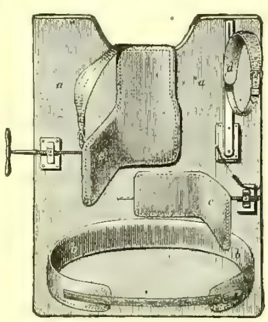

FIG. 2068.—Goldschmidt's Orthopædic Couch.

Various couches were formerly much in vogue, and are even yet highly extolled by some as signally efficacious in the reduction of the deformity of scoliosis. Fig.

2068 represents one of these "orthopædic beds," devised by Goldschmidt. An apparatus which allows the patient to walk about and take necessary exercise is, for evident reasons, greatly to be preferred to a stationary appliance, even if—which certainly admits of doubt—the progress toward cure be slightly retarded in the former case.

Whatever form of apparatus be employed, the surgeon himself should superintend its construction, and should see that the frequent modifications of shape rendered necessary by the varying degree of curvature are properly made. And he should also be provided with the necessary tools for working in steel, should steel apparatus be used, and in any case must understand thoroughly the mechanical indications and the means of meeting them. A knowledge of mechanical principles is as necessary for the orthopœdic surgeon as is that of materia medica and pharmacology for the practising physician.

The exercises employed by different surgeons in the treatment of lateral curvature are innumerable in their variety, but may all be comprised under three general classes, viz.: First, those which make use of the force of gravity to pull the spine straight; in this class are included trapeze exercises, swinging from rings, and autosuspension. Second, those in which the curve is reduced by a direct unbending of the vertebral column; this may be done partly by the patient's own efforts in assuming various postures which tend to curve the spine in a direction opposed to that of the pathological deviation, but usually the motions are passive, and are conducted by the hand of the surgeon or of a properly instructed nurse. The third class comprises all those exercises which develop and strengthen the muscles and render the spine more flexible, without any special reference to the direction of the curvature; these are dumb-bell exercises, anterior and posterior flexion of the spine, raising the trunk from a horizontal to a vertical position while the thighs and legs are held to the floor, etc. No one class of exercises is to be employed to the exclusion of the others, but all should be used in turn. The ingenuity of the surgeon will suggest the particular exercises most applicable in the treatment of individual cases, according to the direction, extent, and location of the curvatures. The gymnastic treatment of scoliosis will be found described in detail in numerous treatises devoted to the therapeutics of this deformity. These exercises should be practised at least twice daily, but should never be carried to the extent of causing fatigue to the patient. The support is, of course, to be removed at these times. After the exercises the patient should rest for a few minutes, lying upon a firm couch, which is raised at the head in such a way that its surface forms an inclined plane, sloping gradually to the feet. The use of a pillow is, however, objectionable. Electricity, massage, and shampooing with some slightly stimulating liniment, are useful means of improving the condition of the spinal muscles, but they should be applied to the muscles on both sides of the spinal column, and not only to those lying over the convexity of the curvature. Cod-liver oil, iron, and general tonics may be given, according to the indications in individual cases. In advanced lateral curvature of the third degree, where synostosis of the implicated vertebræ has taken place, any attempts at straightening the spine will be futile. All that can be done in such cases is to apply some strong and well-fitting apparatus, so as to prevent any increase in the curvature above and below the point of anchylosis. The plaster jacket affords, perhaps, the best support in these circumstances.

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Thomas L. Stedman.

LATHYRISM. A peculiar disease characterized by a spasmodic paralysis of the lower extremities, affecting chiefly the flexor muscles, and occurring in individuals whose diet consists wholly or in great part of a species of lathyrus. The disease has hitherto been met with only in the countries of Europe and Africa bordering on the Mediterranean Sea, in regions where the *lathyrus cicera* or *sativa*, or wild vetch, called by the Arabs of Algeria *djilbes*, is indigenous, and forms part of the diet of the natives when other food fails. Duverney, in 1770, first directed attention to certain poisonous properties residing in the vetch, and since then other writers have from time to time mentioned instances of poisoning from eating the grain; but it is only in recent years that lathyrism has been defined as a distinct disease, due to a specific cause. Several cases of lathyrism were reported by Brunelli at the International Medical Congress of London, in 1881; but we are indebted chiefly to two French physicians, Proust and Bouchard, who studied the affection during an epidemic which occurred in Algeria, in 1882–83, for our knowledge of its etiology and symptoms.

The onset of the disease is sudden, usually occurring after exposure to cold and damp, and only in individuals who have lived for a considerable time entirely, or almost entirely, on the particular variety of chick-pea (in Italian *cicerchia*) above mentioned.

The symptoms are those of a spastic paralysis of the lower extremities, with retention or incontinence of urine, and sharp pains in the loins, and at times also in the feet. There is usually also, at the commencement of the disease, a loss more or less complete of the procreative powers. The paralysis of the bladder and organs of generation is temporary, and disappears spontaneously in a few days or weeks. Patients suffering from lathyrism have a peculiar ataxic walk. The feet are in extension, so that the heels are raised from the ground, the knees are very slightly flexed, and the trunk is inclined forward at nearly a right angle with the thighs, rendering locomotion impossible without the aid of a stick. In taking a step the patient throws his weight on the stick held in front of him, and then by a series of unsteady jerks drags the foot forward, the leg making a slight outward sweep, and the toes dragging along the ground. The traumatism thus produced often causes abrasions and ulcerations of the toes on their dorsal aspect. The sensibility of the skin of the lower extremities is greatly increased, there is a markedly exaggerated patellar tendon reflex, and the ankle clonus is excited by the slightest movement of flexion of the foot. The muscular excitability and integumentary sensibility to electrical stimulus are also increased. There are no ocular troubles nor other phenomena of locomotor ataxia. No atrophy of the affected members has been observed, even in advanced stages of the disease. In some horses poisoned by mixing vetches with their oats, there were symptoms of laryngeal paralysis, but in man the lower extremities, together with the bladder and genitalia, are alone affected.

The symptoms present in lathyrism would point to a

transverse myelitis or hæmorrhage in the cord, followed by secondary degeneration of the lateral columns. The disease has been likened to locomotor ataxia and to beriberi (the *kakké* of the Japanese), but its resemblance to either of these affections is only partial, and altogether insufficient to establish any intimate relationship between them. The principle upon which the poisonous quality of the vetch depends has not been isolated, but experiments upon animals have shown that it resides in the healthy grain itself, and not in a mildew or other accretion.

The prognosis of lathyrism is favorable. The disease sometimes subsides without treatment when the cause is removed, and if not, a cure may be brought about by revulsive applications along the spine, combined with the internal administration of potassium bromide in pronounced doses. The reader will find a description of this disease by M. Proust in the *Bulletin de l'Académie de Médecine*, session of July 7, 1883; also by Bouchard in *Le Progrès Médical* for October 27, 1883. Numerous other articles on the same subject are scattered through the French and Italian periodical literature of 1881 and 1883. *Thomas L. Stedman.*

LAUREL (*Fructus Lauri*, Ph. G.; *Laurier commun*, Codex Med.; Bay Tree, Bay, Roman Laurel, etc.). The true Laurel, of Europe, is a handsome, fragrant-leaved evergreen shrub or small tree, from two to six metres in height, with numerous slender, smooth, green, very leafy branches, and dark-green, shining, leathery, oblong lanceolate or lanceolate entire, but often wavy- or slightly revolute-margined leaves. The flowers are generally unisexual, small, greenish-white, perianth of usually four sepals, stamens twelve, glandular at the base, anthers opening by valves. In the pistillate flowers the stamens are reduced to four sterile filaments. Ovary single, one-ovuled. Fruit, an ovoid berry, with soft flesh and a large, fleshy seed.

This laurel is a native of Asia Minor and Syria. It has long been grown in and is probably a native also of Greece and the islands of the Eastern Mediterranean. Further, it has been cultivated in Italy, at least as long ago as the days of classic Rome, and in the southern part of Europe generally, and in England for several hundred years. It is supposed to be the plant dedicated by the ancient Greeks to Apollo, and regarded as an emblem of purification, peace, victory, and good luck in general. It is the laurel of sculpture, painting, and literature. The laurel fruits are about a centimetre long ($\frac{3}{8}$ inch), and when dried are dull-brownish black, slightly withered, with a brittle papery exterior and a brown, smooth kernel, splitting easily into two large cotyledons. Odor peculiar, strong, spicy; taste balsamic and bitter.

The fruits are rich in fragrant and fatty constituents, the latter principally in the embryos. The *essential oil* (0.23 per cent.), a colorless or yellow liquid, gives them their odor. The *fatty oil* is obtained by pressing or boiling; it is a yellowish-green, buttery, soft-solid, fragrant, with some dissolved essential oil; it is soluble in ether, but only partially so in alcohol. Laurel-fat is a composite substance consisting of glycerides of a number of fatty acids, oleic, stearic, etc., and also palmitic, myristic, lauric, etc. The leaves, which are used abroad as a kitchen flavor for soups, etc., contain *essential oil, tannin*, a bitter substance, etc.

ACTION AND USE.—The leaves and essential oil have no peculiar action to distinguish them from other fragrant substances (see CINNAMON, for instance). The impure fat of the seeds is moderately stimulant to the skin, and is used as an ointment in rheumatism, paralysis, etc., internally as an aromatic. It is a medicine of great antiquity, but at present it is nearly obsolete so far as the practice of physicians goes. Neither the leaves nor the fruit have any consumption in the United States. Certain brands of "stick liquorice" are packed in Bay leaves.

ALLIED PLANTS.—In its restricted sense, the genus *Laurus* comprises only two species, the one just noticed and another growing in the Canary Islands. Sassafras, Spice Bush, the Cinnamons, and Camphor are in the order. See CINNAMON.

ALLIED DRUGS.—The names Bay and Laurel have been applied to a number of entirely different products. The following are to be distinguished:

1. Bay Tree, or Laurel .... *L. nobilis* Linn.
2. Cherry-Laurel .... *Prunus Laurocerasus* Linn.
3. Spurge-Laurel .... *Daphne Laureola* Linn.
4. American Laurel .... *Kalmia latifolia* Linn.
5. West India Bay .... *Myrcia acris* D. C.

Of these the first and last are fragrant; the others have nothing in common with them but glossy evergreen leaves. The combination of oil and fats found in the laurel-fruits may be compared with that found in nutmeg. *W. P. Bolles.*

FIG. 2070.—Lavender; Single Flower. (Baillon.)

LAVENDER (*Lavandula*, U. S. Ph.; *Flores Lavandulæ*, Ph. G.; *Lavande officinale*, Codex Med.). The oil of Lavender is official in Great Britain, but the flowers are not. A perennial, partly shrubby, labiate, with short, crooked, branching stems, and numerous slender, upright, simple branches, from one-third to more than one metre in length. Leaves opposite, linear with entire, slightly revolute margins. Flowers in small opposite cymes, closely aggregated into spike-like clusters at the ends of the slender branches. All the green parts, calyx, branches, and leaves, are covered with a tomentum of stellate hairs and stalked glands. Calyx tubular-ovoid, with only one lobe (the upper) developed. Corolla tubular, curved, with spreading two-lipped border, lobes of both lips rounded, those of the upper longer and straighter than those of the lower, color pale violet; stamens four, inserted in the corolla tube, ovary four-celled and -seeded. Lavender is a native of the southern part of Europe and the northern border of Africa, growing in elevated and dry places. It has also been cultivated for centuries, and the flowers and oil are both in the market.

FIG. 2069.—Flowering Stem of Lavender. (Baillon.)

The flowers, dried, are about five millimetres long ($\frac{1}{5}$ inch), of a general blue-gray color, with very hairy calyx. Fragrance delightful, taste bitterish, aromatic, somewhat camphoraceous.

COMPOSITION. — Lavender flowers contain about one or one and a quarter per cent. of *essential oil*, which they retain, if properly kept, for years; the stems also contain a similar but less agreeable oil. Both products are to be had. Ordinary Oil of Lavender (*Oleum Lavandulæ*, U. S. Ph.), "distilled from the flowering tops or the whole herb," is a "colorless or yellowish, or greenish-yellow liquid, having the aromatic odor of lavender, a pungent bitterish taste, and a neutral reaction while fresh." Sp. gr. about 0.890. The oil of the flowers (*Oleum Lavandulæ Florum*, U. S. Ph.) is not greenish, has

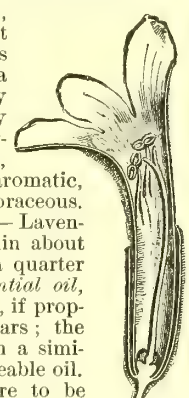


FIG. 2071.—Lavender; Longitudinal Section of Flower. (Baillon.)

the fragrant odor of lavender flowers, but in other respects resembles the above, the difference being only one of flavor and quality. The oils consist of several hydro-carbons and a camphor-like stearoptene in varying proportions.

Action and Uses.—There is nothing peculiar in the action of Lavender to distinguish it from the host of labiate and umbelliferous carminatives. Its odor is more, and its taste less, agreeable, however, than most of them, and it is more used as a perfume, and less as a flavor, than peppermint and anise.

Administration.—The flowers are only used in our Pharmacopœia as an ingredient of the Aromatic Wine (*Vinum Aromaticum,* U. S. Ph.), of which it contains one per cent., as well as the same amount of origanum, peppermint, rosemary, sage, and wormwood. It is a disagreeable tasting liquid, used now and then as a liniment. The common oil is used in the compound tincture of Lavender (*Tinctura Lavandulæ Composita,* U. S. Ph.), which is in daily use as a soothing carminative and vehicle. Its composition is as follows:

Oil of lavender	1 part.
Oil of rosemary	2 parts.
Cinnamon	18 parts.
Cloves	4 parts.
Nutmeg	10 parts.
Red saunders	8 parts.
Alcohol	680 parts.
Water	270 parts.

And, finally, diluted alcohol enough to make one thousand parts. The oils are first dissolved in the alcohol and water, and the spirit so obtained is percolated through the remaining drugs, powdered, and properly mixed and packed. The more expensive oil of the flowers is chiefly used for perfumery and flavoring. There is a Spirit (*Spiritus Lavandulæ,* U. S. Ph.) containing three per cent. of the oil. It is also an ingredient of the officinal Cologne Water (see Bergamot). The dose of the compound tincture first mentioned is from two to six or eight cubic centimetres (2 to 8 c.c. = f ʒ ss. ad f ʒ ij.); of the oil, from two to ten drops.

Allied Plants.—There are about twenty species of *Lavandula,* all natives of the Mediterranean basin, the Canary Islands, and India. Several are of commercial importance. *L. Spica* D. C. (*Lavande commune,* Codex Med.) is a smaller and more tender species, extensively cultivated in the south of France for its oil, which is known as Oil of Spike, a less agreeable and cheaper oil than that of true lavender; used in liniments, veterinary medicine, and as a medium for china painting. *L. Stœchas* Linn. (*Stœchas,* Codex Med.) is gathered and dried as an herb. Patchouly and its oil are a good deal like Lavender. For the order see Peppermint.

Allied Drugs.—In its mild hypnotic power Lavender may be compared to Chamomile and Celery, whose oils are sometimes used like that of Lavender for headaches, nervousness, and wakefulness. As an aromatic it is neither better nor worse than the essential oils in general. See Peppermint, Cinnamon, Anise, Cardamom, etc.

W. P. Bolles.

LAVEY is a village in Switzerland, not far from Sainte-Maurice, lying at an elevation of about 1,200 feet above the level of the sea. There are two springs of nearly the same composition, but differing greatly in temperature, one being cold and the other having a temperature of 113° F. The following is the composition of the latter, according to an analysis made many years ago by Baup. Each litre contains of:

	Grammes.
Sodium chloride	0.3633
Lithium chloride	0.0056
Magnesium chloride	0.0045
Potassium chloride	0.0034
Calcium chloride	0.0015
Calcium carbonate	0.0730
Magnesium carbonate	0.0018
Magnesium sulphate	0.0068
Calcium sulphate	0.0907
Sodium sulphate	0.7033
Strontium sulphate	1.0023
Silica	0.0566
Calcium bromide and iodide, magnesium and ferrous oxides, organic matters, etc	traces.
Total solid constituents	2.3128

The gases are nitrogen, sulphuretted hydrogen, and carbonic acid. The waters are used internally and externally, and when employed for bathing purposes, the strength is often increased by the addition of brine from the neighboring spring of Bex. When the waters are taken internally the strength is also sometimes raised in the same way. This brine is very rich in magnesium chloride (142.8 Gm. per litre), and contains also a number of other chlorides, and some magnesium iodide and bromide.

Lavey enjoys considerable reputation among sufferers from rheumatic and scrofulous affections, from diseases of the bones and skin, dyspepsia, chronic diarrhœa, and vesical catarrh. It is a favorite place for the treatment of children, very many of whom are brought there every year. The season extends from the first of June to the first of October. The accommodations for guests are very good.

T. L. S.

LAXATIVES. This term is applied to all substances which gently evacuate the contents of the intestines. Some authors limit its use to those purgatives which, in large doses, produce normal or nearly normal stools, without obvious irritation. Others extend it to all purgatives which operate without causing decided griping. As generally employed at the present time, it embraces all medicines and articles of food which render the stools softer and more frequent, without causing any notable irritation. Laxatives are frequently termed aperients, lenitives, and eccoprotics.

Articles of food which cause bulky and loose stools generally provoke daily intestinal evacuations, and hence are called laxative foods. They all contain notable quantities of indigestible matter, and some of them salts and acids, which are supposed to operate in the same manner as the saline laxatives.

The succulent vegetables and fleshy fruits contain much cellulose, which, for the most part, resists digestion, and hence increases the bulk of the fæces, and thus mechanically promotes peristalsis of the large bowel. When they constitute a large part of the diet a daily easy evacuation usually takes place. Many persons, however, cannot eat them in sufficient quantity without suffering from dyspepsia. The most laxative fruits are prunes, figs, pears, peaches, apples, and berries. One or two oranges eaten before breakfast will sometimes cause an evacuation in a few hours.

The most laxative foods are those prepared from the unbolted meal of the cereal grains. Graham bread or brown bread, prepared from unbolted wheat-meal, is generally preferred for continued use, and, when it forms a considerable part of the diet, almost uniformly causes sufficient action of the bowels. Cracked wheat is equally laxative, and is occasionally eaten by persons of costive habit. Oat-meal and Indian-meal are also useful, but are usually less relished than brown bread. Pure bran is sometimes employed as a laxative in quantities of one or two tablespoonfuls daily.

Saccharine articles, such as honey, molasses, and brown sugar, if indulged in freely, usually provoke a daily intestinal evacuation. Sugar of milk, in quantities of two to four drachms, dissolved in half a pint of warm skim-milk, and taken about two hours before breakfast, frequently produces one or two loose stools in a few hours. Some persons procure an easy motion soon after breakfast by drinking a tumbler of cool water immediately after rising.

Generally, laxative foods which cause bulky evacuations increase the appetite. In part this results from the waste of much nutritious matter, which is less completely digested when mixed with a quantity of indigestible cellulose or woody fibre.

Laxative medicines are employed in habitual constipation when a laxative diet and other appropriate hygienic measures have failed to cause regular action of the bowels, or when they cannot be adopted. They are generally preferred to stronger purgatives in acute constipation, unless the latter are required to produce effects on the general system.

Manna.—In doses of one or two ounces manna causes feculent stools in four or five hours, and sometimes sooner. Its action is usually attended by slight griping. According to the investigations of Buchheim, its laxative operation is due to its low diffusion-power. On account of its sweet taste and gentle action, it is held to be well adapted to infantile cases, and to the constipation of pregnant women. Usually it is administered in one of the aromatic waters, or in infusion of fennel-seed. For children the dose varies from one to four drachms. The following prescription is adapted to new-born infants: ℞. Mannæ, ʒ j.; aq. fœniculi, ℥ ss. M. Sig. A teaspoonful every half-hour, until the bowels move. Manna is frequently given in combination with more active purgatives, especially senna and salines, as in the officinal compound infusion of senna.

Tamarindus.—In doses of two to eight drachms tamarinds gently move the bowels. Their laxative action is supposed to be due to the presence of vegetable acids and salts, and colloidal substances. On account of their agreeable sour taste, and laxative action, they were formerly much used in febrile affections. Generally, from one to two ounces were mixed with a pint of hot water, and the liquid, after it had been strained and cooled, was given in divided portions within twenty-four hours. Half an ounce of tamarinds boiled with a pint of milk, forms an agreeable drink, which is somewhat more laxative and cooling than ordinary whey. At the present time tamarinds are rarely used, except in the officinal confection of senna and in purgative mixtures.

Magnesia and Magnesii Carbonas.—In moderate laxative doses these medicines cause feculent stools in eight to ten hours. They rarely operate sooner than six hours, and often not before twelve to twenty-four hours. Occasionally their action is attended by some nausea and colic. According to Trousseau, the continued use of magnesia may be followed by irritation of the large intestine, the stools becoming mucous and bloody. Its habitual use has been followed by accumulations of ammonio-magnesian phosphate in the colon, which could be felt through the walls of the abdomen. Such concretions may give rise to obstinate constipation, typhlitis, and perforation of the bowel.

Very small doses of magnesia and its carbonate do not act on the bowels, as they form salts with hydrochloric and lactic acid in the stomach, which are completely absorbed. But when larger quantities are taken than can be thus neutralized in the stomach, the excess passes into the intestines, where it is gradually converted into a bicarbonate, which, on account of its low diffusibility, passes into the lower part of the bowels and excites peristaltic action. One gramme of magnesia is capable of absorbing 1,100 c.c. of carbonic acid gas ; hence it has been used in cases of meteorism, but has not proved very effectual, partly because carbonic acid gas forms only a part of the intestinal gases, and partly because of the arrested peristalsis.

On account of their antacid property, magnesia and its carbonate are indicated when constipation is associated with an excessive formation of acids in the alimentary canal. By combining with the acids they prevent further irritation, and by hastening peristalsis remove the causes of fermentation.

Magnesia is frequently used in infantile diarrhœa when the stools are green in consequence of an excess of acid. Often the diarrhœa ceases as soon as the stools acquire their normal color.

In all cases in which a very gentle laxative is indicated, as in debilitated adults and feeble children, magnesia or its carbonate may be employed.

The dose of magnesia for adults varies from half a drachm to one drachm, and for children from five to twenty grains. Of the carbonate about one-fifth more may be given.

Magnesia is ordered in the form of powder or mixture. Heavy magnesia is preferred for powders, and is usually taken in milk or sweetened water.

Mixtures of magnesia gelatinize rapidly, unless they contain about sixteen parts by weight of water and four parts of syrup or glycerine. According to Hager, a mixture consisting of one part by weight of magnesia, ten parts of distilled water, and four parts of glycerine, remains liquid for a long time.

Liquor Magnesii Citratis and Magnesii Citras Granulatus.—The solution of citrate of magnesium, and the granulated citrate of magnesium, in moderate doses, act very gently. In the alimentary canal they are converted into the bicarbonate of magnesium in the same manner as calcined magnesia.

The dose of the solution is four to six ounces ; of the granulated salt, two to four drachms.

Certain mineral waters containing notable quantities of sulphate and chloride of magnesium, and sulphate of sodium, especially Friedrichshall and Hunyadi-János, are frequently employed as laxatives. They usually act gently, producing thin and watery stools, without griping or tenesmus. Generally they move the bowels in a few hours, but numerous exceptions occur. After a time the bowels no longer respond to them, so that even large doses, which at first operate with considerable energy, soon have little or no effect. The minimum laxative dose varies greatly in different persons, but usually from four to eight ounces act gently and promptly. These salts are said to be useful in habitual constipation depending on simple chronic intestinal catarrh, or on nervous atony of the bowels, as found in hypochondriacal, hysterical, and sedentary persons. Their prolonged use in the constipation of feeble and anæmic patients is injurious.

Potassii et Sodii Tartras.—In doses of two to four drachms the tartrate of potassium and sodium, or Rochelle salt, usually produces one or several loose stools in three to six hours, without colic or tenesmus. On account of its not disagreeable taste and mild action, it is frequently used in the diseases of children and delicate adults, when an aperient is indicated. It is held to be preferable to other laxatives in cases of constipation attended with a deposition of urates in the urine, or with defective secretion of bile.

Generally it is ordered in the form of powders, each two drachms, with a small quantity of sugar and oil of lemon. If ordered in solution, fruit syrups should not be added as flavoring agents, as they are incompatible with the salt. When the stomach is irritable, it is usually given in the form of *Pulvis effervescens compositus*, or seidlitz powders. These consist of two drachms of tartrate of potassium and sodium and forty grains of bicarbonate of sodium, wrapped in a blue paper, and thirty-five grains of tartaric acid, wrapped in a white paper. The two powders, when taken, are dissolved separately, the former in about four ounces of water, the latter in one ounce. The solutions are then mixed and drunk while effervescing.

Sulphur.—Washed and precipitated sulphur, in doses of twenty to sixty grains, act very gently and slowly, producing one or two feculent stools, which usually have a strongly marked odor of sulphuretted hydrogen. The laxative action is held to be due to the sulphide of sodium formed in the intestines. Some of the sulphide is decomposed by the carbonic acid gas of the bowels, which causes the evolution of sulphuretted hydrogen. As only a part of the sulphur can undergo chemical changes, large doses do not produce brisk purgation. After prolonged use of sulphur a disagreeable odor may be detected in all the secretions.

As a laxative sulphur is held to be useful in cases of piles, fissure of the anus, and stricture of the rectum, because it produces soft, easily moulded stools, which pass from the rectum without irritating the highly sensitive parts. It is often combined with other purgatives, such as magnesia, bitartrate of potassium, and senna, but acts well without such additions. The following formula of Brodie's is highly recommended by Cripps as a mild laxative for internal piles. ℞. Conf. sennæ, ℥ jss.; sulph. præcip., ℥ ss.; mel. rosæ, q. s. M. S. About a teaspoonful every night. Usually sulphur is ordered in the form of powder, which may be taken in milk, syrup, or molasses. It should not be ordered in liquid mixture, as it soon firmly adheres to the bottom of the phial.

Oleum Ricini.—Castor-oil in appropriate doses usually acts very gently, producing one or two evacuations in from three to six hours. Large doses act more briskly, and often cause nausea and vomiting, with somnolency and a feeling of weakness. If the oil is rancid, small doses may be followed by such effects.

In the duodenum castor-oil is decomposed like other oils, and its recinoleic acid set free. Some authors hold that this acid irritates the mucous membrane and thus excites peristaltic action. Others suppose that an acrid substance, insoluble in water, alcohol, ether, and alkalies, and readily decomposed by heat, is the purgative principle. In experiments on isolated parts of the intestines of dogs, Brieger found that the oil caused firm contraction of the bowel without any appearances of hyperæmia

On account of its gentle, speedy, and certain action, castor-oil is often used when constipation occurs in the diseases of children, in pregnant women, after parturition, and in delicate persons. For the same reasons it is generally preferred to other laxatives when evacuation of the contents of the bowels is required in typhoid fever, dysentery, and other inflammatory affections of the intestines or adjacent organs. It is also suitable to cases of diarrhœa caused by the presence of undigested food or other irritating substances.

It is not appropriate in habitual constipation, as its continued use soon causes disorder of the stomach ; and it is contra-indicated in gastric catarrh.

The only objection to castor-oil is its disagreeable taste, due chiefly to its adhesiveness and viscidity. Various methods of disguising it are in use. Its adhesion to the mouth and throat may be prevented by previously rinsing these parts with an alcoholic liquid. It may be rendered less viscid and comparatively tasteless by mixing it with hot bouillon, hot coffee, or milk, or with the foam of ale or beer, or peppermint water and brandy. Its taste is hardly perceptible when it is mixed with an equal quantity of glycerine and a few drops of oil of cinnamon or gaultheria. Sometimes it is administered in capsules, which, of course, are perfectly tasteless. It is said that the oil is not repulsive when rubbed up into a mass with three parts of sugar, or with two parts of compound powder of liquorice. The latter form is adapted only to adults, the former to children. The mass may be divided into large pills which, placed upon the tongue, can be conveniently swallowed with a draught of water. Sometimes the oil is ordered in emulsion with gum arabic: ℞. Olei ricini, ℥ ss.; pulv. acaciæ, ʒ j.; syrupi, ʒ ij.; aq. menth. pip , q. s. ad ℥ ij. M. Ft. emuls. In emulsions of castor-oil the gum arabic should not exceed in weight one-fourth of the oil, as it is apt to interfere with the laxative action.

The laxative dose of castor-oil for adults varies from one to four drachms, for children from one to two drachms. Sometimes from twenty to thirty minims, taken two hours before breakfast, act gently in a few hours.

Rheum.—In some persons from three to five grains of rhubarb cause a feculent evacuation in from eight to twelve hours. In others as much as ten grains are necessary for this effect. Doses of ten to fifteen grains, if repeated several times, usually cause two or three stools in from five to ten hours, each stool being preceded by some griping. The stools are usually yellow and semi-liquid.

On account of the yellow color of the stools, it was formerly supposed that rhubarb increases the secretion of bile ; and although the coloring matter of rhubarb is the cause of the yellowness of the stools, the late investigations of Röhrig and Rutherford have confirmed the ancient view.

If taken habitually, laxative doses of rhubarb soon fail to act, and finally, even large doses may have little effect. There are, however, numerous exceptions to this rule, some persons using it habitually for many years without being under the necessity of materially increasing the dose.

Rhubarb is well adapted to the habitual constipation of persons with feeble digestion. Often laxative doses not only produce a daily evacuation, but also increase the appetite and relieve oppression after meals. In the constipation of persons afflicted with piles, five to ten grains taken every night, or as often as needed, act well and frequently give great relief. A daily laxative dose is useful also in the costiveness and hæmorrhoidal swellings incident to pregnancy.

Rhubarb is often preferred to other laxatives when constipation occurs during convalescence after acute diseases, or in anæmic, cachectic, very feeble, or very aged patients. In icterus also, a laxative being required, many physicians prefer rhubarb. It is used in some forms of diarrhœa, especially when symptoms of dyspepsia are associated with the looseness of the bowels. In such cases only very small doses are given, and the good effects depend rather upon the bitter and astringent than upon the purgative principle of the medicine. Laxative doses are required when looseness of the bowels is caused by irritating substances, as in the diarrhœa of children when the discharges are green. In such cases magnesia is often associated with rhubarb in order to neutralize the excess of lactic acid, as in the officinal *compound powder of rhubarb.*

The dose and mode of administration vary in different cases. In habitual constipation one dose of three to ten grains is usually given in the evening. In acute constipation, such a dose may be administered every three or four hours until the bowels move. In diarrhœa with acid stools, small doses are given several times a day.

Rhubarb is rarely administered in the form of powder on account of its disagreeable taste, which may, however, be somewhat disguised by the addition of an aromatic, especially the officinal aromatic powder. The officinal pill of rhubarb, containing three grains of rhubarb and one of soap, is usually preferred in habitual constipation, one to three pills being taken at bedtime Some costive persons daily chew a small piece of rhubarb, weighing from five to ten grains, in order to increase the action of the bowels.

Of the liquid preparations, the wine, the simple tincture, and the aromatic tincture, in appropriate doses, are suitable laxatives for convalescent, feeble, and aged patients, and the syrup and aromatic syrup for children.

Aloe.—In doses of two to five grains, aloes usually produces one or two stools in from ten to fifteen hours. Occasionally it acts in six or eight hours, but more frequently its action is delayed beyond sixteen hours. The stools are soft, bulky, and dark. Sometimes they are attended by slight griping and tenesmus. These effects are more marked after larger doses, which also cause the stools to become thinner, but do not act much more speedily than small ones. The persistent use of aloes is sometimes followed by a feeling of weight and fulness in the pelvis, and, it is said, by the development of true hæmorrhoids. According to Lewin, delicate young persons and the aged are predisposed to such effects. The slowness of action and the symptoms of hyperæmia of the rectum, show that aloes influences chiefly the descending colon and rectum. According to the researches of Rutherford, it increases the secretion of bile and renders it more watery.

Aloes does not usually lose its activity when habitually taken, the same dose producing the same laxative effect for many months, and sometimes for years ; in some cases the dose may even be gradually diminished. For this reason it is one of the most appropriate laxatives for habitual constipation.

Aloes is held to be preferable to other laxatives when constipation is associated with dyspepsia, hypochondriasis, and biliary derangement, and, in females, with atonic amenorrhœa. The presence of piles does not contra-indicate the use of laxative doses, unless they are inflamed. But aloes should not be employed when active hyperæmia of the large intestine exists, or diseases of the uterus tending to hæmorrhage. And though small doses might do no harm in pregnancy, it is better to resort to other laxatives.

On account of its slow action, aloes is usually taken just before or after the last meal, and, as a rule, acts on

the next morning after breakfast. If it act sooner, it should be taken just before retiring.

As aloes is intensely bitter, it is generally ordered in the form of pills, of which five varieties are officinal. For all ordinary cases of constipation the *pilulæ aloes*, containing each two grains of aloes and soap, answer well, one pill being given daily. The *pilulæ aloes et mastiches*, known also as Lady Webster's dinner pills, also contain each two grains of aloes and a little mastic; the latter has no effect. The *pilulæ aloes et ferri* are adapted to the constipation of anæmic persons Some authors state that the sulphate of iron in these pills increases the activity of the aloes. The *pilulæ aloes et myrrhæ* are held to be suitable to constipation associated with atonic amenorrhœa.

Resina Podophylli.—The resin of podophyllum, or podophyllin, as it is commonly called, in doses of one-eighth to one-half grain operates slowly, moving the bowels in about eight to twelve hours. Administered in the evening, it usually produces a feculent evacuation next morning after breakfast. Sometimes it causes griping, especially in delicate females. Like aloes, it retains its laxative action for a long time without necessitating an increase of the dose. According to Rutherford and Vignal, podophyllin increases the secretion of bile without altering its composition.

The laxative operation of podophyllin is somewhat uncertain, a dose which acts gently in some persons acting either severely or not at all in some others.

On account of the smallness of its dose, the convenience of its administration, its persistent action in the same dose, and its cholagogue power, podophyllin is much used in various forms of habitual constipation. It is held to be especially adapted to cases of atony or torpor of the muscular layer of the bowel, and to constipation associated with an insufficient secretion of bile. Harley found it very useful in cases of feeble liver, where the insufficient secretion of bile resulted from want of nervous power.

Podophyllin is generally administered in the form of pill. To prevent griping, a small quantity of extract of belladonna or extract of hyoscyamus is incorporated with it, and, when required, some extract of nux vomica. Podophyllin is sometimes dissolved in alcohol and taken in sweetened water.

The active principle of podophyllum, called podophyllotoxin, has been given to adults in doses of one-sixth to one-fourth of a grain, usually dissolved in alcohol and taken in syrup or sweetened water. Its action is said to be more certain and regular than that of podophyllin. To children it has been given in doses of $\frac{1}{120}$ to $\frac{1}{12}$ grain, according to their age.

Senna.—Senna is rarely given alone as a laxative, but frequently in combination with less active purgatives, as in the officinal *Confectio Sennæ* and the *Pulvis Glycyrrhizæ Compositus.* Having little or no unpleasant taste and acting very gently, the confection of senna is often used to unload the bowels in pregnancy, convalescence, and hæmorrhoidal affections. The dose is one or two drachms, which may be conveniently taken at bedtime. The compound powder of liquorice is adapted to the same cases, and is sometimes used in habitual constipation. It is given in doses of half a drachm to one drachm in a small quantity of water, preferably at bedtime.

Colocynthis.—The extract and compound extract of colocynth are sometimes employed as laxatives in habitual constipation, the former in doses of one-half to one grain, the latter one to five grains. Generally they are combined with other laxatives, and with extract of hyoscyamus or extract of belladonna, to prevent griping, as in the following pills: ℞. Extr. colocynth. comp., gr. iv.; pulv. ipecac., gr. ij.; podophyllin, extr. bellad., āā gr. j. M. Ft. pil. No. iv. Sig. One pill at bedtime.

Cascara Sagrada.—The fluid extract, in doses of twenty drops two or three times daily, has been strongly recommended as a laxative in habitual constipation. Its activity is said to become increased by repetition.

Frangula.—In doses of fifteen to thirty minims the fluid extract of frangula is said to be a mild but uncertain laxative. As it does not quickly lose its activity, it has been recommended for habitual constipation.

Samuel Nickles.

LEAD. I. General Medicinal Properties of Compounds of Lead.—Absorbed into the system, lead exerts a peculiar influence, developing a unique series of symptoms. The influence is wholly toward deterioration of tissue and perversion of function, and has no application in medicine. Locally, the effects differ among the compounds mainly according to solubility. The insoluble compounds are soothing and absorbent, like the insoluble salts of bismuth, while the soluble are decidedly astringent, but yet, in proportion to the astringency, far less irritant than most other astringent metallic salts. The therapeutics of lead salts consist in the application of the insoluble compound (carbonate) as an absorbent and healing dusting powder, and the employment of the soluble salts as metallic astringents in catarrhs, or, in weak solution, as cooling lotions in conditions of inflammation or irritation of the skin. In these applications the following points need attention: 1. The carbonate should not be applied too extensively over a raw surface, else, through chemical conversion, enough lead may be absorbed to produce distinct constitutional lead-poisoning. 2. No lead compounds should be applied to the eye, for, though excellent for simple irritation or catarrh of the conjunctiva, yet there is the peculiar danger that if a loss of the epithelium of the cornea occur, whether by ulceration or traumatic abrasion, application of a lead solution will produce an instant, indelible, opaque, white streak over the area of exposed underlying corneal tissue. 3. Lead salts should not be given internally for longer than a very few days, lest constitutional lead-poisoning result.

II. The Medicinally Used Compounds of Lead.—These are the *monoxide, carbonate, iodide, acetate, basic acetate, nitrate,* and *oleo-palmitate* (lead plaster).

Lead Monoxide: PbO. Lead monoxide is the compound so well known as *litharge.* It is officinal in the U. S. Pharmacopœia as *Plumbi Oxidum,* Oxide of Lead, and is "a heavy yellowish or reddish-yellow powder, or minute scales, permanent in the air, odorless, tasteless, and insoluble in water or alcohol. When heated in contact with charcoal, it is reduced to metallic lead" (U. S. Ph.). Litharge is not used medicinally under its own form, but is officinal as being the source, in pharmacy, of the solution of the subacetate of lead and of lead plaster.

Lead Carbonate: $(PbCO_3)_2Pb(HO)_2$. This salt, the common *white lead* of the paint shops, is officinal in the U. S. Pharmacopœia as *Plumbi Carbonas,* Carbonate of Lead. It is "a heavy, white, opaque powder or pulverulent mass, permanent in the air, odorless, tasteless, and insoluble in water or alcohol. When strongly heated, the salt turns yellow, without charring, and, if heated in contact with charcoal, is reduced to metallic lead" (U. S. Ph.). The compound is, as the formula above shows, a mixture of the normal carbonate and the hydroxide. White lead is used as a dusting powder, as already set forth, or it may be mixed to the consistence of paint with linseed-oil and thus applied, or it may be used in ointment, in the shape of the officinal *Unguentum Plumbi Carbonatis,* Ointment of Carbonate of Lead, a mixture of ten per cent. of white lead with benzoinated lard. White lead, being so largely used in the arts, is a fruitful source of lead-poisoning.

Lead Iodide: PbI_2. This compound is officinal in the U. S. Pharmacopœia as *Plumbi Iodidum,* Iodide of Lead. It is "a heavy, bright citron-yellow powder, permanent in the air, odorless and tasteless, and of a neutral reaction. Soluble in about two thousand parts of water at 15° C. (59° F.), and in about two hundred parts of boiling water; very slightly soluble in alcohol, but readily dissolved by aqueous solutions of the acetates of alkalies, and by solution of chloride of ammonium. When strongly heated, the salt fuses, and, at a higher temperature, it is decomposed, emitting violet vapors of iodine, and leaving a citron-yellow residue" (U. S. Ph.). The

claim of lead iodide to medicinal recognition is based upon the theory that the salt will yield the peculiar effects of an iodide along with those of lead. But in practice the medicine seems to amount to little else than a very slightly soluble lead salt, and is little used. It has been given internally in doses of from 0.03 to 0.20 Gm. (one-half to three grains). For external application there is an officinal *Unguentum Plumbi Iodidi,* Ointment of Iodide of Lead, consisting of ten parts of the lead salt to ninety of benzoinated lard.

Lead Acetate: $Pb(C_2H_3O_2)_2$. $3H_2O$. Normal lead acetate, the salt well known as *sugar of lead,* is officinal in the U. S. Pharmacopœia as *Plumbi Acetas,* Acetate of Lead. It is in "colorless, shining, transparent, prismatic crystals or scales, efflorescent and attracting carbonic acid on exposure to air, having a faintly acetous odor, a sweetish, astringent, afterward metallic taste, and a faintly acid reaction. Soluble in 1.8 part of water and in 8 parts of alcohol at 15° C. (59° F.); in 0.5 part of boiling water, and in 1 part of boiling alcohol. The solutions exhibit generally a slight turbidity, which is removed by the addition of a few drops of acetic acid. When heated, the salt melts, then begins to lose water and acetic acid, and, at a higher temperature, it is decomposed" (U. S. Ph.). Commercial sugar of lead is apt to be contaminated with lead sulphate or carbonate, an impurity which may be suspected if a sample fail to dissolve wholly in water. The salt is decomposed by the alkalies, by acids, by soluble sulphates, chlorides, citrates, and tartrates, and by lime-water.

Acetate of lead is one of the most powerful of the lead salts. In rather weak solution it evinces the combined astringency and soothing influence characteristic of soluble lead compounds, but in strong solution is distinctly irritant, so that the salt is a possible severe irritant poison. Acetate of lead may be used externally in solution as an astringent wash, with the caution already given about application to the eye. The strength of lead lotions commonly ranges from the one-half of one to one or two per cent. Internally the salt is a good deal given as an astringent in diarrhœas, and has also an ancient reputation of being of avail for the arrest of hæmorrhage in quarters inaccessible to local measures. This alleged hæmostatic potency is held in high esteem by some, but by others is considered wholly imaginary. By the very conditions of the case this virtue is one impossible to establish or disprove by methods of precision.

Lead acetate is administered in doses of from 0.06 to 0.20 Gm. (one to three grains) every two hours or so, and, when given in diarrhœa, is probably more often than not combined with an opiate.

Basic Lead Acetate: $Pb(C_2H_3O_2)_2$. $2PbO$. When lead monoxide (litharge) is boiled in a solution of lead acetate it dissolves with the formation of certain basic acetates, the composition of the resulting basic salt depending on the proportion of litharge to sugar of lead in the making. The U. S. Pharmacopœia avails itself of this reaction, and by taking the ingredients in the proportion of twelve of litharge to seventeen of acetate, obtains a solution of basic acetates of which the principal one is the triplumbic acetate of the formula given above. This solution is proportioned so as to be about twenty-five per cent. strength of salts, and is officinally entitled *Liquor Plumbi Subacetatis,* Solution of Subacetate of Lead, called also *Goulard's Extract.* It is "a clear, colorless liquid, of a sweetish, astringent taste, and an alkaline reaction. Sp. gr. 1.228. When added to a solution of acacia, it produces a dense white precipitate. In other respects it possesses the reactions of an aqueous solution of acetate of lead" (U. S. Ph.). Solution of subacetate of lead is exceedingly easy of decomposition; even the "carbonic acid" of the atmosphere will attack it and render it milky by the formation of the insoluble carbonate of lead. It must therefore be kept in well-stoppered bottles. It is decomposed also by so many other substances, organic and inorganic, that the practical rule is a good one to combine this solution, in extemporaneous prescribing, only with opiates. The following preparations of the U. S. Pharmacopœia are made from this solution:

Ceratum Plumbi Subacetatis, Cerate of Subacetate of Lead; Goulard's Cerate. This cerate consists of twenty per cent. of the above solution mixed with camphor cerate, and is specially directed to be "freshly prepared when wanted for use." This because the preparation rapidly decomposes on keeping, turning yellow and becoming rancid.

Linimentum Plumbi Subacetatis, Liniment of Subacetate of Lead. This consists of solution of the subacetate, forty per cent., mixed with cotton-seed oil.

Liquor Plumbi Subacetatis Dilutus, Diluted Solution of Subacetate of Lead; Lead-Water. This solution is simply three parts of the foregoing diluted with ninety-seven of distilled water, previously boiled and cooled to deprive it of free carbonic acid. Lead-water is of the average strength wanted for actual application of a subacetate of lead solution, and may, therefore, be prescribed for use without dilution.

These three preparations, derived from the parent solution of the subacetate, are much used as gently astringent, and at the same time soothing, applications to sores, excoriations, or inflamed conditions of skin. Lead-water is frequently combined with laudanum for the allaying of superficial pains, such as the pain of erysipelas, of a scald, or of a sprain.

Lead Nitrate: Pb $(NO_3)_2$. The salt is officinal in the U. S. Pharmacopœia as *Plumbi Nitras,* Nitrate of Lead. It is in "colorless, transparent or white, nearly opaque, octahedral crystals, permanent in the air, odorless, having a sweetish, astringent, afterward metallic taste, and an acid reaction. Soluble in two parts of water at 15° C. (59° F.), and in 0.8 part of boiling water; almost insoluble in alcohol. When strongly heated the salt decrepitates, emits nitrous vapors, and finally leaves a residue of oxide of lead." Lead nitrate acts like the acetates, and is used only for external applications. A peculiar property of the salt is that it decomposes sulphuretted compounds, and thus proves deodorant to parts generating foul secretions, such as nasal surfaces in ozæna. *Ledoyen's disinfecting fluid* is a twelve and a half per cent. aqueous solution of lead nitrate. Lotions of the nitrate average two per cent. in strength.

Lead Plaster (Diachylon Plaster). Under the title *Emplastrum Plumbi,* Lead Plaster (Diachylon Plaster), the U. S. Pharmacopœia recognizes the product resulting from boiling together in a sufficiency of water thirty-two parts of oxide of lead and sixty parts of olive-oil. Such product, an oleo-palmitate of lead, is a fairly hard solid, "white, pliable, and tenacious, free from greasiness or stickiness. It should be entirely soluble in warm oil of turpentine (absence of uncombined oxide of lead)" (U. S. Ph.). Lead plaster exerts but feebly the peculiar effects of lead compounds, though a case of lead colic has been recorded as resulting from long-continued application of the plaster as a dressing to an ulcerated surface. The main use of lead plaster is as a basis, non-specific, for medicated plasters.

Edward Curtis.

LEAD, POISONING BY.—Pure metallic lead does not appear to be directly poisonous. But it is readily acted upon by the secretions of the body, and the compounds thus formed may be absorbed through the stomach, lungs, or even the skin, and give rise to symptoms of poisoning. The form of poisoning which occurs under these circumstances is usually the chronic, and is observed especially among those whose occupation brings them into repeated contact with metallic lead or its alloys.

Acute Poisoning.—Acute poisoning by the compounds of lead is of rare occurrence, and has usually been the result of accident. The preparations which have most frequently given rise to this form of poisoning are lead acetate, or sugar of lead; basic lead acetate, or Goulard's extract; lead carbonate, or white lead; and lead chromate, or chrome yellow (see Chromium, Poisoning by). Nearly all the compounds of lead, however, are more or less poisonous, and may give rise to acute symptoms if taken in large doses.

Symptoms.—The normal acetate of lead may be taken as the type of lead compounds, since it has been the cause

of most of the reported cases of acute lead-poisoning. It is a weak irritant. When a large dose has been taken, the symptoms generally appear within a few minutes, though they have been delayed as long as two hours. The first symptom is a sweet, followed by a disagreeable metallic, taste. This is succeeded by a burning pain in the throat and œsophagus, nausea and vomiting. The vomited matters have frequently a milky-white appearance, due, probably, to the presence of the lead chloride formed by the action of the hydrochloric acid of the gastric juice, and are occasionally streaked with blood. Acute abdominal pains of a colicky character, and relieved by pressure, then occur. The abdominal walls are retracted. Thirst is usually excessive. There is almost invariably obstinate constipation, but sometimes diarrhœa. The fæces, if any are passed, are generally black from the lead sulphide. The urinary secretion is generally diminished. There is frequently great prostration. The countenance is pale and anxious, or excited, the pulse usually slow, the skin pale and cold. In protracted cases cramps in the calves of the legs or in the thighs, numbness or paralysis of the extremities, giddiness, or stupor may be present. In fatal cases death may be preceded by coma or convulsions. The blue line upon the gums is sometimes seen in protracted cases, but is more characteristic of chronic lead-poisoning. The symptoms are subject to considerable variation, and all those enumerated are not likely to be present in any given case. The most constant, and at the same time most characteristic, symptoms are colic and constipation.

In the few fatal cases which have been recorded, death has usually taken place on the second or third day. Recovery is the most frequent termination, even after the ingestion of large doses; for example, 31.1 Gm. (1 ounce) or more of the acetate. Convalescence is usually established in four or five days, although disturbances of digestion, weakness, and anæmia may persist for a long time. According to Husemann, symptoms of chronic lead-poisoning may make their appearance months after the acute symptoms have disappeared.

Fatal Quantity.—Fatal cases of lead-poisoning have been of such rare occurrence that the minimum fatal dose of any of the lead compounds has not been accurately determined. Lead acetate is not an active poison, and the amount required to endanger life is quite large —probably 15.5 Gm. (4 drachms) or upward. Amounts varying between one and four grams (15.4 to 61.5 grains), have been administered daily for several days without causing any injury. Exceptionally, serious symptoms have resulted from taking smaller amounts than these. A number of cases are recorded in which the amount taken was 31.1 Gm. (1 ounce) and upward. Most of these terminated in recovery.

Basic lead acetate is probably more dangerous than the normal acetate. It has caused death in a few instances, but the quantity taken was unknown. Among non-fatal cases of poisoning by this salt, two are recorded in which the amounts taken were fifteen grams (approximately) and sixty grams (15.5 drachms) respectively.

The rest of the lead compounds, excepting possibly the nitrate, are probably less dangerous than the acetates; but nothing definite is known concerning the amount required to endanger life. Recovery has followed the taking of 19.5 to 23.5 Gm. (5 to 6 drachms) of lead carbonate, and seventy grams (2¼ ounces) of red lead. According to Christison it required twenty-six grams (400 grains) of the crystallized nitrate of lead to kill a dog in sixteen hours; and Paton states that 1.2 Gm. (19 grains) of lead iodide, administered in two doses, caused the death of a cat in three days. The action of these two salts on the human subject has not been observed.

Appearances.—These are not constant or characteristic. The mucous membrane of the alimentary canal is sometimes found reddened and injected. The mucous membrane of the stomach and intestines is sometimes covered with thick, white mucus, mixed with the salt of lead. The mucous membrane of the stomach has been found corroded; but the salts of lead, excepting the chromate, do not appear to have a marked corrosive action. The intestines have generally been found contracted. Frequently no noticeable morbid changes are present.

Treatment.—Vomiting should be encouraged, when necessary, by the administration of an emetic. Zinc sulphate is to be preferred for this purpose, since it also acts as a chemical antidote, converting the lead salt into the insoluble lead sulphate. A solution of magnesium or sodium sulphate should then be administered, if possible. These act as chemical antidotes, and also, if in excess, as cathartics. In the absence of these, milk and white of egg should be given freely, in order to convert the lead salt into the less poisonous albuminate of lead. It is then well to administer castor-oil, or some other purgative, to hasten the evacuation of the bowels. Gastro-intestinal irritation may be allayed by albuminous drinks, and pain is best relieved by opium. In other respects treatment is symptomatic.

Chronic Poisoning.—Chronic lead-poisoning is the most common of all forms of poisoning. Lead is a cumulative poison, and the frequently repeated introduction into the system of even minute quantities may, after a while, give rise to serious symptoms.

Sources.—This form of poisoning is almost always accidental. The greatest number of cases occur among those who manufacture lead carbonate (white-lead), and among those who habitually use it, especially painters. In former years makers of glazed cards, and workmen employed in lace-whitening were frequent sufferers from the effects of the white-lead used by them. Quite severe symptoms have resulted from simply sleeping a few nights in newly painted rooms. Cases also occur with great frequency among those whose occupation brings them into repeated contact with other compounds of the metal, or even the metal itself. Workers in lead mines and workers in lead or its alloys, as plumbers, lead-pipe makers, type-founders, type-setters, etc., and those who constantly handle articles made of lead or its alloys, furnish a considerable number of cases. Workmen engaged in the manufacture of glass, and of glazes for porcelain and pottery, frequently suffer from the effects of the oxides of lead used in these industries. Cases often occur among those engaged in the manufacture of lead pigments, such as lead chromate and red-lead, and among those who constantly use or handle these pigments, or articles dyed or colored with these and other lead compounds. Lead chromate, for example, is used for dyeing cloth and yarn, and many cases of poisoning have occurred among workmen as a result of inhaling the dust given off in the process of weaving such cloth or yarn. Cases of poisoning have been traced to the ingestion of candy colored with lead chromate; to the inhalation of snuff colored with lead chromate or red lead; to the use of matches, containing the chromate, to light a pipe; to the habitual use of wafers colored with red-lead (moistened in the mouth); and in seamstresses to the habit of biting off thread or cotton containing a lead compound. Cases have also occurred among artists who use lead pigments; among makers of sealing-wax (chrome yellow or white-lead used as pigments); and among workers in horse-hair (lead oxide used in coloring).

The accidental introduction of lead or its compounds into various articles of food or luxury has been the cause of many cases of subacute and chronic lead-poisoning. The use of cooking utensils lined with an enamel containing lead is especially objectionable, since various articles of food may take up from such a dangerous amount of lead. Canned goods, especially acid fruits and vegetables, may take up from the solder with which the can is sealed a small amount of lead, and if such foods are used frequently during a considerable period, symptoms of poisoning may result. Poisoning has followed the drinking of cider, wine, or malt liquors contained in bottles which had been cleaned with shot, but from which the shot had not all been removed; the daily drinking of beer and cider which had stood over night in a lead-pipe; the drinking of wine sweetened with litharge or sugar of lead; the use of flour ground with stones, the cavities in which had been filled with lead; the use of sugar cast in moulds, the insides of which had been painted with white-

lead; the use of butter preserved in a brine containing lead, etc. The use of spurious tin-foil has been the cause of many cases of chronic lead-poisoning. This foil, which sometimes contains more than ninety per cent. of lead, is used for wrapping tobacco, snuff, chocolate, *cachous*, and other substances. Artificially aërated waters sometimes contain lead, which they have taken up from pewter stopcocks, and wines may contain lead taken up from the spurious tin-foil which is sometimes used for covering the corks.

The use of lead pipes for conducting drinking-water is another source of chronic lead-poisoning. Pure distilled water, free from air and other dissolved gases, has no action on pure lead. If, however, water containing air is brought into contact with metallic lead, the latter is soon covered with a thin film of lead oxide. This is slightly soluble in water. If the water contains carbonic acid, the dissolved oxide is, for the most part, precipitated as a basic carbonate. A small amount remains in solution. The same series of changes may then be repeated again and again.

Natural waters vary considerably in their action on lead. Rain- and snow-water, which contain but traces of saline ingredients, and which resemble in this respect distilled water, easily corrode lead. The action of other waters upon lead depends much upon the nature of the salts which they contain. The presence of chlorides, nitrates, and nitrites increases the corrosive action of water on lead, while the presence of sulphates, carbonates, and phosphates retards such action. Hard waters, therefore, which contain lime and magnesium sulphates and carbonates, have, as a rule, less action upon lead than soft waters. A lead pipe in contact with such hard waters becomes covered with a firmly adherent coating of lead sulphate or lead carbonate, which is but very slightly soluble, and which practically protects the metal from the further action of the water. Hard waters, however, vary somewhat in their action on lead. If, in addition to the lime and magnesium salts, they contain alkaline salts, the latter may dissolve a little of the lead sulphate or carbonate; and the presence of free carbonic acid in a water will, by reason of its solvent action on lead carbonate, counteract the favorable effect of lime and magnesium carbonates.

The use of lead suction-pipes in wells is especially dangerous, and has probably been the source of many cases of chronic lead-poisoning. If the water is one which acts readily on lead, it is desirable to substitute for the lead pipe a pipe of some other material The best substitute is pure block-tin. Tin-lined lead pipes are unobjectionable if properly made. But if the coating is imperfect, or if it is an alloy of lead and tin, as is frequently the case, galvanic action may be set up and the action of the water on the lead increased. There is no objection on sanitary grounds to pipes made of enamelled wrought iron or of galvanized iron. When the lining wears off, however, they rust very readily. Safety may also be secured by having the lower part of the pipe made of pure block-tin, which should be soldered on to the lead pipe above the highest level of the water, and by always running to waste the water which has stood several hours in the pipe.

The use of lead pipe for house distribution, in connection with a public supply, does not appear to be dangerous, if the precaution is always taken to run to waste the water which has stood in the pipe for several hours. An appreciation of this fact on the part of the public is undoubtedly the explanation of the comparatively few cases of poisoning from this cause.

The use of lead cisterns for storing drinking-water cannot be too strongly condemned. Even the use of lead covers for cisterns, otherwise unobjectionable, is dangerous; for the water slowly evaporates and condenses on the under surface of the cover. It then acts on the lead in the same manner as distilled water, and, dropping back into the cistern, contaminates its contents.

Chronic lead-poisoning has occasionally followed the long-continued medicinal use of lead acetate, the external application of preparations of lead, such as lead carbonate, lead plaster, etc., in the treatment of cutaneous disorders; the use of cosmetics containing lead carbonate; and the use of hair-dyes and hair-restorers which frequently contain lead compounds.

Symptoms.—The time within which symptoms appear in persons exposed to the action of lead varies. Poisoning has been observed after an exposure of one or two weeks, while in other cases months, or even years, elapse before any decided symptoms appear.

Saturnine Cachexia. In the majority of cases the action of lead on the system is manifested first by the development of certain characteristic symptoms which have been grouped together under the name "lead" or "saturnine cachexia." These are a characteristic pale yellow color of the skin (not due to biliary pigments), gradual emaciation, loss of strength and appetite, a sweetish-styptic taste, and fetid breath. A blue or slate-colored line, about two or three millimetres wide, at the junction of the gums with the teeth, is a quite constant sign. It is due to a deposit of lead sulphide, and its presence is generally a positive symptom of poisoning by lead or mercury. In some cases of chronic lead-poisoning, however, this line is not seen. Blue patches on the inside of the lips and cheeks may also be observed; and occasionally the blue color spreads over the whole mucous membrane of the mouth. The gums are thin and retracted, and often present a fungous appearance, and bleed easily. If the nature of the disease is recognized at this stage, and the patient removed from further exposure to the action of the lead, the condition just described gradually disappears, and the patient regains his accustomed state of health. If, however, the exposure continues, symptoms of one or more of the true saturnine diseases usually appear. Not unfrequently, however, the patient continues in this state of cachexia for a long time, although still exposed to the cause.

Four forms of specific lead or saturnine disease have been described: 1, Lead or painter's colic; 2, lead rheumatism or arthralgia; 3, lead paralysis; 4, lead encephalopathy—*encephalopathia saturnina.* The most frequent of these is lead colic.

1. Lead Colic. This is usually the first serious symptom of chronic lead-poisoning. It may come on suddenly without any premonitory symptoms, but is usually a sequel to the lead cachexia. For a few days or weeks preceding the attack the patient frequently experiences uneasy sensations and cramps in the stomach and abdomen. These finally culminate in a violent attack of colicky abdominal pain. The pain is sometimes constant, sometimes intermittent, but usually remittent. It is generally relieved by pressure. The abdominal walls are very rigid, and usually retracted in the region of the umbilicus. The countenance is anxious, and the skin covered with cold perspiration. There is frequently nausea, sometimes violent vomiting. There is almost always obstinate constipation, but occasionally diarrhœa. The tongue is coated; thirst is excessive. Occasionally there is jaundice. The pulse is generally slow and hard, the respiration somewhat accelerated. The urine is usually diminished, and may contain albumen. The paroxysms are of short duration—usually a few moments. The disease, as a whole, may last a long time, but, as a rule, disappears within a few days. If, however, the patient continues to expose himself to the action of the poison, the attacks are liable to recur repeatedly, and usually with increased severity, and may finally be followed by other forms of lead-poisoning.

2. Lead Arthralgia. This is usually a sequel to lead cachexia or lead colic, but sometimes comes on without premonitory symptoms. It is characterized by more or less severe pains in the muscles and joints of the extremities. The lower extremities are affected more frequently than the upper extremities, and the flexor muscles more frequently than the extensors. Other muscles, as those of the back, thorax, neck, face, and scalp, may be affected. The pains are diminished by pressure. Cramps, tonic contractions, and tremors of the affected muscles are often observed.

3. Lead Paralysis. This is usually a sequel to one or

more attacks of lead colic or arthralgia, but may come on without having been preceded by either of these affections. The muscles most frequently affected are the extensor muscles of the forearm (excepting the supinator longus), hand, and finger. As a result the fingers are flexed; and, when the arm is raised, the hand drops. The paralysis sometimes affects other muscles of the arm, especially the triceps and deltoid; and, in advanced cases the extensors of the lower extremities. In rare cases the paralysis extends to the muscles of the trunk, one muscle after another becoming affected, and death may result from paralysis of the muscles of respiration. Usually the paralysis affects both extremities symmetrically. The paralyzed muscles undergo atrophy, and, if the disease is not arrested, finally cease to react to either the induced or constant current, retaining longest, as a rule, the power of reacting to the constant current. The paralysis is sometimes associated with anæsthesia of the part affected. This is usually partial, and confined to a few localities. According to Beau, however, there may be complete insensibility over the whole body, and this may extend to the mucous membrane of the throat, nose, and conjunctiva.

4. Encephalopathia Saturnina. This form of lead-poisoning is characterized by various cerebral symptoms. The cases of chronic lead-poisoning in which cerebral troubles are developed, are, as a rule, the more advanced cases—those which have a history of antecedent colic, paralysis, etc. The cerebral trouble may manifest itself by a state of apathy, stupor, delirium, or mania; but most frequently by convulsions. The convulsions may come on suddenly, or may be preceded for a few days by headache, dizziness, ringing in the ears, etc. They are frequently of great severity, and follow one another in rapid succession. In the intervals the patient may be in a state of coma, during which death may take place. In other cases the attacks are much less violent and less frequent.

Amaurosis, due probably to neuritis optica or to atrophy of the optic nerve, is sometimes observed in cases of chronic lead-poisoning; and gout, albuminuria, and chronic nephritis are not infrequent.

In a certain number of cases the long-continued action of lead on the system is finally manifested by an advanced state of cachexia, which may continue for years; death finally resulting from exhaustion or from some complication, as pleurisy, pneumonia, nephritis, etc.

Appearances.—The appearances which have been hitherto observed in cases of chronic lead-poisoning are not very characteristic. In cases of death during lead colic, the intestinal canal has been found constricted—most noticeably near the pyloric orifice of the stomach and along the small intestine—the muscular coat of the intestine thickened, and the mucous membrane more or less atrophied (Kussmaul, Maier). The muscles, in cases of paralysis accompanied by atrophy, are pale, shrunken, and granular. Friedländer found, in a case where there was paralysis of the extensors, degeneration of the nerves of these muscles extending to the cord. Déjerine, in four similar autopsies, found disappearance of the axis cylinders and degeneration in the muscular nerves, nerve-trunks, and in the anterior roots of the cord. Gombault found numerous degenerated nerve-fibres in the peripheral spinal nerves; while Popow, who studied the effects of lead experimentally on animals, found no such appearances; but observed changes in the cord which present the appearance of a diffuse myelitis. Popow does not, however, deny the possibility of the occurrence of the changes, described by Gombault, as a secondary result.

Action of Lead.—Our knowledge of the manner in which lead acts to produce the symptoms of chronic lead-poisoning is by no means satisfactory. A number of theories have been advanced to explain the paralysis. Some authorities regard the toxic action of lead as central, like a poliomyelitis anterior; while others locate the lesion in the peripheral nerves and muscles. Another opinion is that the lead may attack the system peripherally, centrally, or both, even in the same individual. The symmetry and localization of the paralysis point to a central origin (poliomyelitis anterior). But all the above theories find some support in the various symptoms caused by the action of lead and in the lesions which have been observed after death. Popow, whose experiments have been alluded to, believes that the action is central. He thinks that the nervous symptoms (cramps, anæsthesia, etc.) can be explained by the loss of the nervous elements in the cord, and cannot be referred in any way to the peripheral nerves.

Harnack has made extended investigations upon the action of lead, and explains the symptoms of chronic lead-poisoning as follows: The colic is due to irritation of the intestinal ganglia. In man the result of this irritation is a spasmodic contraction of the intestine producing constipation, while in animals the result is an increased peristaltic action producing diarrhœa. As a result of the contraction the blood is forced out of the intestine, causing an increased fulness and tension of the arteries and slowing of the pulse. The pain is due to the spasmodic contraction of the intestine, the rigidity and retraction of the abdominal walls to a reflex contraction of the abdominal muscles. The paralysis is due to the action of lead on the voluntary muscles, whereby they are placed in a condition of exhaustion, which is soon followed by paralysis. The cerebral symptoms are due to stimulation of various nerve-centres.

Professor Potain has called attention to the fact that during paroxysms of lead colic the liver undergoes a temporary diminution in size, recognizable by percussion; and Brouardel has found that, during the occurrence of paroxysms of lead colic, accompanied by retraction of the liver, there is a marked diminution in the amount of urea and uric acid eliminated by the kidneys, and a consequent accumulation of these substances in the blood and tissues.

Absorption and Elimination.—After death lead may be detected in nearly all the organs and secretions of the body. The amount absorbed is dependent only to a certain extent upon the amount introduced into the body (Lehmann). Heubel found, in cases of chronic lead-poisoning in animals, the largest amount of lead in the bones, liver, spinal cord, and brain, in the order named. According to Lehmann, the liver, which in most cases of metallic poisoning holds the first place in order of examination, in cases of lead-poisoning contains, relatively to the weight, very little lead. The bile and bones, on the other hand, contain a relatively large amount. Absorbed lead appears to be very slowly eliminated from the system. Elimination takes place with the urine and bile; according to Lehmann about equally with each.

Treatment.—Prophylactic measures are of first importance in the case of workmen who manufacture and use white-lead and other lead pigments. Food should not be brought into the workshop; the hands should be washed and the mouth rinsed out before partaking of food; the mouth should be frequently rinsed out with water during the day; the hands and face should be washed, and the hair and beard combed, before leaving the workshop; clothing should be changed before and after work, and if possible a full bath should be taken daily after leaving the shop and before putting on clean clothing. In very dusty shops good ventilation should be secured, and respirators should be worn to prevent the particles of dust from entering the mouth and nose. In some establishments sulphuric acid lemonade, or milk, are provided for the workmen to drink. The object of these is to convert the lead compound, if any has been swallowed, into other compounds less soluble in the fluids of the stomach and intestines. Occasional doses of Epsom salts have been recommended to prevent constipation.

If symptoms of poisoning have made their appearance, the further introduction of lead into the system should be prevented if possible. The indications then are: 1, To hasten the elimination of the lead from the system; 2, to treat symptoms. The first indication is best fulfilled by the internal administration of potassium iodide. This salt promotes the elimination of lead through the urine, and frequently has a decided effect in relieving the symptoms. It should be administered in doses of 0.32–0.65

Gm. (5 to 10 grains), gradually increased to 0.97–1.3 Gm. (15 to 20 grains), three times daily. Pouchet recommends the occasional suspension of the iodide for a few days, since he has found that, although the elimination of lead is at first materially increased under its influence, it again decreases at the end of from six to ten days, and becomes less marked than before treatment was instituted. The amount of lead eliminated is again increased, however, if the administration of the iodide is resumed after an intermission of a few days. In cases of colic, opium is indicated for the relief of pain, and purgatives for the relief of constipation. If the latter will yield to the milder purgatives, as senna, Epsom salts, or castor-oil, these should be given the preference. Croton-oil has been used with benefit in cases of very obstinate constipation. Lead paralysis is best treated by the local use of electricity, either the induced or constant current, according to the indications.

William B. Hills.

LEAMINGTON is a spa in Warwickshire, England, on the river Leam, two miles from Warwick and ten miles from Stratford-on-Avon. It is a very popular watering-place, on account of its mild climate as well as because of the virtues of its mineral springs. The season embraces the entire year, but visitors are more numerous from November to April, during the fox-hunting season. There are five springs, known as Lord Aylesford's, Wood's, Hudson's, the Alexandra, and the Pump Room Spring. The following is the composition of two of them, expressed in grammes per litre, according to the analysis of Dr. Patrick Brown:

	Aylesford's Spring.	Hudson's Spring.
Sodium chloride	3.4243	2.8523
Calcium chloride	2.8398	1.7112
Magnesium chloride	1.2555	1.0245
Sodium sulphate	3.9929	3.1967
Silica, sodium iodide and bromide, and ferric oxide	traces.	traces.
Total solid constituents	11.5125	8.7847

The gases are carbonic acid, nitrogen, oxygen, and sulphuretted hydrogen. The temperature of the different springs varies from 51° F. to 74° F. The waters are taken internally, and used in the form of general baths and of warm and hot douches. The accommodations for both pleasure seekers and invalids are excellent. The waters are used in the treatment of digestive troubles associated with congestion of the abdominal organs, in strumous adenopathy, chronic joint affections, anæmia and chlorosis, rheumatic troubles, and chronic catarrhs of the respiratory tract.

T. L. S.

LEAVENWORTH. The accompanying chart, representing the climate of the city of Leavenworth, Kan., and obtained from the Chief Signal Office in Washington, is here inserted for convenience of reference. A detailed explanation of this and of other similar charts, together with suggestions as to the best method of using them, will be found in the article on Climate.

H. R.

Climate of Leavenworth, Kan.—Latitude 39° 19′, *Longitude* 94° 57′.—*Period of Observations, June* 1, 1871, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 809 *feet.*

	A			AA	B		C	D	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature.
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January	21.6	31.7	26.2	26.5	41.4	15.1	36.5	19.2	65.0	46.0	20.0	−29.0	25	29
February	26.3	39.7	32.8	32.9	42.0	20.5	43.1	24.7	73.0	51.0	19.0	−12.0	21	23
March	33.9	48.2	40.3	40.8	50.6	36.3	53.7	33.5	84.0	68.0	28.0	2.0	24	24
April	46.2	61.5	52.9	53.5	58.5	48.1	65.2	44.8	89.0	79.0	35.0	13.0	16	21
May	58.6	72.4	64.2	64.4	70.1	58.7	74.4	55.2	94.0	83.0	49.0	31.0	24	23
June	68.4	81.2	72.5	74.0	77.3	70.0	82.5	63.8	99.0	90.0	63.0	45.0	18	21
July	72.2	85.0	76.6	77.9	82.3	72.5	86.8	68.3	104.0	94.0	64.0	53.5	25	23
August	69.7	84.8	75.3	76.6	81.7	72.7	86.8	67.0	107.0	90.0	63.0	52.0	22	27
September	59.8	75.4	65.3	66.8	70.7	63.4	77.7	57.2	101.0	85.0	46.0	37.0	21	19
October	48.2	64.1	54.1	55.4	62.0	50.6	66.0	48.0	89.0	78.0	39.0	19.0	20	21
November	34.0	46.5	38.6	39.3	45.9	31.7	50.8	33.2	77.0	64.0	25.0	zero.	26	23
December	25.9	36.2	29.8	30.6	44.1	21.0	41.0	24.7	72.0	50.0	17.0	−14.0	21	28
Spring	......	......	......	52.9	56.5	50.7	......	......	......	......	......	......	......	......
Summer	......	......	......	76.1	79.9	73.1	......	......	......	......	......	......	......	......
Autumn	......	......	......	53.8	57.3	49.8	......	......	......	......	......	......	......	......
Winter	......	......	......	30.0	39.3	23.7	......	......	......	......	......	......	......	......
Year	......	......	......	53.2	55.4	51.0	......	......	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind, in miles, per hour.
						Inches.	From	Miles.
January	94.0	72.7	11.0	9.6	20.6	1.35	S.	7.2
February	85.0	69.5	11.0	9.0	20.0	1.60	S.	7.6
March	82.0	64.1	13.2	8.8	22.0	2.39	N.	9.3
April	76.0	59.9	10.1	9.0	19.1	3.56	S.	9.3
May	63.0	64.6	13.5	6.8	20.3	5.07	S.	7.8
June	54.0	65.9	14.8	9.0	23.8	5.89	S.	7.2
July	50.5	66.7	14.0	11.4	25.4	4.79	S.	5.5
August	55.0	63.6	12.4	13.8	26.2	3.20	S.	5.2
September	64.0	62.5	11.6	12.4	24.0	3.10	S.	6.4
October	70.0	62.8	12.5	11.7	24.2	3.36	S.	6.6
November	77.0	63.9	12.1	10.3	22.4	2.57	S.	7.4
December	86.0	69.7	11.8	9.1	20.9	1.74	S.	6.8
Spring	92.0	62.9	36.8	24.6	61.4	11.02	S.	8.8
Summer	59.0	65.4	41.2	34.2	75.4	13.88	S.	6.0
Autumn	101.0	63.1	36.2	34.4	70.6	9.03	S.	6.8
Winter	102.0	70.6	33.8	27.7	61.5	4.69	S.	7.2
Year	136.0	65.5	148.0	120.9	268.9	38.62	S.	7.2

LEBANON SPRINGS. *Location and Post-office,* Lebanon Springs, Columbia County, N. Y.

Access.—To Chatham, N. Y., or Rutland, Vt., thence by Harlem Extension of Central Vermont Railroad to Springs.

Therapeutic Properties.—The characteristic ingredients of this water are the soda and lime carbonates. It is diuretic and alterative, and its use, combined with the unusually attractive and healthful surroundings, renders a sojourn here both agreeable and restorative to those suffering from chronic diseases of the digestive and urinary apparatuses. The use of the bath is largely relied upon.

ANALYSIS (Professor H. Dussauce).—One gallon contains:

		Grains.
Sulphuret of sodium		0.02
Carbonate of soda		2.41
Sulphate of potash		1.04
Chloride of sodium		0.96
Carbonate of lime		4.05
Sulphate of magnesia		1.06
Alumina		0.45
Oxide of iron		0.94
Silicic acid		3.25
Organic compounds	Glairine	0.75
	Baregine	9.47
Total		24.40
Gases.		Cubic inches.
Oxygen		2.00
Nitrogen		3.50
Carbonic acid		0.50
Sulphuric acid		traces

Lebanon Valley, in which the spring is located, is celebrated for its beautiful scenery. The spring is in the courtyard of the hotel, and discharges five hundred gallons of water per minute, of a temperature of 73° F. The hotel, "Columbia Hall," has accommodations for three hundred guests. The bath-house is a large and commodious building, and contains separate baths for both sexes. Churches of the several prominent denominations are near the hotel. The season opens in June and closes in October. Lebanon Spring is the only known thermal water east of Pennsylvania. *G. B. F.*

LEECH (or Leach). Synon.: *Bdella, Sanguisuga, Hirudo;* Fr., *Sangsue;* Ger., *Blutegel.* The medicinal leech belongs to the family Gnathobdellidæ, order Discophora, class Annelida, sub-kingdom Annulosa. It is a spindle-shaped worm, flattened on its ventral, and slightly rounded on its dorsal surface, and provided with a sucker at each extremity. The anterior extremity is the narrowest part of the spindle, and the anal sucker is expanded into a broad disk. The mouth is provided with three serrated teeth, or, more properly speaking, with three cartilaginous jaws, with a hundred or more teeth in each jaw.

FIG. 2072. — Hirudo Medicinalis, or English Leech.

There are three principal varieties used in medicine, which have received different names in different countries. They are known in this country as the Hirudo (or Sanguisuga) medicinalis, or English or gray leech; the Hirudo (or Sanguisuga) officinalis, or Hamburg or green leech; and the Hirudo (or Macrobdella) decora, or American leech. The English leech (Fig. 2072) is of an olive-green color, with six longitudinal, russet-colored stripes on the back, and the belly is yellowish-green and speckled with black. The Hamburg leech (Fig. 2073) resembles the one just described, except that it is of a deeper green color on the back, and has no black spots on the belly. These two varieties are the most commonly used, and are usually classed together under the name of the European or Swedish leech. They are of large size, and will abstract usually about half an ounce of blood each. The American leeches (Fig. 2074) are usually smaller, having a capacity of only about one drachm. The accompanying illustration is an enlarged copy of a drawing taken from life, but sometimes the worms grow to even a larger size. The writer has been unable to find any illustration of the American leech, and believes that the drawing by Mr. Emerton is the first that has been made of this variety.

FIG. 2073.—Hirudo Officinalis, or Hamburg Leech.

The leech seizes hold of the part to which it is applied, by elongating its anterior sucker and drawing in a conical fold of the integument; this is then pierced by the three cartilaginous jaws, which are moved by strong muscular cushions at their bases; the blood is now drawn into the pharynx by suction, and propelled into the digestive tract by the peristaltic action of the œsophagus. The wound made by the leech is triradiate star-shaped.

Leeches are obtained from stagnant or slowly running water. They should be kept in covered jars, provided with numerous small air-holes near the top. The jars should be half-filled with water, and should have a thick layer of mud at the bottom. The water need be changed only at long intervals. A leech which has been once used should be kept for six or eight months in soft mud, and may then be employed again. This practice is not to be recommended, however.

For the medicinal use of leeches, see Bloodletting.

Sometimes leeches are accidentally swallowed by bathers, and they have been known to cause alarming hæmatemesis. Copious draughts of salt water will cause their dislodgement in such cases.

T. L. S.

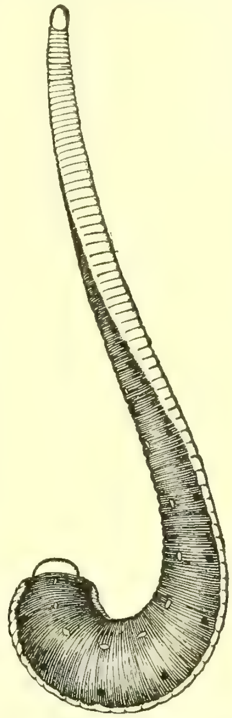


FIG. 2074.—Hirudo Decora, or American Leech. (From original drawing made by J. H. Emerton, of Boston, for the HANDBOOK.)

LEG, APPLIED ANATOMY OF. In anatomy the term leg is used to indicate only that part of the pelvic limb between the knee and the ankle, the portion above the knee being known as the thigh.

The shape of this region is somewhat characteristic of man. In most other animals the bellies of the great muscles are above the knee, and the leg is comparatively slender. In man, however, the erect position requires the constant application of muscular force to hold the foot at right angles to the axis of the limb, and this causes very considerable bellies to be formed below the knee. The prominence of the calf is, therefore, not only characteristic of footmen, but, to a certain extent, marks the higher races of mankind generally. Australians and other low savages resemble children and apes in the insignificant calibre of their legs.

It is not quite correct to compare the leg to an inverted cone, as is often done. In a fully developed man the prominence of the calf is confined mainly to the upper and posterior part of the limb, and represents the two bellies of the gastrocnemius, the inner one being larger and descending somewhat farther than the outer. This prominence is enormously developed in ballet-dancers, who possess here a dense, hard ball of muscle, quite characteristic of the occupation. It may be brought out more fully by rising upon the toes. In women the calf has usually a somewhat different shape, the muscular prominence being masked to a certain extent by fat, and descending somewhat lower than in males. The bones being more slender, the ankle is more finely modelled, and the whole contour of the limb approaches more nearly those lines of grace which please the eye in the "Greek Slave" or in Canova's "Venus." It is this contraction of the leg toward the ankle that makes it necessary to take certain precautions in bandaging, by proceeding from below upward and making the necessary reverses. It is also the reason why the circular operation for am-

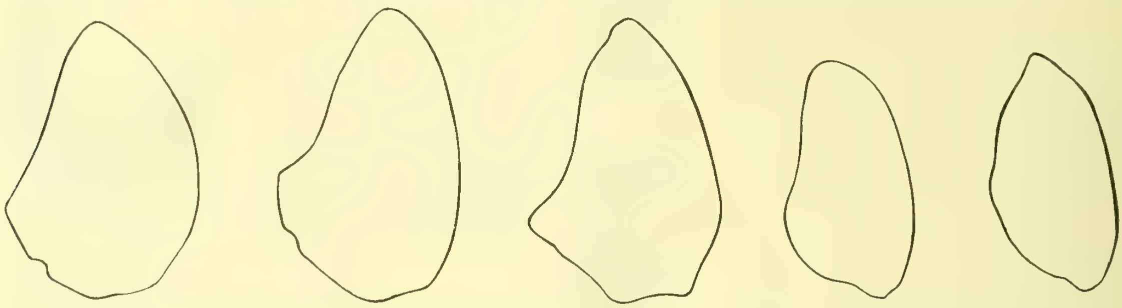
putation is not so easily performed here as above the knee, it being difficult to sufficiently retract the "sleeve." The shape of the ankle is, however, far from being cylindrical, the strong, flat, tendo-Achillis producing a prominent projection behind, as will be seen on inspecting Figs. 2079 and 2082. Anteriorly, the leg is remarkable for the considerable area where the bone is quite subcutaneous. The inner surface of the tibia, along its whole length from the tuberosity downward to the end of the malleolus, is but slightly covered, and in case of fracture the ends are very apt to extrude, a compound fracture being more frequent here than in any other part of the body. The anterior edge, popularly termed the shin, may be followed down as far as the lower third, where it begins to be rounded and covered with tendons passing over the ankle into the foot. The lack of soft parts here to serve as a cushion under the skin causes it to be liable to certain injuries. A blow from a blunt instrument, which would elsewhere produce a contusion, will here cause an incised wound. Contusions may also produce the same blood tumors that we see occasioned in a similar way upon the skull.

The usual curve of the crest of the tibia may be exaggerated by various causes. One of the earliest signs of rickets is an increase of the bend at the lower part. If children are encouraged to walk too early there is usually deeply embedded between the bones than is the case in the usual type, adapting the foot to strong inversion of the sole, as is the case with apes, and thus making climbing easy.

The fibula, although not so superficial as the tibia, may be felt for a great portion of its course, especially below, where fracture is most common. The head and the external malleolus, with the triangular facet above it, are subcutaneous. The close contiguity of the skin to the periosteum and bone makes it very easy for pathological processes to be continued from one to the other. It is often seen, therefore, that ulcers of the leg are followed by periostitis and necrosis of the bone.

The skin and subcutaneous tissues are not as freely supplied with arterial vessels as are the corresponding portions of the upper extremity. The superficial veins are, on the contrary, very numerous, as may be seen on an inspection of Figs. 2076 and 2077. Being far removed from the heart, acting against gravity, outside the muscles, and therefore without the assistance of muscular contraction, the circulation through them is unusually sluggish.

These peculiarities cause this region to be particularly liable to congestive disturbances and to defective nutrition. Eczema is common here ; it is a favorite locality for the spots of purpura, and patches of brownish discol-



A B C D E

FIG. 2075.—Cross-Sections of Tibiæ taken at the Level of the Nutrient Foramen. (From casts of specimens in the Army Medical Museum, Washington, D. C.) A, usual type; French male adult of about thirty; prepared by Auzoux in 1866 (Specimen No. 1). B, slight platycnemism; Ute female of about thirty-five (Specimen No. 2240). C, slight platycnemism; from a skeleton found in a mound near Fort Totten, Dakota Territory (Specimen No. 1121). D, marked platycnemism; from a mummy found on the western coast of Patagonia; stone hatchet found with it (Specimen No. 239). E, marked platycnemism; Pah-Ute Indian, female of about forty (Specimen No. 964).

an outward bend, causing the child to appear bandy-legged. It is probable, however, that when this is considerable, there is a defect in the nutrition of the bones. In some parts of the United States, as at New Orleans, there is a marked deficiency of lime salts in the water, and it is accordingly noted that deformities of this kind are more common there. Still, it is not unusual to see the limbs of a bandy-legged child straighten as puberty approaches, and it may be questioned whether a certain degree of this defect is not due to a reversion to the type of tibia found in our "frugivorous ancestors of arboreal habits." Among negro children bandy legs are very common. As this defect occasions an unusual prominence of the shin, and consequent liability to injury, it is probable that there may be some slight ground for the prevalent notion that the shin of the negro is one of his most vulnerable points.

In certain races, especially those that approximate to the prehistoric type, such as the Esquimaux, the Patagonians, certain Indians, early Europeans, and the mound-builders, a peculiar form of tibia is found which is decidedly simian in character. The bone is markedly flattened from side to side, and presents a sabre-like edge on the crest. This is known as the platycnemic tibia. Fig. 2075 shows sections of tibiæ of this kind compared with the usual type, the sections being made at the level of the nutrient foramen. Wyman found upon examination of a considerable number of skeletons of the mound-builders that about sixty per cent. of their tibiæ were platycnemic. It seems quite probable that in such legs the tibialis anticus muscle is larger and more oration appear from the staining of the skin with the coloring-matter of the blood, especially in old persons who heat the legs much before the fire. This the older physicians called *ephelis ab igne*, indicating its relation to freckles, or *ephelis a sole*. Ulcers are very common ; a small abrasion, which would elsewhere heal without trouble, here remaining indefinitely, and being very difficult to cure without placing the patient for some time in a recumbent position.

The most common situation for ulcers is naturally where the bones are subcutaneous, and the leg most exposed to violence. Syphilitic ulceration is also common, especially in front of the knee.

The principal venous trunks are two. The internal saphenous vein (Fig. 2076) commences on the inner side of the foot, courses upward in front of the internal malleolus, then behind the internal border of the tibia, and passes into the thigh behind the inner condyle of the femur. It finally discharges into the femoral vein through the saphenous opening in the fascia lata. The external saphenous vein (Fig. 2077) arises from the back of the foot, passes behind the external malleolus, upward along the tendo-Achillis over the gastrocnemius, and penetrates the deep fascia to empty into the popliteal vein. Both of these veins communicate frequently with the deeper veins by short branches through the fascia, and both are accompanied by cutaneous nerves.

For the reasons before mentioned these veins are very liable to become varicose, especially with those who stand much in one position, like washerwomen ; and these varicosities usually occur at those points where the com-

munication exists between the superficial and deep systems. The enlargement is frequently accompanied by considerable pain, because of the pressure upon the accompanying nerves. Varicosities are also likely to occur in those whose occupations require them to use powerfully the muscles of the leg while the thoracic and abdominal muscles are comparatively fixed, as, for instance, in pushing a heavily loaded wheelbarrow up hill. In this case the vein is constantly acted upon by the con-

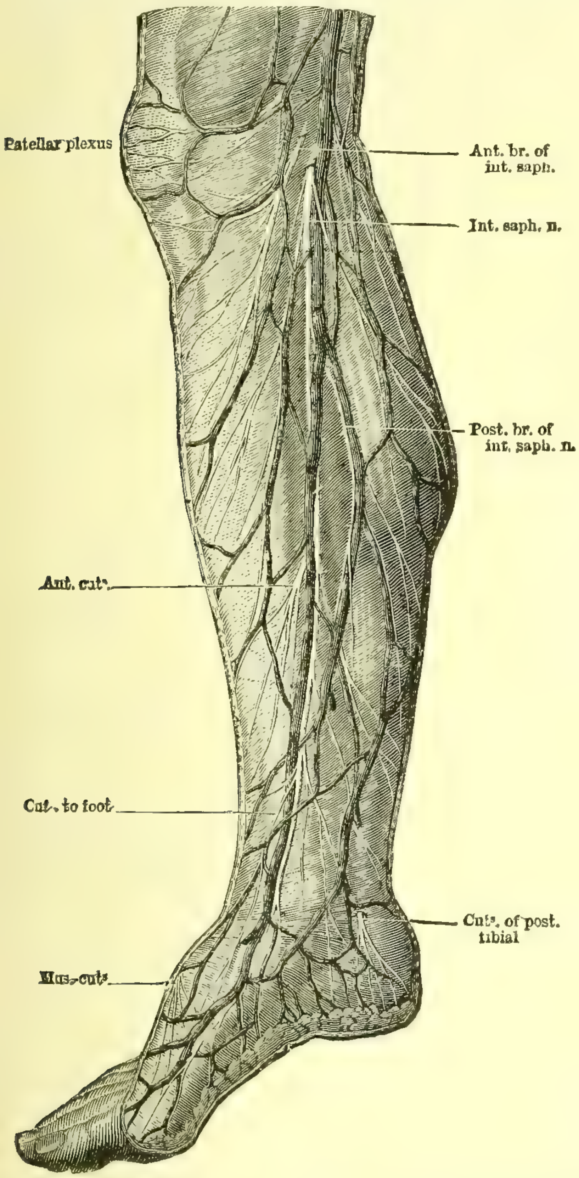


FIG. 2076.—Cutaneous Veins and Nerves of the Right Leg, Internal View.

traction of the leg muscles, which force the blood from the deep veins into the more superficial ones, and also by the weight of the superincumbent column of blood, and the compression exercised upon it by the muscular action of the diaphragm and the abdominal muscles. The wearing of tight garters, or any other obstruction to the circulation, such as a gravid uterus or any other abdominal tumor pressing on the main vascular trunks, is liable to occasion varices, anasarca, or some other symptom of congested circulation. It is found that the left leg is more commonly affected in this way than the right. This may be partly accounted for by the presence of the sigmoid flexure of the colon on the left side, which, containing periodically an accumulation of fæces, presses on the iliac veins.

Probably atony of the walls of the colon, with a dilatation and partial impaction of the sigmoid flexure are less rare than is commonly supposed. It is said that cold feet

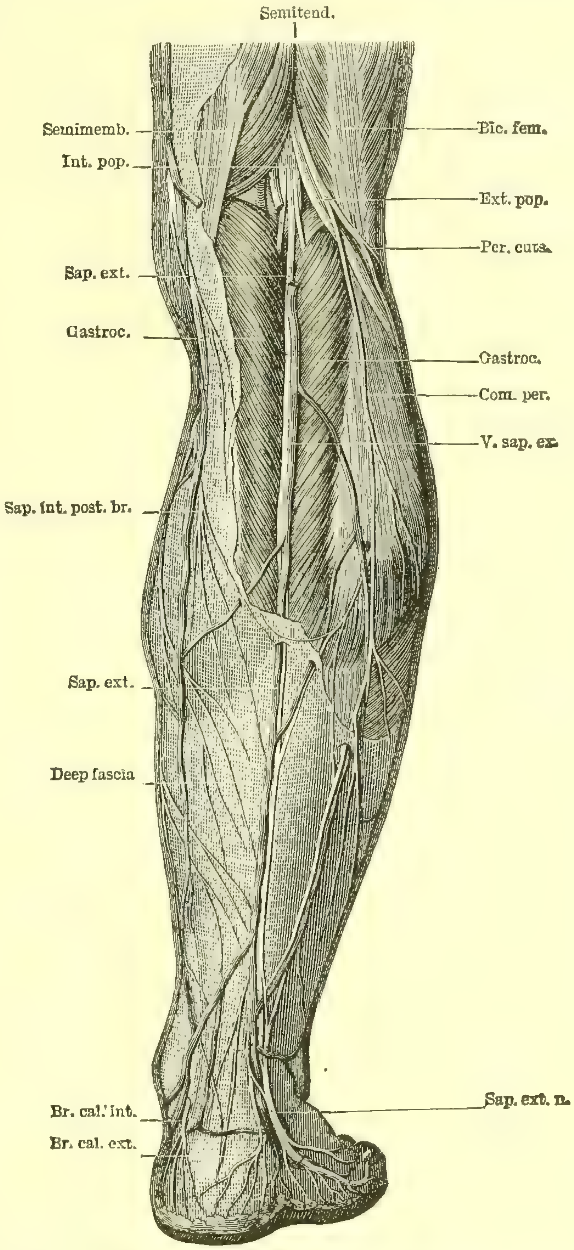


FIG. 2077.—Branches of Right External and Internal Saphenous Veins

have been cured by a thorough washing out of the colon, and thus modifying the circulation of the limb. But another cause for the greater frequency of affections of this kind in the left leg is the peculiar arrangement of the iliac veins. Since the vena cava is on the left side of the spine, the left common iliac has to cross to the opposite side, and in doing so dips under the right common iliac artery, which is crossing in a similar way from the aorta to the right side. A little lower down the iliac vein passes under the left common iliac artery. In both

these cases the artery crosses nearly at right angles to the direction of the vein, and at every pulsation occasions a certain amount of obstruction to the free flowing of blood through the latter. On the right side the arteries which cross the veins do so obliquely, so that there is

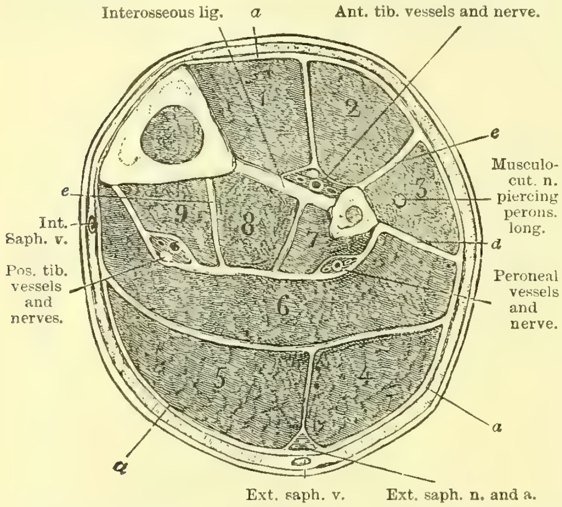


FIG. 2078.—Diagram of a Transverse Section through Right Leg, at Upper Third, to show the Disposition of the Intermuscular Septa. Lower surface of section. *a, a, a,* Deep fascia or aponeurosis; *d, e,* intermuscular septa; 1, tibialis anticus; 2, ext. long. dig.; 3, peroneus longus; 4, ext. head of gastroc.; 5, int. head of gastroc.; 6, soleus; 7, flex. long. hall.; 8, tibialis posticus; 9, flex. long. dig.

much less obstruction. Varices are not confined to the superficial veins. Verneuil thinks that they frequently occur in the venous plexus, which exists between the superficial and deep muscles of the calf, and that this may explain the pain which occurs without obvious cause in those whose occupation requires them to stand a great deal. It is interesting to note that we may trace the ulti-

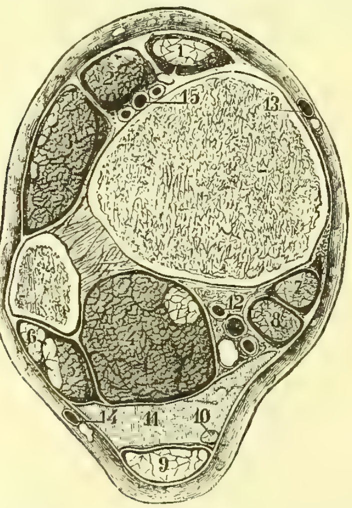


FIG. 2079.—Transverse Section of Left Leg, just above the Bases of the Malleoli. Inferior surface of section. 1, Tendon of tibialis anticus; 2, ext. prop. hall.; 3, ext. com. dig.; 4, flex. long. hall.; 5, peroneus brevis; 6, peroneus long.; 7, tibialis posticus; 8, flex. long. dig.; 9, tendo-Achillis; 10, plantaris; 11, fatty tissue; 12, sheath of posterior tibialis, vessels and nerves; 13, internal saphenous vein and nerve; 14, external saphenous vein and nerve; 15, anterior tibial vessels and nerves.

mate cause of varices to the erect posture. Man is the only animal in which the weight of the whole column of blood contained in the vena cava presses directly upon the veins of the lower limbs. The cava has no valves, and recalling the action of the hydraulic press, we see at once what a powerful effect the weight of its column of blood must have. This defect in the structure of the vascular system is explained when we remember that in other animals the vena cava lies, in the ordinary posture, in a nearly horizontal direction, and the blood it contains exerts no pressure upon the veins of the leg. The leg itself is amply provided with valves. The cessation of valves at just the point where they would be of most use is really one of the many proofs which anatomy gives that man has assumed the erect posture within so recent a period that the body is not yet perfectly adapted for it.

The fascia covering the leg is arranged as in the other limbs. A single dense layer ensheathes the whole, blend-

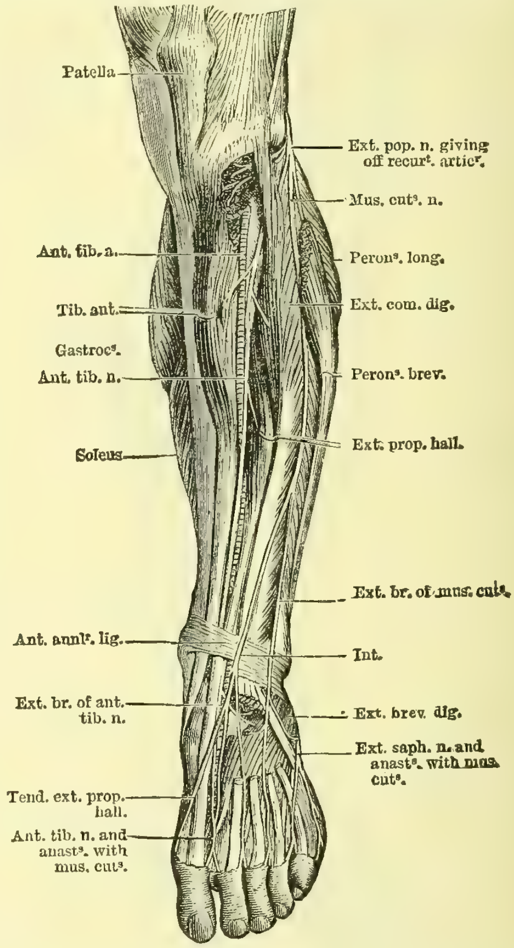


FIG. 2080.—Dissection of the Front of the Left Leg and Dorsum of Foot.

ing intimately with the periosteum wherever it touches the bone, and with the ligaments both above and below. Its thickness prevents abscesses from readily appearing on the surface, and pus is more apt to burrow along the intermuscular septa.

The sartorius at its insertion sends a strong aponeurotic expansion to it, so that any action of the muscle makes the fascia tense. The superficial muscles of the leg have all a considerable origin from the fascia, and this greatly increases their effectiveness. They also arise from the septa which the fascia sends down between the muscles. Of these there is one on the outer side, passing inward to the posterior border of the tibia, and one passing between the tibia and fibula, usually spoken of as the interosseous ligament (Fig. 2078). These two separate the muscles in front and externally from the posterior muscles, dividing thus the leg into two separate compartments, which are

practically independent of each other, as any effusion in one never passes into the other. The muscles in the anterior compartment are so compressed by the dense tissues surrounding them that they usually bulge out through an incised wound, and when it is necessary to make in it a longitudinal incision, as, for instance, when the anterior tibial artery is tied, it is advisable to relieve the sharp tension of the edge of the fascia by a cross incision.

The anterior compartment is again subdivided by a layer of fascia extending from the external sheath to the anterior border of the fibula, separating off the peroneal muscles from the remainder. The latter again are divided by a fibrous partition, which passes between the anterior tibial and the extensor communis. This, a well-marked fibrous septum, may be used as a guide in tying the anterior tibial artery. In the lower part of the leg the extensor of the great toe and the peroneus tertius lie directly outside the tibialis anticus. The order in which the tendons pass down over the instep is shown in the article on the Foot.

The anterior tibial artery (Fig. 2080) is the chief object of surgical importance in the anterior compartment. It is the smaller of the two divisions of the popliteal, and attains the front of the leg by passing between the two heads of the tibialis posticus muscle, and above the interosseous ligament, which is deficient in the upper part of the tibio-fibular interspace. It is here very firmly united with the denser fibrous tissues, and when wounded it is very difficult to secure it. Being held open by its attachments, hæmorrhage is usually profuse, and it is often necessary to tie the femoral artery to control it. The general direction of the vessel is under a line drawn from the inner side of the head of the fibula to midway between the malleoli. This latter point should be estimated by standing directly in front of the foot with a finger on each malleolus. As the artery lies in the first muscular interspace which occurs on passing outward from the tibial crest, there may be a slight groove brought out directly over the course of the artery when the muscles are caused to contract by strongly bending the foot upward. At its upper portion the vessel lies deeply against the tibia and the interosseous membrane, and between the tibialis anticus and the extensor communis. It is here very difficult to reach, and is not usually tied, except when wounded. In that case the usual rule is followed of enlarging the wound and securing the bleeding ends. Lower down, as the muscles become tendinous, it is more accessible and easily secured. It then lies between the tibialis anticus and the extensor proprius hallucis, the latter tendon covering it just as it passes under the annular ligament to become the dorsalis pedis. The artery is accompanied by the anterior tibial nerve, which reaches it by passing around the head of the fibula (Fig. 2081), where it is somewhat liable to injury. The nerve is, therefore, at first external to the vessel, it afterward gets in front, and occasionally crosses to the inner side. Venæ comites accompany the artery, and by their frequent anastomoses greatly increase the difficulty of securing it. It is not unusual for the artery to be wounded by splinters of bone when the tibia is fractured; and the nerve may also be injured in the same manner, causing great pain, which may appear to the patient to be in the foot or ankle. Section of the nerve is not a serious matter, as it does not alter notably the functions of the member.

In the external or peroneal compartment there are but two muscles, the peroneus longus and brevis (Fig. 2081). These are long and slender, attached strongly to the fibula and to the deep fascia above, and tapering below into rounded tendons, which pass behind the external malleolus. They are supplied by the peroneal nerve, which may be injured by a fracture of the fibula, whence may result a considerable impairment of the functions of the foot, as the outward pointing of the toes is mainly accomplished by these muscles. The head of the fibula is sometimes torn off by the sudden muscular traction of the biceps muscle, and the lesion is usually accompanied by a considerable amount of pain, which may continue during the entire time that the callus is forming. This is due to the close contiguity of the peroneal (external popliteal) nerve.

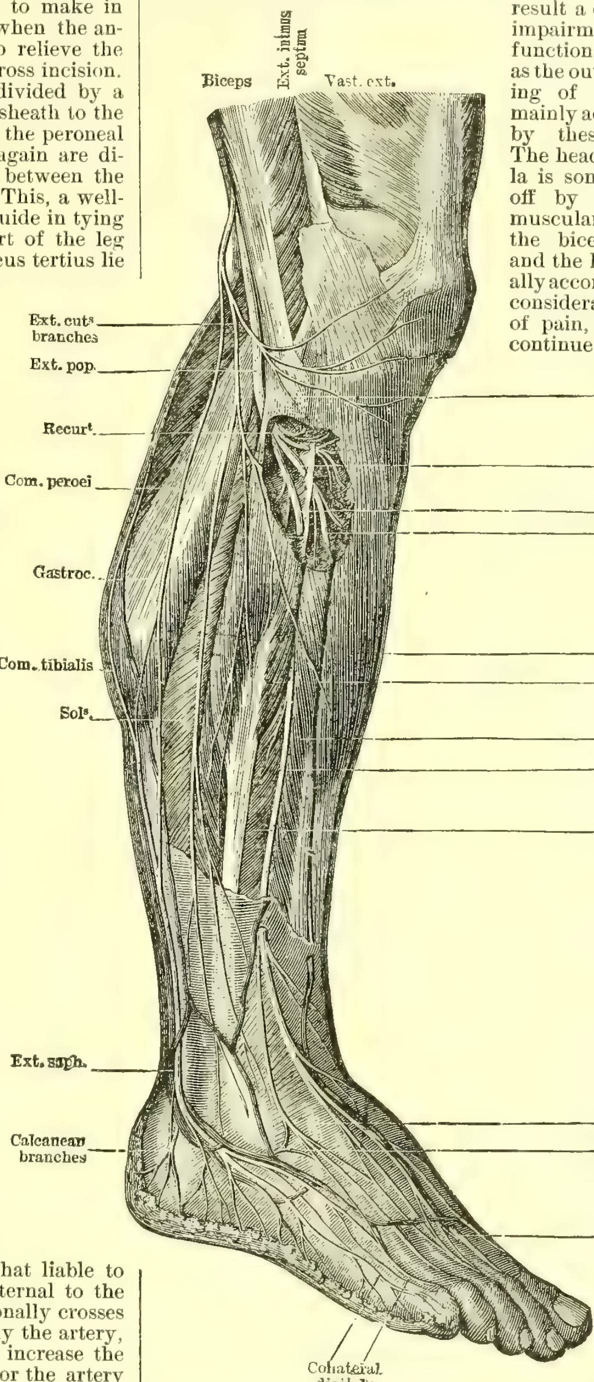


FIG. 2081.—Dissection of Outer Side of Right Leg and Foot, showing branches of Right External Popliteal Nerve.

The posterior compartment of the leg is by far the largest of the three. A strong intermuscular septum divides it transversely into two (Fig. 2078), separating the muscles into superficial and deep groups. The superficial muscles

form a well-marked group attached to the tendo-Achillis, and therefore act together as a rule. These form the prominence of the calf before mentioned, and consist of the gastrocnemius superficially, under it the soleus, which considerably exceeds it in size, and the insignificant plantaris. Many anatomists describe the gastrocnemius as two

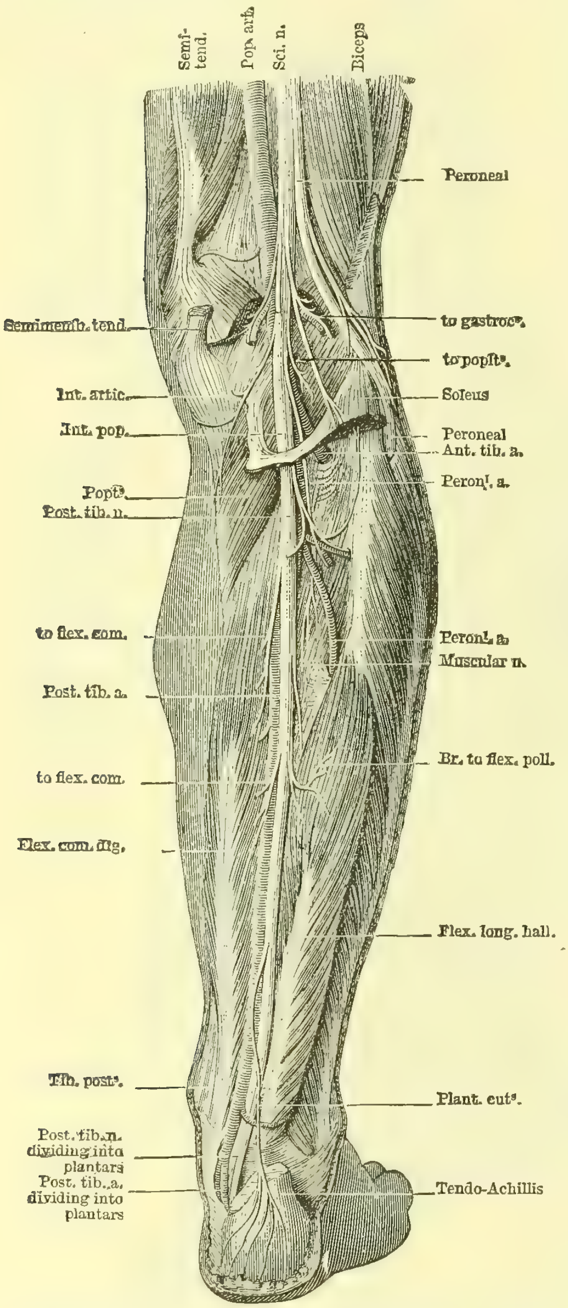


FIG. 2082.—Right Posterior Tibial Nerve and Artery. The internal popliteal nerve is seen passing beneath the fibrous arch of the soleus.

muscles, and from this conception arises the French name *les jumeaux*. Combined with the soleus the whole muscular complex is known as the triceps extensor suræ. The two heads of the gastrocnemius take origin above the condyles of the femur. It is, therefore, a muscle which controls two joints, and its contraction flexes the knee and at the same time extends the foot. When it is affected by rheumatism it may cause spurious anchylosis of the knee-joint. The co-existence of extension of the foot will enable a diagnosis to be made. The fibres of either head are arranged in a beautiful penniform manner around a tendon which cannot be completely displayed until the muscle is cut and turned back. Its coadjutor, the soleus, does not pass over the knee-joint, but is attached to the tibia and the fibula, throwing across between the two a fibrous arch of fascia which protects from compression the vessels as they pass under it. The gastrocnemius and the soleus are remarkably subject to cramps. This muscular affection, which appears usually to be an

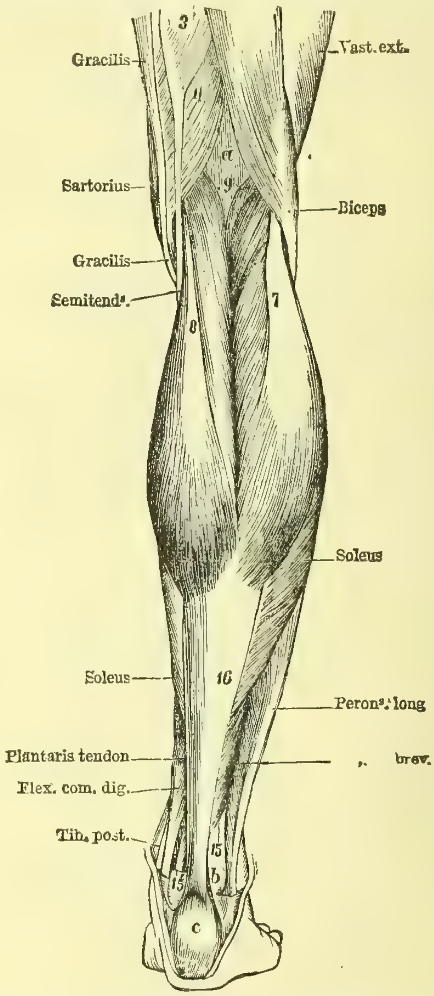


FIG. 2083.—Superficial Muscles of Back of Right Leg. *a*, Popliteal space; *b*, extl. malleolus; *c*, os calcis; 3, semitends.; 4, semimembs.; 7, 8, Gastrocs.; 9, plantaris; 15, 15, flex. long. hall.; 16, tendo-Achillis.

irregular muscular action, independent of the nervous system, may be brought about by slight causes, such as a draught of air blowing on the calves, vigorous exercise in swimming or running, especially when cold currents are directed on the limb. The greater frequency of the disorder in these muscular masses is probably due to the peculiarities of the blood-supply to the leg, to which allusion has been made, and anything that tends to produce a more active circulation through the muscles, such as kneading or rubbing, will relieve the cramp. It is suggested that both in this case and in others where massage upon the leg is necessary, some care be taken to apply it along the trunks of the veins and in a direction from the periphery toward the heart. Cramps of these muscles are frequent during pregnancy, and in that case may per-

haps be due either to pressure upon the iliac veins or upon the nerve-trunks in the pelvic cavity.

The little plantaris (Fig. 2083) is a vestigial muscle, representing a much larger one found in other animals. Its muscular portion is frequently not more than an inch long. It arises above the outer condyle of the femur, and terminates in a slender, threadlike tendon, which passes down along the internal border of the tendo-Achillis, and finally inserted with it into the posterior border of the calcaneum. It is probably of no importance whatever, though the French surgeons have imagined that its tendon may be ruptured by a sudden action, producing the affection known as *coup de fouet*—a sudden stinging pain in the calf. This affection is not rare. In a case within the writer's knowledge it occurred to a lady while dancing. It is more likely that there is a rupture in the large muscular mass of the gastrocnemius and the nerves of supply. It is not clear that the little tendon of the plantaris would cause any pain if it were to rupture, and the lesion has never been demonstrated clinically, so far as the writer is aware.

The tendo-Achillis passes down to be inserted upon the tuberosity of the calcaneum. The projection which this makes behind the malleoli determines the length of that arm of the lever. In negroes and others with flat feet this projection is somewhat greater. By this setting back of the tendon two fossæ are formed, one on either side, behind the malleoli (Fig. 2079).

Between the triceps suræ and the deeper layer are the principal vessels and nerves. The posterior tibial artery (Fig. 2082) is the direct continuation of the popliteal, and receives its name on passing under the fibrous arch of the soleus. It almost immediately gives off the anterior tibial and the peroneal arteries, the rule being, according to Holden, that in amputations one inch below the head of the fibula one artery is divided, two inches two arteries, three inches three arteries. It bifurcates into the plantar arteries at a line drawn from the point of the malleolus to the middle of the heel (Wyeth). If we take a point midway on this line, and draw another line upward through the centre of the calf, we will have approximately the course of the artery. In the upper part of its course it is so deeply buried under muscular masses that it is very difficult to reach. On this account it is usual in ligating it not to make the incision directly over the artery, but, to avoid cutting the gastrocnemius, by commencing only two finger-breadths from the internal edge of the tibia, finding the edge of the gastrocnemius, and pushing it aside. The fibres of the soleus are then carefully divided in the direction of the artery. There is usually a deep aponeurotic tendon inclosed within the fibres of the soleus, having muscular fibres inserted on its anterior and posterior surfaces. When this is reached it serves as a warning to the operator that the artery is not far off. By separating the edges of the incision the vessel may be found, even if not exactly in the direction of the cut. It is very rarely tied here.

Below, where the artery becomes more superficial, there is no difficulty in finding it. In operating anywhere on the inner side of the leg the internal saphenous vein must be avoided. The artery is accompanied throughout by two veins, with frequent cross anastomoses, and by the posterior tibial nerve, which is at first on its inner side, but crosses over to the outer side, below where the peroneal artery is given off. A section of the nerve paralyzes the plantar muscles.

The deep layer of muscles is constituted by the tibialis posticus, the flexor communis, the flexor longus hallucis, and the popliteus. The latter muscle is confined to the upper part of the leg, arising by a rounded tendon from the groove above the external condyle of the femur, and passing obliquely inward to the tibia. It is believed to represent the pronator radii teres of the arm, and, like that muscle, assists in rotating the segment and in bending the joint. All the other muscles terminate in tendons which pass down behind the inner malleolus into the foot. Besides a considerable origin from the intermuscular septum, the tibialis posticus and flexor communis arise from the tibia; the flexor longus hallucis from the fibula. As the tendons pass downward those of the flexor communis and the tibialis posticus twist around each other, interchanging places, so that at the ankle the latter is nearest the bone. (See article Foot.)

Within the fibres of the flexor longus hallucis the peroneal artery runs close to the fibula, and is therefore often wounded when that bone is fractured. The artery may be of larger size than the posterior tibial, and may take the place of the anterior tibial. At its upper part it is so surrounded by fibrous structures that aneurism of it is extremely rare. It is also so well protected by the fibula that it is rarely wounded. It is still more difficult to reach for ligation than the posterior tibial, and this is not practically done except as a surgical curiosity. When effected, it is by detaching the fibular origin of the soleus and raising the flexor longus hallucis.

Frank Baker.

LEMON (*Limonis Cortex, Limonis Succus,* U. S. Ph., Br. Ph.; *Fructus Citri,* Ph. G.; *Citron ou Limon,* Codex Med.). *Citrus Limonum* Risso, the Lemon, is a large, evergreen, fragrant shrub, two or three metres or more in height, with numerous straggling grayish branches and green or reddish spiny twigs. The scattering leaves are like those of the orange, articulated to the petiole; they are ovate, rather narrow, pointed, slightly serrate. Petioles not at all, or very narrowly, winged. The deliciously sweet flowers have the same structure as those of the orange, but are rose-colored or purplish externally. The fruit (Lemon) resembles the orange in structure, but differs from it in its lighter color, generally rougher skin, and especially in its oblong, nipple-tipped, or pointed shape, and its exceedingly sour taste. This plant, like the others of its genus (Orange, Bergamot, Citron, Shaddock, etc.), came originally from Northern India, has been cultivated from an unknown period, and exists now in many arboricultural varieties. Lemons need no formal description. The peel and juice are officinal. The former for medicinal use is pared off with a knife in thin ribbons, so as to include but little more than the oleiferous zone. It has a fragrant, pleasant odor, and a bitterish, aromatic taste. Lemon-juice is prepared by simple expression of the pulp, and straining if there are any evident shreds of the pulp or partitions in it, as these will make it bitter upon standing. It is a slightly turbid, yellow, nearly odorless, pleasantly but intensely acid liquid, of sp. gr. about 1.030. Besides these, which are prepared extemporaneously from commercial Lemons, the Oil of Lemon (*Oleum Limonis,* U. S. Ph., Br. Ph., etc.), imported from the south of Europe, is also in extensive use as an elegant and popular flavor.

Composition.—Lemons contain three distinct leading constituents, in as many distinct anatomical parts of the fruit: The *essential oil,* in a zone of large spherical glands situated just beneath the outer surface of the peel. It should not be distilled, but separated from the rinds by the same processes as are used for the oils of orange and bergamot—that is, by in some way rupturing the vesicles and collecting it mechanically. It is a pale-yellow, fragrant liquid, of an aromatic, bitterish taste and a neutral reaction; soluble in two parts of common alcohol, and in one or two thousand parts of water. It keeps badly, becoming thicker by age, and acquiring a disagreeable turpentine-like odor. The white spongy part of the peel and the partitions have a bitterish taste, due to the crystalline neutral substance *hesperidin,* common also to the other fruits of the genus. It is not used in medicine. The pulp owes its acidity to five or six per cent. of, mostly free, *citric acid* (of which lemons, limes, and sour oranges are the principal sources), and to a little *malic acid.*

Uses.—Lemons are mostly used as an agreeable and wholesome flavor for food and drink. Their medicinal value is slight, and consists in their antiscorbutic quality, for which the juice (or lime-juice) is carried on shipboard, and, on long voyages, is meted out to sailors and passengers. The introduction, however, of steam navigation, by making short voyages, and of canned meats and vegetables for ocean use, has nearly obliterated scurvy.

As a grateful refrigerant drink in fevers, and especially in rheumatism, lemonade has no equal. The oil has the properties of the aromatic oils in general, but is only used as a flavor.

ADMINISTRATION.—The following preparations (not including citric acid or the citrates) are officinal: Spirit of Lemon (*Spiritus Limonis*, U. S. Ph., the Essence of Lemon of the kitchen) contains six parts of Oil of Lemon, four of Lemon-peel, and enough alcohol to make a hundred; macerate and filter. The Syrup of Lemon (*Syrupus Limonis*, U. S. Ph.) is made of: Lemon-juice, forty parts; fresh Lemon-peel, two parts; sugar, sixty parts; and water enough to make one hundred parts. Boil the juice, add the peel, and, when cold, filter, adding water enough to make forty parts; finally put in and dissolve the sugar. The Syrup of Citric Acid (*Syrupus Acidi Citrici*, U. S. Ph.) keeps better and is almost invariably substituted for this by the apothecaries. It contains: Citric acid, eight parts; water, eight parts; spirit of Lemon, four parts; syrup, nine hundred and eighty parts; and is a close imitation of the other. The mixture of Citrate of Potassium (Neutral Mixture, *Mistura Potassii Citratis*, U. S. Ph., an old fever-mixture not much used at present) is Lemon-juice neutralized by bicarbonate of potash. Lemon-juice is frequently added to the alkaline carbonates to form an effervescing draught.

ALLIED PLANTS.—See ORANGE.

ALLIED DRUGS.—The fruit-acids, and the aromatics.

W. P. Bolles.

LENTIGO, or freckle, consists in a pigment deposit in the skin, characterized by round or irregular, pin-head to pea-sized, yellowish, brownish, or blackish spots, occuring usually about the face and on the back of the hands.

The affection is common, but varies in the degree of development. There may be only a few insignificant spots, or they may exist in such profusion as almost entirely to conceal the natural skin. It is common to all ages except infancy, but is most frequently seen in its greatest development during adolescence. Individuals with light complexions, and especially those with red hair, are most liable to these blemishes. Heat and the sun's rays favor their production, hence lentigo is more marked in summer than during the cold season; in fact, freckles to a great extent often fade away as winter approaches. The color of the spots varies from light-yellow to a brown, or even blackish, tint. In rare forms of atrophy of the skin, complicated with telangiectasia, blackish freckles are met with, as in the cases reported by Hebra and Kaposi, Taylor, and Duhring.

Lentigo consists of a circumscribed deposit of pigment granules—merely a localized increase of the normal pigment. It differs from chloasma only in the size and shape of the lesion. Treatment is the same in both affections (see Chloasma). The blemishes can be removed by treatment, but their return is almost certain.

Henry W. Stelwagon.

LEPRA. SYNONYMS: Leprosy; Elephantiasis Græcorum of the Norwegians; Leontiasis of the ancient Greeks; Zaraath of the Hebrews.

HISTORY.—The term zaraath is used in many places in the sacred writings to signify a disease which is now known as leprosy; but at the same time it was used to designate other diseased conditions, and, in fact, it appears to have been applied to various severe or contagious maladies, such as psoriasis, scabies, etc. It is probable that leprosy existed among the Jews when they migrated from Egypt to Palestine, and it was doubtless prevalent among the Egyptians before that time. Hippocrates and the older Greeks used the term lepra to denote white spots covered with rough scales, and it has since been used by Willan and the older English writers to signify a particular form of psoriasis. The term elephantiasis was used by Celsus in his description of a disease at that time but little known in Italy, but which was, no doubt, identical with the leprosy of modern times.

After the downfall of the Roman Empire all accurate knowledge of leprosy disappeared. The Arabian physicians referred to it, but their knowledge was obtained from the old Greek and Roman writers.

From the eighth to the fourteenth century the disease became prevalent in Europe. During the era of the crusades there existed a great deal of poverty and wretchedness in those countries whose armies were engaged in foreign war. The disease was probably brought from the East by returning soldiers, and spread rapidly among the common people, who were already predisposed to it by the hardships and miseries of their lot. Its greatest virulence was experienced during the twelfth and thirteenth centuries, when it is stated that 19,000 lazarettos existed in Europe. During the fifteenth century it began to subside, and in the sixteenth it almost entirely disappeared. After the revival of learning in the fourteenth century old manuscripts came to light in which the disease was treated of under the several names of lepra, elephantiasis, etc. This multiplicity of terms caused much confusion, which is still a drawback to the study of the disease.

Of modern writers, Danielsen and Boeckh were among the first who gave an exhaustive and accurate account of the malady. They possessed special advantages for its study, as they lived in Norway, where it has existed for years, and they had travelled in those countries bordering on the Mediterranean, where it is still found.

Virchow, and afterward Hebra and Kaposi, made independent and thorough studies of leprosy, confirming and adding to the observations of Danielsen and Boeckh. Very much valuable information was collected by the Committee of the Royal College of Physicians, and is embodied in their report. In this country Dr. J. C. White, of Boston, has devoted a great share of attention to the subject, and has written some very able articles on the contagiousness of leprosy. At the present day the geographical distribution of leprosy is very extensive. It is found in those countries around the Mediterranean Sea where it was formerly so prevalent, as well as in various other parts of Asia and Africa. In Northern Europe its principal home is in Norway and Sweden. It is found in the West Indies, in the islands of the Pacific Ocean, in Madeira, in South America, and in Mexico, Louisiana, California, British Columbia, Minnesota, and New Brunswick. Isolated cases of leprosy have appeared from time to time in the principal cities of the United States.

In North America the principal colony of lepers exists in New Brunswick, in the country lying between the Bay of Chaleurs and the Miramichi River. The origin of the disease in this district is shrouded in obscurity.

The first persons known to have been affected were two women who came to Tracadie from a neighboring parish, married, and settled there about the year 1815. Some years afterward the disease spread rapidly, attacking families not related to one another. In 1844 the attention of the Government was drawn to it, and a lazaretto was built on Sheldrake Island, in the Miramichi River.

In 1849 the present lazaretto was established at Tracadie. In former years patients were compelled to enter the lazaretto as soon as the disease was discovered, but it was found impossible to carry out the law. For several years the priest of the parish, who is always on the watch for the appearance of the disease among his people, has induced those who are affected by it to live in the hospital, persuading them that it is the best course for themselves and their neighbors.

A few undoubted cases of leprosy have been discovered in Cape Breton, and were described by Dr. McPhedran in the *Canadian Journal of Medical Science* in September, 1881. In Minnesota leprosy is confined to the Norwegian settlements. Dr. Boeckh, who visited these colonies in 1870, found eighteen cases, most of whom were leprous before they emigrated, though some contracted the disease after they came to America. It had not appeared, however, in any who were born on this side of the Atlantic. In California and British Columbia the disease exists exclusively among the Chinese. In Louisiana leprosy, after having been prevalent during the last century, disappeared entirely for a time, so far as is

known, but within the last twenty years it has reappeared and a number of cases have been reported.

Clinical History.—Although the symptoms of leprosy may vary very much in different cases, there is a similarity in the pathological processes which makes the diagnosis comparatively easy, especially when the disease is fully developed. Two types of leprosy have been generally recognized: Lepra tuberosa or tubercular leprosy, and lepra anæsthetica or anæsthetic leprosy. A prodromal stage is common to both types of the disease. During this period the patient feels languid and depressed, suffers from sleeplessness, and feels a disinclination to do any active work. Chills, loss of appetite, and symptoms of indigestion are often noticed. This general condition of malaise may last for months or even years, or the disease may be ushered in at once without any prodromal symptoms. Very often the first hint of his state the patient receives is from his companions, who notice the brown, macular condition of the skin which will be described farther on.

Lepra Tuberosa.—After the existence of the above-described symptoms for a varying length of time, maculæ or tubercles make their appearance, either separately or together. As a general rule the tubercles follow the maculæ. The maculæ are generally extensive; they may be as large as the palm of the hand or even larger. They are well defined, and are at first of a pale or bluish-red hue, but afterward they become of a dark yellowish-brown color. The patch is smooth, glistening, and somewhat elevated above the surface. When felt, the part presents more or less thickening and hardening. The patches are found mostly on the trunk, being more abundant on the back. They also exist on the extremities, mostly on the extensor surfaces. They are rarely found at first on the face. Their arrangement is often symmetrical. These maculæ undergo many changes. They may increase gradually in extent, while at the same time their centre acquires a brownish-red or ash-gray color. After a time the centre becomes quite pale, and the margin presents a deep reddish color which gives the skin a peculiar variegated appearance. Resolution often takes place, and a white, glistening surface remains, but in some cases the skin resumes its normal aspect. This macular condition may continue for years before any further development takes place.

The tubercles are of various shapes and sizes. They frequently form where maculæ have previously existed. The skin becomes thickened and raised, and assumes the form of a tubercle with a broad base. They are often, on the other hand, round, and range in size from that of a pea to that of a walnut. These latter may be found singly, or arranged in groups. Both forms are met with in the largest numbers on the face, where they produce much deformity. The skin over the forehead becomes infiltrated, so as to form elevations over the eyebrows. The lips become thickened, and there is a widening of the nose at the base. The whole face at the same time assumes a brownish color which, together with the tubercles, gives it the peculiar leonine appearance which suggested one of the names by which the disease was known to the Greeks.

It must be remembered, however, that tubercles may form on the nose or cheek without the occurrence of any of the other changes which have been described. Next to the face these growths are found most frequently on the hands. The tubercles increase in size and undergo various changes: (*a*) They shrink and gradually become absorbed, leaving the skin somewhat atrophied; (*b*) they soften and form abscesses; (*c*) ulceration takes place. This process occurs to a greater extent in the flat forms which appear over the joints. It is frequently followed by necrosis of the bones of the joint. The pus discharged is of unhealthy appearance and often possesses a horrible odor—a condition which makes attendance upon patients so affected a matter of difficulty.

While this process is going on there is elevation of temperature, accompanied by other symptoms of fever. Erysipelas often accompanies this stage, and may spread to the other patients in the hospital.

Mucous Membranes: While these processes are taking place on the surface of the body, no less serious pathological changes often go on in the mucous membranes. Tubercles may form on the inside of the cheeks and on the soft and hard palate. The epiglottis becomes thickened, and the true and false vocal cords become affected. The voice, which is at first hoarse, afterward becomes reduced to a whisper. Ulceration takes place and more or less of the parts may be destroyed. The eyes are often attacked and destroyed by ulceration. When tubercular leprosy has existed for a number of years anæsthesia of the skin becomes manifest, and this symptom may become so prominent as to predominate over the tubercular condition. Norwegian physicians believe that every case of tubercular leprosy would become anæsthetic if the patient lived long enough. In most cases, however, the severe tubercular lesions are followed by a fatal result. Patients often sink from some intercurrent disease, such as erysipelas or blood-poisoning, or they may die of marasmus induced by pain and discharge of matter. In other cases, again, manifestations of the disease take place in internal organs. The duration is usually from eight to ten years.

Lepra Anæsthetica.—This form may become developed as such from the beginning, or, as before stated, may follow the tubercular variety. After the prodromal stage the first sign is the appearance of bullæ, which vary in size and resemble very much those of pemphigus. They disappear after some days, leaving a white, glistening cicatrix. The formation of bullæ is followed by the appearance of maculæ on the face, trunk, and extremities. These pursue a course somewhat similar to that which characterizes those of tubercular leprosy.

Hyperæsthesia is a prominent symptom. It varies in extent and severity, being frequently found in the face and hands. Patients have often to be fed, as they cannot touch anything without feeling pain. This state of abject misery may last for months or years. It gradually subsides and often terminates in anæsthesia.

Thickening and enlargement of the nerve-trunks often take place. The nerve most frequently affected is the ulnar. The latter condition is followed by contraction of the little and ring fingers.

Anæsthesia: The parts most frequently affected by want of sensation are the white central patches or the parts which still retain their pigment. There is no regular or symmetrical arrangement of these anæsthetic patches, nor do they follow the course of nerves. The anæsthesia may affect an extremity, and may be so perfect that a pin can be driven into the flesh without producing the slightest pain. Instances have occurred in which patients have been severely burnt by placing their hands unconsciously in contact with stoves.

Another important change which takes place in this form is atrophy. The skin may be wrinkled and parchment-like, or it may become thin, shining, and tightly drawn over the subjacent parts. The greatest changes are found in the hands and feet, when atrophy of the bony, muscular, and nervous structures leads to deformity, ulceration, and loss of parts. Fingers and toes fall off, leaving painful stumps. Many cases occur in which all the fingers and toes are thus lost. This form of disease is usually of longer duration than the tubercular variety.

After a time the central nervous system becomes affected. The patient becomes somnolent and morose. He has occasionally clonic spasms, and finally dies from marasmus, if he has not previously been carried off by intercurrent disease.

Morbid Anatomy.—The pathological changes take place principally in the skin and nervous system.

In the skin the most marked feature is the formation of tumors similar to those of lupus and syphilis. These growths are most frequently found in the corium, and may extend into the subcutaneous areolar tissue. They are made up of small round cells existing in a fibrous stroma. According to Kaposi, in the younger tubercles this cellular structure surrounds the blood-vessels, cutaneous glands, and hair-follicles, and the remaining part of the growths is fibrous in character.

In the older growths the round-celled structure is more generally diffused, and the connective tissue has to a great extent disappeared. The cell mass is not circumscribed, but penetrates into the surrounding structures. As the process advances the normal structures of the skin are obliterated and the tubercles either undergo atrophy and disappear, or a slow form of ulceration takes place.

The changes which take place in the nervous system have been accurately described by Virchow. The nerves most frequently affected are the ulnar, the median, and the peroneal. The trunks are not uniformly enlarged, but present swellings at intervals. These latter generally form where the nerve is situated near the surface or near some unyielding tissue. This thickening is partly due to the peculiar round-celled deposit and partly to the interstitial neuritis. The color of the nerve is changed. The neurilemma is hardened and thickened, and the connective tissue between the ultimate nerve-fibres becomes the seat of densely packed cells. As the process advances fatty degeneration and atrophy of the nerve-fibres take place, and the function of the nerve is destroyed.

The phenomena of hyperæsthesia and anæsthesia are explained by these changes in the nerve-trunks. The former occurs during the acute inflammatory stage, and the latter after the stage of atrophy. The abnormal conditions of sensation may also depend on changes in the ultimate peripheral nerve-fibres. In advanced cases the internal organs become the seat of this round-celled structure, where it produces the same changes as those we have already described.

The lungs, liver, kidney, testicles, and intestines have been found affected.

Lesions, the result of intercurrent disease, have also been found in post-mortem examination, such as inflammatory exudations, tubercle, pyæmic deposits, etc.

PATHOLOGY.—As early as 1874 Dr. T. A. Hensen, of Bergen, made a report to the Christiania Medical Society in which he stated that he had discovered, in the leprosy-nodules, little rod-like bodies lying within the cells.

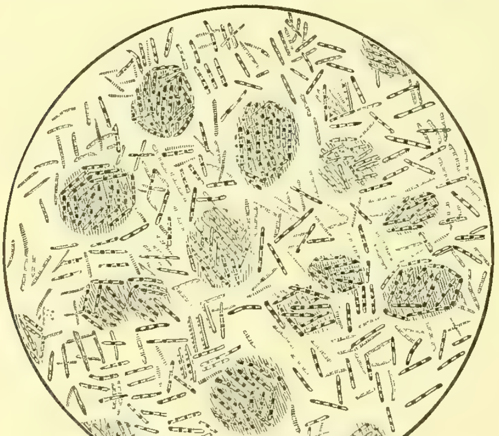


FIG. 2084.—Bacillus Lepræ. (Zeiss' $^1/_{18}$ o. i. Oc. 4.) Copied from Crookshank's "Introduction to Practical Bacteriology."

These he took to be the bacteria of leprosy. In 1880, encouraged by the success of Dr. Koch in the cultivation of the bacilli of anthrax, Dr. Hensen renewed his study of the pathology of leprosy, and by the use of the new methods of staining procured beautiful specimens, in which the bacilli were clearly brought out.

In 1879 Neisser reported independently the discovery of the bacilli of leprosy. He inoculated rabbits and dogs with leprous matter, when inflammatory nodules were produced. Experiments have, however, failed so far to prove that the disease, in its entirety, can be communicated to the inferior animals by inoculation. The bacilli are minute, rod-like bodies found in parallel rows, or ranged end to end. It is probable that the spores, or the bacilli themselves, find their way into the body through some lesion in the epithelium, and that thus, by their growth and increase, the system becomes affected. The nodules and infiltrations are thus the result of a specific irritation due to the presence of the bacilli. Although it has not been yet absolutely proved that this is the true theory of the origin of leprosy, it is in all probability the correct one, and only needs further investigation to confirm it. It certainly gives the best explanation of the many and varied clinical and pathological phenomena met with in the disease.

ETIOLOGY.—The causation of leprosy has been the subject of much discussion. In ancient times and during the middle ages the disease was thought to be very contagious, a belief which led to the segregation of lepers in lazarettos; and in many countries where the disease is endemic the same opinion still prevails among the common people.

The various causes which have been suggested may be discussed under the following heads: (1) Surrounding conditions, (2) heredity, (3) contagion.

The principal conditions which predispose to leprosy are bad hygienic surroundings, crowded dwellings, and the use of unwholesome food. In many countries where the disease is prevalent the inhabitants eat stale fish. This occurs so frequently that some authors have given it as the principal cause of leprosy. It is, however, extremely improbable that this or any circumstance connected with the surroundings of patients can act as the sole cause of the disease.

In Tracadie, the leprous district of New Brunswick, all these conditions are present. Many families of ten and twelve individuals are crowded into dwellings of two or three rooms. During the long winter most of the time is spent within doors; one of the principal articles of diet is stale fish, which is preferred to the fresh article. Tuberculosis is a prevalent disease, and the people easily succumb to slight inflammations. But north of the Bay of Chaleurs, and south of the Miramichi River, there are French settlements in which the people live under similar conditions to those described, and yet leprosy is unknown in these latter districts.

The opinion of Hebra and Kaposi, as given in their exhaustive treatise on dermatology, that the disease is caused by surrounding conditions, is hardly tenable with the knowledge which we now possess on this subject.

The theory has been held by many that hereditary transmission is the principal, if not the sole, cause of the disease. This theory was strongly held by Danielsen and Boeckh, and was further confirmed by the report of the Committee of the Royal College of Physicians. On reading the report one can scarcely understand how the learned members could arrive at such definite conclusions from the data supplied by the observations of those who have lived in leprous countries. There is no doubt that we have in heredity a very strong predisposing cause to the disease, but it has not been proved in any case that this is the only reason for its existence. It is probable that leprosy is hereditary in the same way as tuberculosis, in which there may be a strong family predisposition; but unless the patient is brought into immediate contact with the contagion the disease is not produced. So far as is known to the writer, no case has yet been reported which would prove conclusively that the disease can arise from hereditary influence alone.

The theory of contagion has been revived during the last decade, and the discovery of the bacilli has given it much support. The writer has elsewhere given the result of his observations on this point, made in Tracadie. He is convinced that the origin and course of the disease in that district is most readily explained on the theory of contagion. There is no doubt that unwholesome food, unhealthy surroundings, and heredity are strong predisposing conditions, and that one or all of them must be present before the disease can be propagated. A very

remarkable proof of the contagion is given by the outbreak in the Sandwich Islands. Some isolated cases were known there as far back as 1830, but it was not until 1860 that the disease made headway. It then increased rapidly, and the patients were sent to an island from which they could not escape. Since 1866, up to the time of the last report, two thousand patients have been sent there, and new cases are constantly appearing.

That the contagion did not spread further in New Brunswick is largely due to two facts: 1, The peculiarly isolated position of the three parishes in which it exists; 2, the other inhabitants of the Miramichi district are of the Anglo-Saxon race, and are a much more enterprising people than those of French descent. They live in more comfortable dwellings, eat wholesome food, and are altogether more able to withstand disease. From all the data attainable one might fairly formulate the following conclusions: 1, That leprosy is a bacterial disease; 2, that it is contagious only by inoculation; 3, that certain predisposing conditions must be present in order that the disease may be propagated, the two most important of these being bad food and heredity.

Leprosy occurs at all ages. The youngest patient who contracted the disease in Tracadie was eight years of age, and the oldest was over eighty. Males and females are affected in about equal numbers.

It might here be stated that, quite recently, an exceedingly interesting report has been made upon leprosy in the Sandwich Islands. The Board of Health of Honolulu invited Dr. Arning, the celebrated German bacteriologist, to investigate the nature of the disease. After two years' work a report has been published. Dr. Arning discovered that in the anæsthetic form the bacilli were found in the trunks of nerves supplying the affected parts, and not in the anæsthetic patches or in the chronic sores. He was never able to find the bacilli in the blood, even during the febrile attacks. He did not succeed in cultivating the bacilli in any of the ordinary artificial soils, nor was he able to produce the disease in any of the lower animals by inoculation. Dr. Arning has come to the conclusion that the bacillus lepræ is a parasite limited to the human race, and that it is transmissible directly from individual to individual, or passes through an intermediate (spore) condition.

Diagnosis.—It is difficult to recognize leprosy in its earlier stages, but when the tissue-changes already described have commenced the diagnosis is a comparatively easy matter. In districts where the disease is prevalent physicians attain great skill in recognizing it in the very earliest stages. The maladies with which it is most frequently confounded are syphilis, lupus, multiple sarcoma of the skin, and vitiligo. In its earlier stages it might be taken for pemphigus or morphœa. Sir Erasmus Wilson held the view that morphœa, as we meet with it in the Anglo-Saxon race, was a remnant of leprosy, but his opinion has not been confirmed by other observers. Of all the diseases mentioned syphilis is most likely to be mistaken for leprosy. In leprous districts cases of syphilis are frequently treated as lepers. In the Tracadie lazaretto there was one undoubted case of syphilis.

On the other hand, in countries where lepra seldom occurs a case of the macular variety might be taken for syphilis. In the former disease the occurrence of tubercles, areas of infiltration, anæsthetic patches, atrophy and contraction of muscles ought to distinguish it from constitutional syphilis.

In vitiligo the general health is good and there is no pathological change in the skin, except the absence of pigment.

Cases of multiple sarcoma of the skin have been mistaken for acute tubercular leprosy. A diagnosis might readily be made by microscopical examination of the tubercles. In the former disease the structure peculiar to sarcoma would be demonstrated, and in the latter the bacilli of leprosy. It is rare indeed that leprosy runs such an acute course as to be mistaken for sarcoma.

Prognosis.—As a rule the prognosis is extremely unfavorable. In almost all cases a fatal result follows, either directly or indirectly, from the disease. According to Danielsen and Boeckh the tubercular form has an average duration of from eight to nine years. The anæsthetic variety lasts much longer.

In the Tracadie lazaretto the writer found one patient who had then been twenty-four years an inmate, and the disease was continually progressing.

The duration is much influenced by the care taken of the patients. They live longer when they are removed from their leprous surroundings and are placed under good hygienic conditions, with appropriate tonic treatment. There is an acute form of leprosy which, although rare, is sometimes met with. In it the disease runs its course sometimes in a few months. On the other hand, there have been cases which have entirely recovered. The writer found a patient in the Tracadie lazaretto who was then seventy years of age, and who had suffered from leprosy forty years previously. She was admitted to the hospital on Sheldrake Island in 1844, when it was first established. During the five or six years of her residence there she suffered from anæsthetic leprosy. She lost all the fingers of both hands, leaving only the first phalanges of the thumbs. The patient was discharged cured, and afterward married. She became the mother of three children, one of whom has now been over twenty-five years in the hospital. The other two remained free from the disease. She has been subject during the last two or three years to perforating ulcers of the foot. They have probably been caused by defect in nutrition—a result of leprosy rather than a symptom of the disease itself; otherwise the patient is quite well and more active than most women of her age.

Treatment.—A great variety of remedies have been used from time to time in leprosy, but no specific has yet been discovered. The course of the disease can doubtless be much modified by improving the surroundings of the patient. Good food, fresh air, and a comfortable dwelling are of great service.

The treatment may be conveniently divided into internal and external. Iron, cod-liver oil, and stomachic tonics have been found useful in supporting the strength. Iodide of potassium, mercury, and arsenic have been administered as alteratives. Of late years chaulmoogra and gerjun oils have been highly recommended by physicians in leprous districts. The former is best given in the form of emulsion. Four of the cases at Tracadie were treated, at the writer's suggestion, by the internal administration of chaulmoogra oil and the local application of gerjun oil. Three of the patients ceased taking the internal remedy, as it disagreed with the stomach. The fourth, a case of tubercular leprosy, persevered, and developed, after some weeks, symptoms of acute mania, which disappeared when the drug was discontinued. The remedies did not appear to produce favorable results in any of the cases. Gerjun oil has been highly spoken of by Dr. Hillis, of the leper asylum in British Guiana. Hoang-nan, the powdered bark of a species of strychnos, is said to be of service.

The external treatment is adapted principally for the relief of pain and the healing of ulcerated patches. The means to be adopted depend on the condition present. Nitrate of silver solution is used as an application to sores on the mucous membranes. Iodine is applied over the diffuse infiltration, and chaulmoogra and gerjun oils, as well as the oil of the cashew nut, have been used as outward applications. Notwithstanding the employment of any or all of these remedies, the disease in almost all cases goes on to a fatal result.

Dr. Arning found, in the external use of salicylic and pyrogallic acids, agents of undoubted value for symptomatic local treatment. With these agents he was enabled to destroy leprous tubercles, and often diffused leprous infiltrations, and sometimes even to restore the feeling lost over the infiltrated patches. *James E. Graham.*

LE PRESE is a sulphur spa, beautifully situated on Lake Poschiavo, in the Lower Engadine, Switzerland. Although it lies at an elevation of about 3,500 feet above the sea, the climate is comparatively mild and equable,

the average temperature for the season from the middle of June to the middle of September being about 62.5° F. There is but one spring at Le Prese, which is known as La Sorgente Caddea, of which the following is the composition, as determined by Dr. Wittstein.

Each litre contains of—

	Gramme.
Potassium sulphate	0.0738
Sodium sulphate	0.0250
Ammonium sulphate	0.0090
Calcium sulphate	0.0650
Calcium chloride	0.0045
Calcium phosphate	0.0038
Calcium subsulphate	0.0084
Magnesium subsulphate	0.0568
Magnesium bicarbonate	0.0095
Ferrous bicarbonate	0.0065
Silicic acid	0.0260
Organic matters	0.0290
Total solid constituents	0.3173

The gases are carbonic acid and sulphuretted hydrogen. The water is taken internally, sometimes mixed with milk, and is also employed in the form of baths and douches. A course of treatment usually extends over a period of three weeks. Le Prese is frequented by sufferers from scrofulous affections; chronic laryngeal and bronchial catarrh; various skin diseases—eczema, herpes, ecthyma, and psoriasis; anæmia, chlorosis, and menstrual irregularities; and from the effects of poisoning by mercury, lead, or arsenic. *T. L. S.*

LESLIE WELL. *Location and Post-office*, Leslie, Ingham County, Mich.

ACCESS.—From Jackson, Mich., by Saginaw Division of Michigan Central Railroad to Leslie.

ANALYSIS (Professor R. C. Kedzie).—One pint contains:

	Grains.
Carbonate of potassa	0.359
Carbonate of soda	0.380
Carbonate of magnesia	0.650
Carbonate of iron	0.171
Carbonate of lime	2.214
Sulphate of lime	0.733
Silica	0.216
Organic matter	0.067
Total	4.790
Carbonic-acid gas	168 cub. in.

A mild carbonated calcic water.

Leslie is situated in the southern part of Michigan, sixteen miles north of Jackson. It has a population of about eleven hundred. There is a bath-house connected with the well. *G. B. F.*

LEUCOCYTHÆMIA (Bennett), **LEUKÆMIA** (Virchow). HISTORICAL NOTICE.—The first accurate description of this affection was published by Professor J. H. Bennett, of Edinburgh, in the *Edinburgh Medical and Surgical Journal* for October 1, 1845. In his report he drew particular attention to the chief anatomical feature of the disease—the abnormal increase in the number of white blood-cells—but attributed it to a "suppuration of the blood, independent of inflammation." He also noted the enlargement of the spleen and lymphatic glands, which was well marked in his case, but did not appreciate the relation of cause and effect between the blood lesion and the glandular hypertrophy.

Six weeks after Bennett's publication Professor Virchow, of Berlin, reported his first case of the disease in the second number for November of Froriep's *Notizen.* He recognized the fact that the condition of the blood was not due to suppuration, but to an excess of normal elements furnished by the lymphatic system, and proposed the name of leukæmia, from the gross appearance of the blood in high degrees of the affection. In 1851 Bennett proposed for this affection the name of leucocythæmia (white-cell blood), which has since been generally adopted by English writers. It is more accurate than the term leukæmia (white blood), which might be applied to the appearance of the blood after a meal containing fat; and is more comprehensive, since the disease may exist in well-marked degree without the color of the blood being sensibly affected. Nevertheless, it has been practically rejected by German writers, whose important contributions to our knowledge of this disease entitle their preferences to respectful consideration. The term leukæmia will, therefore, be used interchangeably with leucocythæmia in the course of this article.

ANATOMICAL CHARACTERS.—The characteristic lesion of leucocythæmia—the abnormal increase in the number of the white blood-cells—is secondary to hyperplasia of one or more organs of the lymphatic system, in which, with reference to the causation of this affection, are generally included the spleen and lymphatic glands proper, and the marrow of the bones. The part taken in the production of leucocythæmia by other lymphatic organs, such as the thymus and thyroid bodies, the tonsils and intestinal glands, is not thoroughly established. The thymus has been found persistent and much enlarged in some rare instances; but as the affection is essentially one of adult life—the greatest number of cases, according to Mosler, being found in men between thirty and forty and in women between forty and fifty—the part taken in its production by affections of the thymus is doubtful. The cases attributed to a diseased thymus were reported, for the most part, before attention had been called by Neumann to disease of the bone marrow as a causative factor of leucocythæmia, and, therefore, there is no proof that these cases were not of the myelogenous form. The same criticism applies to a case of Bennett's—that of a woman, aged sixty, with cancer of the lung, thyroid body, and lymphatic glands of the neck—in which the blood was leucocythæmic.

At present three forms of the disease are recognized—the splenic, lymphatic, and myelogenous—corresponding to pathological changes in those organs—the spleen, lymphatic glands, and marrow of the bones—from which the white blood-cells are derived under normal circumstances. In health there is a temporary increase in the number of the white blood-cells after meals, corresponding to the coincident hyperæmia of the spleen and lymphatic glands. This physiological condition is known as *leucocytosis.*

The first stage of leucocythæmia is one of hyperæmia, which differs from the normal condition just mentioned in that it is persistent and leads to numerical hypertrophy of the lymphatic glandular elements.

In the spleen the hyperæmia, in the first stage, is intense and leads to great enlargement and softening of the organ, which is lobulated on its surface, the depressions corresponding to the insertions of the fibrous trabeculæ. This enlargement, due to vascular engorgement, and therefore functional, soon becomes structural or organic, from permanent increase in the number of the cells of the splenic pulp. The Malpighian corpuscles of the spleen are not, as a rule, prominent in cases of purely splenic leucocythæmia, but often undergo decided hypertrophy in the lymphatic and lieno-lymphatic varieties. In the splenic form the cut surface is firm, even, smooth, and sometimes without a trace of follicles; its normal macroscopic appearance may have entirely disappeared, so that it resembles very closely the liver on section. Under the microscope, in such a case, the normal structure of the spleen—reticulum, trabeculæ, and follicles—is plainly apparent. In other cases the macroscopic appearance of a cut surface precisely resembles that of a normal spleen, and the follicles may be quite sharply defined and prominent. The most striking alteration in the spleen is its enlargement, which may be enormous. The hypertrophied organ may fill the space between the ribs and the groin on the left side, and extend from the spine beyond the umbilicus. Its weight may be ten or fifteen times greater than normal. The results of chronic inflammation of its peritoneal covering, in the form of opacities, thickenings, and adhesions to neighboring organs, are commonly observed. Hæmorrhagic infarctions are also met with. The changes in the lymphatic glands are those of simple hyperplasia. The peripheral glands are generally first affected; later those nearer the thoracic duct. The glands of the groin, mesentery, axilla, neck, and mediastinum are most often involved, but in extreme cases all the glands of the body are enlarged.

They frequently attain the size of a hen's egg, and may be as large as a man's fist. They vary in color, some being white, others yellow, gray, or, as in the case of the bronchial glands, dark purple, or even black, from pigmentary deposit. Their consistence is generally soft, sometimes almost fluctuating. The alterations in the marrow are analogous to those in the other lymphatic organs. Microscopically, they are seen to consist of an enormous increase of leucocytes, which often give to the tissue the macroscopic appearance of suppuration. The appearances of the marrow to the unaided eye are twofold, and, at first sight, very diverse. In the first form it is of a grayish-yellow or yellowish-green color, closely resembling thick, creamy pus. In the second, it is of a grayish-red or meat-red tint, and possesses a soft, gelatinous consistence. These different appearances are attributed by Ponfick to various densities of the cell accumulations and to corresponding variations in the fulness of the blood-vessels. By careful examination the leucocytes may be seen to be embedded in an extremely fine reticular tissue. In this newly formed lymphoid tissue there may be apoplectic extravasations, such as often occur in the spleen in the lienal form of the affection. The bones of which the marrow is most often the seat of the leucocythæmic process are the sternum, ribs, and vertebræ.

Changes in other than lymphatic organs are secondary to the altered state of the blood, and consist in the formation of lymphatic tissue, either as a diffuse infiltration or in nodular masses resembling miliary tubercles. The organs chiefly affected are the liver and kidneys. The former may be so greatly enlarged as to reach the crest of the ileum. "Lymphadenoid" tissue has also been found in the lungs and muscles, on the pleura, peritoneum, and mucous membranes of the air-passages and stomach. The peritoneum may be covered with small nodules, varying in size from a pin's head to a pea, gray in color, and almost transparent. Under the microscope these nodules are seen to be made up of reticular tissue infiltrated with round cells, and may also contain giant cells. This "leukæmic peritonitis" may closely resemble miliary tuberculosis or miliary carcinoma. In Laache's Case II. the peritoneum, including its different omenta, was thickly strewn with nodules composed of a reticulum containing round cells, with numerous giant cells and large round cells arranged in spaces, so as to resemble the structure of alveolar sarcoma. When lymphatic structures other than the spleen, lymph-glands, and bone-marrow are involved in the leukæmic process there is always room for difference of opinion as to whether the affection is primary or due to a secondary infiltration of leucocytes.

Changes in the Retina.—The retina is the seat of important lesions, first described by R. Liebreich in 1861. Their frequency can only be determined by an ophthalmoscopic examination of all cases, since in some they have not been accompanied by visual disturbance on account of their peripheral situation. The slightest changes in or near the macula lutea produce scotomata, the size of which is in direct ratio to that of the lesion. In all well-marked cases of leucocythæmia the color of the fundus oculi is of an orange-yellow tint. The retinal veins are pale and much broader than normal, and traces of retinal hæmorrhage are commonly observed ; they were found in four out of five cases examined by Gowers. This tendency to hæmorrhage cannot be solely attributed to malnutrition of the vessel-walls, as in pernicious anæmia, but is undoubtedly favored by the aggregation of leucocytes in the retinal vessels. Besides the extravasations, whitish-yellow spots are observed, generally with a reddish border of extravasated blood. They are composed of leucocytes and are analogous to the lymphoid growths in other organs. Their situation is generally peripheral.

Changes in the Blood.—The characteristic blood-change is the disproportionate increase in the number of the white cells, which, in extreme degrees of the affection, may be actually greater than that of the red. The macroscopic effect of an increase in the number of the leucocytes sufficient to constitute leucocythæmia is a pale-red, grayish-red, or chocolate color ("milchchocolade"), according to the degree of the affection. The cells may vary greatly in size and appearance. For example, in a case reported by Mosler (*Berlin. Klin. Woch.*, 1876, No. 49) the smallest white cells were one-third smaller than the red ; the largest more than double the size of the red, some even four times as large. To similar variations in the size and other properties of the cells Virchow has attributed a diagnostic significance. He distinguished two forms of leucocythæmia, the one originating in the spleen and manifesting itself by the presence in the blood of numerous cells identical with those of the splenic pulp ; the second, a lymphatic form characterized by the presence in the blood of cells of which the majority are identical with the elements of the lymphatic glands. Of late years considerable doubt has been thrown upon the accuracy of these distinctions. It is certain that in pure splenic leucocythæmia the diameter of the white cells may vary from 5 μ to 15 μ. Neumann regards the presence of red nucleated cells in the blood as characteristic of medullary leucocythæmia. These, although carefully looked for, were never found in a remarkable case of Mosler's (*loc. cit.*), which may be regarded as typical of primary medullary leucocythæmia, but the blood contained white cells much larger than any hitherto observed, which were found to be identical with cells withdrawn during life from the diseased marrow of the sternum. The reduction in the number of the red corpuscles is, as a rule, not extreme. Cases have steadily proceeded to a fatal termination without a reduction of more than fifty per cent. in the number of these elements. Exceptional cases have been reported in which the number of the red corpuscles has been as small as that found in pernicious anæmia, namely, 0.5 million per cubic millimetre. The proportion of hæmoglobin to red corpuscles is also well maintained, rarely sinking below seventy-five per cent. The dimensions of the red corpuscles are either normal or slightly below normal. The number of white and red cells together is below that of the normal number of red corpuscles, a point of some importance in discussing the pathogeny of the disease. Lactic and formic acids and hypoxanthine have been found in considerable quantity in the blood ; also an albuminoid, gelatinizing substance closely resembling gelatine. From the blood after death are deposited certain crystals, first described by Charcot in 1853. They were first observed in this country by Dr. White, in the blood of a patient under the care of Dr. Bowditch at the Massachusetts General Hospital in 1858. They are described as colorless, elongated octohedra, "exhibiting irregularities of form indicating an organic structure." They were named by Dr. White *leukosin*, and, subsequently, by Dr. Howard Damon, who observed them in a case of his own in blood taken before death, *leucocrystallin*. The specific gravity of the blood is diminished owing to the reduction in the number of red corpuscles, the diminished amount of albumen, and the retention of the normal amount of water. The blood-vessels in leucocythæmia are, as a rule, well filled. This is in marked contrast to what obtains in pernicious anæmia, in which affection the entire mass of the blood is notably reduced. The proportion of fibrin is, as a rule, increased.

Clinical History.—The onset of leucocythæmia is insidious and its progress gradual. An attempt has been made to divide the course of the disease into two stages: 1. A stage of development of the leucocythæmic progress in the organs first attacked and in the blood. The shortest duration of this stage may be but a few days ; the longest eight years. It averages from one to two years. In Mosler's above-quoted case of medullary leukæmia it seems to have lasted between six and seven years. 2. The extension of the process to other organs, which coincides with the establishment of the leukæmic cachexia. This division is too anatomical, too objective, for clinical purposes.

The first symptoms complained of are weakness and indisposition to exertion, either physical or mental ; loss of appetite, indigestion, dyspnœa on exertion ; later, hæmorrhages from mucous surfaces, either spontaneous, as in the form of epistaxis, or after any traumatism, such as the extraction of teeth ; diarrhœa, œdema of the feet and legs, and ascites.

The two latter symptoms are most prominent when the affection is markedly splenic, but it is not necessary to the production of ascites that the liver be enlarged, as evidenced by Bennett's second case, in which this symptom was present with a liver weighing but three pounds twelve ounces. Ascites may be due to enlarged liver, to enlarged spleen, to leukæmic peritonitis, or to one or more of these causes combined with the impoverished state of the blood. The appetite is generally greatly impaired, but may be voracious, as in a case of splenic leucocythæmia reported by Professor Da Costa in the *Am. Jour. of the Med. Sci.*, for January, 1875. Notwithstanding the inordinate consumption of food and the absence of diarrhœa, the patient's loss of flesh was progressive. In a case of Mosler's, also, the digestion was unimpaired and the body-weight maintained, while the blood was chocolate-colored and the white cells were to the red as two to three. Night-sweats may be a symptom of early appearance and obstinate continuance. Dizziness is sometimes extreme, as in a case reported by Dr. F. C. Curtis, in the *Am. Jour. of the Med. Sci.* for October, 1876, the patient walking with his legs wide apart and using a cane to support and steady himself. The dizziness is aggravated by movement, and may disappear entirely when the patient is at rest. In the splenic variety the patient may complain of dull pains and a sense of weight in the left hypochondrium. In the medullary form, tenderness over the affected bones, particularly the sternum, is to be sought for. Visual disturbances, due to hæmorrhage and leukæmic deposit, are common, although, even when these are not complained of, marked retinal changes may be detected with the ophthalmoscope. In the absence of swelling of superficial lymphatic glands and colossal enlargement of the spleen, there is no characteristic *facies* of this disease. In marked contrast to what obtains in pernicious anæmia, the cheeks may present a circumscribed redness even in a late stage of the affection. Although irregular pyrexia is often observed, the temperature, pulse, and respiration offer nothing that can be truly called diagnostic.

Hypoxanthine has been frequently found in the urine, and is said to be present only when the spleen is involved in the morbid process. The uric acid is increased, and may reach six (Laache) or even eight times (Bartels) the normal percentage. This increase has been attributed to insufficient oxidation from want of red corpuscles, and to the splenic tumor; but neither explanation suffices, for in chlorosis, in which the red corpuscles are often fewer in number than in leucocythæmia, it has not been observed, and splenic tumors are not always attended with this hyperexcretion. The occurrence of suppuration may be followed by a decided increase in the proportion of red cells to white. Thus, in a case of Laache's there were extensive pyæmic abscesses, which had their starting-point in a superficial gangrene of the skin, caused by the hypodermatic injection of dialyzed iron. The proportion of white to red cells which, before the suppuration, had been as 1 to 10, decreased to 1 to 30. The size of the spleen may greatly diminish, even in cases which steadily progress to a fatal result. In the case just mentioned, the spleen, which had advanced to the right beyond the middle line, and downward almost to the symphysis, became gradually smaller, until just before death its lower boundary was but three centimetres below the costal border.

Pathogenesis.—A thoroughly satisfactory theory of the nature of leucocythæmia has yet to be offered. Both on account of its ingenuity, as well as because there is no better one to bring forward, the theory of Norris, of Birmingham, deserves mention. It is based upon a series of laborious researches, and cannot fail to meet with favor from the many who hold that the red corpuscles are, at least, in part, derived from the white. It is simply that the white cells circulating in the blood, both in health and disease, have escaped conversion into red corpuscles on account of the shortness of their stay in the lymphatic organs. In health, Norris holds, the vast majority of the lymphatic cells are, before leaving the site of their production, converted into a pale, colorless disk, first observed by the late J. Hughes Bennett, in chyle taken from the thoracic duct, and lately described and figured most elaborately by Norris, of Birmingham, in his valuable work on the "Physiology and Pathology of the Blood." The conversion is called by Norris the *major process* of blood formation, in contradistinction to the change into red corpuscles, which he supposes the white cells to undergo while circulating in the vessels. This he designates the *minor process.* For the proper development of the primary lymph-cells, a certain amount of detention in the retiform tissue of the glands is essential, a period of incubation which is interfered with to a greater or less extent when these organs are the seat of hyperæmia, the effect of which is to hasten their escape into the general circulation, where they are observed as the ordinary white blood-cell. The normal glandular hyperæmia occurring during the digestion of food is accompanied by an increase in the number of the white cells circulating in the blood, a condition known as leucocytosis, which subsides in the intervals of digestion. In leucocythæmia the hyperæmia is continual, and in addition, there is an increase in the functional activity of the organs affected, due to numerical hypertrophy of their elements. In the words of Norris: "Leukhæmia, in a word, is the encroachment of the minor upon the major process of blood-making."

An objection to this theory is that, in leucocythæmia, the number of red and white cells together is less than the number of red corpuscles in health. There is a deficit of red or white cells, or of both, of which it takes no account.

Under this heading it is appropriate to mention the fact that some pathologists deny the existence of a purely lymphatic leucocythæmia. While it is generally held that certain lesions, above described, of the spleen, lymphatic glands, and bone-marrow, either separate or in combination, are the cause of leucocythæmia, it is held by some that the spleen alone is the origin of the disease; by others, that the starting-point may be either in the spleen or bone-marrow, but that certainly the lymphatic glands are in no way concerned in its production. Among those who believe that there is but one form of leucocythæmia—the splenic—is Dr. Moxon, who holds that the enormous accumulation of leucocytes found in the marrow, in the so-called medullary form, and the enlargement of the lymph-glands in the so-called lymphatic variety, are secondarily due to the deposit in these organs of leucocytes from the blood-vessels. He points out that in health there is always a certain number of leucocytes in the lymph-spaces of the various tissues, which Dr. Klein has demonstrated to be out-wandered white blood-cells, and has himself demonstrated that in leucocythæmia these cells in the lymph-spaces are increased in number. They find their way through the lymphatic vessels to the glands, and if these are pervious, eventually re-enter the blood; if, however, the glands are not pervious, they will enlarge by the continual accession of out-wandered white blood-cells. The accumulation of leucocytes in the marrow is, according to Dr. Moxon, caused by the difficulty of the circulation in the unyielding venous channels, a circumstance favorable to the transmigration of white blood-cells; "so that," he concludes, "lymphatic leuchæmia, is a myth; and the pathology of leuchæmia, now so complex, should be simplified, when it will better conform with the clinical uniformity which characterizes the disease."

The writer inclines to the view of Dr. Moxon for the following reason: The lesion of Hodgkin's disease is identical with that of the so-called lymphatic leucocythæmia, but is unattended with an abnormal number of white cells in the blood, except in cases in which there is reason to believe that the splenic pulp is secondarily affected. The only explanation that can be given of these different results of an identical lesion is that in the so-called lymphatic leucocythæmia the glandular enlargement is secondary. Much better proof of the existence of a primary medullary leucocythæmia has been advanced by Neumann, Mosler, Ponfick, and others.

Etiology.—Leucocythæmia having thus far been ob-

Leucocythæmia.

served to be twice as common in the male as in the female sex, it seems unreasonable to attribute any marked causative influence to numerous rapidly succeeding pregnancies, as is done by some authorities, since large numbers of women are exposed to such depressing influences. The influence of age is not striking, although the greatest number of cases occurs between the ages of thirty and fifty. Cases have been observed in infancy—one at fifteen months by Trousseau, and another at sixteen months by Mosler, both of the splenic variety. Old age is not exempt, one of Vidal's cases being sixty-nine years of age. Predisposing causes are insufficient food and unfavorable hygienic conditions, with their attendant depressing emotions. The poorer classes furnish the greatest number of cases. There is no necessary connection between malarial poisoning and leucocythæmia, as is proved by the great frequency of the former and the rarity of the latter. Traumatism has been assigned as a cause both of the splenic and medullary form, but the same sort of criticism is here applicable as in the cases that are supposed to be due to rapidly succeeding pregnancies, namely, that blows over the splenic region and fractures of bones are so numerous, as compared with cases of leucocythæmia, that the relation between them can hardly be considered other than accidental. Long-continued exposure to cold has been the exciting cause in several instances ; for striking proof of which statement the reader is referred to Mosler's case in the *Berlin. Klin. Wochen.*, 1876, No. 49, and to Laache ("Die Anämie"). In the majority of cases the cause is absolutely unknown.

Diagnosis.—The diagnosis of leucocythæmia can only be made by a microscopic examination of the blood either before or after death. In the first case on record, that of Professor J. H. Bennett, the condition of the blood was not detected until after death. When, during life, a drop of blood taken from the finger-pulp is examined, the white corpuscles are seen to be greatly in excess of the normal number. A mere examination of a drop of blood under a glass cover will suffice for the diagnosis in well-marked cases of the disease, but for accurate statements of the grade of the affection it is necessary that a count of both red and white corpuscles in the same fields be made with one of the counting-instruments in general use, such as that of Gowers, Hayem, Malassez, or Thoma and Zeiss (see article on Blood, in vol. i.). The degree of increase in the number of the white cells necessary to establish the diagnosis of leucocythæmia is not agreed upon by observers, and this is not surprising when the wide diversity of opinion regarding the normal proportion between white cells and red is borne in mind. To constitute leucocythæmia the increase in the number of the white cells must not only be relative, but absolute. The examination of a drop of undiluted blood under a glass cover has often led to the erroneous diagnosis of leucocythæmia. I was asked to make an enumeration of the blood-corpuscles in a case in which an examination of a drop of blood on a slide had shown an apparent increase in the number of the white cells. I found a decided reduction in the number of the red corpuscles, and a proportion of 1 to 80 between the white and red, but the number of the white per cubic millimetre was normal. In another case, in which there was marked tenderness in the region of the spleen, without perceptible enlargement, and a history of old malarial poisoning, I found, on rough examination, from twelve to fifteen white cells in each field of the microscope ; but a more careful examination with the hæmacytometer demonstrated that this increase was merely relative. When the number of white cells per cubic millimetre is increased, and the proportion of white to red is as 1 to 50, the case should be kept under observation and the blood frequently examined. If the case be one of leucocythæmia, there will probably be a progressive increase, both absolute and relative, in the number of the white corpuscles.

The affections with which leucocythæmia is certain to be confounded without an examination of the blood are Hodgkin's disease, or pseudo-leukæmia, and enlargement of the spleen with malarial cachexia. The different varieties of the affection—namely, the lymphatic, splenic, and myelogenous—are distinguished by the exclusive or predominant affection of lymphatic glands, spleen, or bone-marrow ; but, in addition, it is claimed that each variety can be determined by the appearance of the white cells under the microscope. In the lymphatic form the leucocytes are said to be small, with a relatively large single nucleus. In the splenic form the cells are larger, multi-nucleated, and finely granular. In the medullary form the cells are said to be more coarsely granular than in the splenic. In the section on the changes in the blood I have called attention to the wide variations in size of the leucocytes in cases of purely splenic leucocythæmia. The futilty of attempting the diagnosis of lymphatic leucocythæmia by the microscopic appearance of the white blood-cells becomes apparent when it is recalled that its very existence, as a primary affection, is called in question. The diagnosis of the myelogenous form is made, negatively, by exclusion of any lesion of spleen or lymphatic glands, and, positively, by the detection of well-marked tenderness over any of the bones, particularly the sternum and ribs.

It has been claimed by Dr. John Cavafy that the amœboid movements of the white cells in leucocythæmia are either absent or greatly diminished, and that, therefore, these bodies are either dead or dying, and hence incapable of development. "The earliest observations on this point were made by Dr. Laking, in 1873, but remained unpublished. The results were communicated by Dr. Pye-Smith to the Pathological Society in 1878, and, in the same year, to *The Lancet* by Dr. Cavafy. Neumann, also in 1878, found amœboid movements wanting or very sluggish in a case of leukæmia, although they were active in the corpuscles of fluid from blisters in the same patient" (*The Lancet*, 1880, ii., 769).

Prognosis.—The prognosis of leucocythæmia has hitherto been regarded as absolutely unfavorable, probably owing to the fact that the disease has not been recognized until it has reached an advanced stage. In the earliest stage, that of hyperæmia of the hæmatopoietic organs, there is reason to believe that treatment may be curative. When, however, the hyperæmia has been followed by numerical hypertrophy of the ductless glands the prognosis is decidedly unfavorable, and becomes absolutely so when the leukæmic infection has become general, as indicated by the new formation of lymphadenoid tissue in organs of which it is not a normal constituent, such as the liver, kidneys, mucous membranes, and retina. For purpose of prognosis, as well as diagnosis, the ophthalmoscope may be of decided service.

Death from apoplexy is not uncommon, and is caused in what may be termed a negative manner by malnutrition of the vessel-walls, as well as positively by the aggregation of leucocytes within their lumen.

The duration of the disease averages from one to three years.

Treatment.—As just stated, it is only during the first stages of the disease that any hope of curative treatment can be entertained. An early diagnosis is therefore of the utmost importance from a therapeutical point of view. The cases of cure reported have been, for the most part, in children and infants, which may be indirectly due to the fact that their impressible systems render an early diagnosis easier. The very fact that a child has less power of resisting the disease than an adult is, in a sense, favorable ; for very positive symptoms may manifest themselves when the lesion of spleen or medulla is so little advanced that in an adult it would in nowise affect the general health. Mosler has reported the cure of a case of splenic leucocythæmia, the patient being a boy of ten, who "took a drachm and a half of sulphate of quinine in the course of four days, and then ten grains, and afterward six grains, daily ; he completely recovered." Dr. Goodhart reported to the Clinical Society six cases, under two years of age, in which the spleen was moderately enlarged and the leucocytes increased about tenfold. "They all got better under treatment, the medicine used being either phosphorus or the iodide of iron or cod-liver oil." Of all internal remedies, Mosler gives the preference to quinine, the effect of which ap-

pears to be augmented by cold-water douches over the splenic region. The writer just mentioned has proved to his own satisfaction that eucalyptus globulus, as well as quinia, causes contraction of the normal spleen (*Deut. Archiv für Klin. Med.*, Bd. x., p. 164) and, therefore, recommends its employment in leukæmia (presumably only when the spleen is affected, either primarily or secondarily), either alone or in combination with piperin. He quotes some experiments of Hans Soenderop to show that this last substance causes contraction of the spleen in animals (dogs). Oil of eucalyptus dissolves piperin very readily, and may be given with it and quinine in the form of a pill. Such a triplex pill was given by Mosler in one case, with the result of improving all the symptoms, and apparently bringing the disease to a standstill.

The favorable influence of arsenic in this disease also seems to be manifest. In the course of two months Laache has seen the red corpuscles increase, during its use, from 2.6 to 3.8 millions per cubic millimetre, and the proportion of red to white from 8 to 1 to 31 to 1.

A local treatment of the spleen, with the object of reducing its size, such as cold affusions and electricity, has been practised; but, once the affection is firmly established, the spleen may vary greatly in size during the course of the disease without corresponding variations in the number of the white cells. Still, such a treatment is indicated, since in some cases a reduction of the size of the spleen has been attended with a diminution of the number of these bodies, and if recovery is to ensue, it is certainly not with an enormously hypertrophied spleen. Extirpation of the spleen is not to be thought of in this disease. Transfusion of defibrinated blood has been practised, with temporary benefit in some cases, but cannot be regarded as a curative measure. *Frederick P. Henry.*

LEUCORRHŒA. Synonyms: Fluor Albus, *Leucorrhée, Weisser Fluss,* The Whites, White Discharge.

Definition.—A discharge or excessive secretion, non-hæmorrhagic in character, coming from any portion of the mucous surface of the female organs of generation. In order to understand thoroughly what we mean by leucorrhœa, it will be necessary for us to first obtain a correct idea of the anatomy of the female organs of generation, the character of the mucous membranes, their nerves, lymphatics, and blood-channels.

Beginning with the vulva, we include in that term the mons veneris, labia majora and minora, clitoris, and glands of Bartholini, or the vulvo-vaginal glands. Of these parts it is with the glands of Bartholini that we have most to do in considering the subject of non-specific leucorrhœa as affecting this part of the genital tract. These glands are two in number, about one-third or one-half inch in diameter, rounded or uniform in outline, racemose in character, and yellowish-red in color. They lie between the cellular tissue of the vaginal wall and the constrictor muscle of the vagina, behind the lower part of the spongy body. The duct, half an inch in length, passes forward to open between the nymphæ and the hymen or its remains, its orifices being situated in the fossa navicularis, the space between the commissure and the fourchette.

The mucous membrane of the vulva has squamous epithelium, and is pink in color. Around the nymphæ and urethral orifice we find numerous simple racemose gland-follicles. The sensitiveness of the mucous membrane is increased by well-developed papillæ, which are extremely abundant in this position. Sebaceous glands are found at the junction of skin and mucous membrane, at the free end of the clitoris, and on the labia majora. The lymphatics of the vulva are continuous with the internal iliac and inguinal glands. This close relationship is well illustrated in the simultaneous pathological involvement of the lymphatics of the extremities or of the pelvic organs, and those of the vagina. The blood-supply is derived from the internal pudic, the more superficial parts being supplied by branches from the external pudic. The venous circulation is maintained through the vaginal plexus, which empties into the obturator veins. The superficial veins empty into the external pudic and into the femoral. The nerves are branches of the ilio-inguinal and genito-crural of the lumbar plexus.

The vagina is a tube composed of muscular tissue and mucous membrane, slightly curved from before backward, narrowed below where it joins the vulva, and receiving the cervix uteri at its upper part. Its usual length is two and one-half inches, but it can readily be stretched to twice that length; the walls, as a rule, are in apposition. What are understood as the vaginal columns are two elevations of the mucous membrane, seen anteriorly and posteriorly. Folds or rugæ may be noted running transversely to the longitudinal ridges. These are especially prominent on the anterior surface toward the external outlet. The anterior wall of the vagina is in the vesico-vaginal septum, the posterior in the recto-vaginal septum. By far the most important structure for us to study is the mucous membrane, which is situated upon the muscular and connective tissue. It has squamous epithelium, which covers large papillæ; the glands of Luschka, racemose glands, are situated at both extremities; throughout the rest of the tube the glands are of little importance.

The mucous membrane of the body of the uterus is thin, composed of ciliated columnar epithelium on a delicate basement membrane, and presents a punctated appearance, owing to the numerous openings of the glandular follicles which are scattered over its surface; these follicles are lined with non-ciliated, cuboid epithelium. The mucous membrane of the neck is much thicker and covered with squamous epithelium, the lower portion of which is furnished with villi; the glands at this part resemble those of the body, secreting a clear, tenacious substance. The Nabothian follicles are probably over-distended glands, having a cyst-like appearance, within the mucous membrane.

The arteries of the uterus are derived from the uterine artery, a small branch of the epigastric. The veins empty into the uterine plexus, a portion of the blood going to the ovarian veins. The nerves are derived from the inferior hypogastric and spermatic plexuses, and from the third and fourth sacral nerves. The lymphatics run to the pelvic and lumbar glands.

We have dwelt at some length upon the anatomy of the female genital tract, and especially upon the character of the mucous membrane, and the relationship existing between the different parts, because, as we shall see, the various forms of leucorrhœa are dependent upon local irritation, and upon certain alterations in the anatomical position of, and also in the relationship existing between, the various component parts. Continuity and contiguity of structure play an important part in the progress of the diseases which have leucorrhœa as a symptom.

The Fallopian tubes or ovi-ducts, measuring about four inches in length, are lined internally with ciliated columnar epithelium, which extends even to the outer or peritoneal surface; in the interstitial portion, or that within the cornu of the uterus, the mucous membrane is entirely smooth, the opening of the tube at this point being very narrow.

In reality leucorrhœa may be looked upon simply as a symptom, and its causes may be classified under the following heads: *primary, secondary, traumatic, specific.*

It can be readily seen that, although leucorrhœa, proceeding from an irritation of the muciparous glands, and resulting in hypersecretion, with loss of epithelial structure and of albuminous material, may have a cause which is either constitutional or due to some displacement, the affection of the mucous membrane will persist after the cause has been removed, and the treatment required will have to be directed to it alone.

Leucorrhœa has also been considered under various heads with reference to the locality affected, viz., *vulvar, vaginal, intra-uterine,* and *tubal.* Whatever division we choose to make, it will be necessary to bear two points in mind: first, that leucorrhœa proceeds from inflammation of the mucous membrane, and as such will require local treatment; the other, that we frequently have, either as a cause or as a complication, a constitutional failing or a

mechanical irritation, which needs as much attention as does the local trouble.

It is better, then, for our purpose, in order to facilitate the study of the symptomatology and treatment, to accept the second of these modes of classification.

Leucorrhœa of the vulva may be a purely local affection, without involving the mucous membrane higher up in the canal. It is characterized by a viscid secretion, collecting upon the surface of the labia majora, becoming inspissated, and gluing the lips more or less together at their margin. It is most common in children, and may be caused either by constitutional weakness, as seen in the scrofulous or lymphatic temperament, by want of cleanliness, cold, parasites, gonorrhœa, or by local irritation, as masturbation, attempt at rape, etc.

This form of leucorrhœa is particularly interesting in that it opens a wide field for differential diagnosis. We may briefly state that a history of want of cleanliness, exposure to cold, or constitutional tendency to rickets, scrofula, or general anæmia, and the presence of a non-purulent secretion which is glairy and viscid, and the absence of mutilation, would be almost conclusive evidence of a simple infantile leucorrhœa. Attention has recently been called to the fact that, even in leucorrhœa which is the result of gonorrhœa, or which has followed attempted rape, abrasions are by no means the rule, and, therefore, the absence of any evidence of forcible rupture should not lead to the belief that rape, in its legal sense, has not been attempted.

The question is still *sub judice* in regard to the exact amount of secretion which comes from the glands of Bartholini in infancy ; but the probability is that the vulvo-vaginal muciparous glands and sebaceous follicles at this period of life, and in fact until puberty or the childbearing period, give but very litle secretion. The glands of Bartholini are intended to lubricate the perineum.

Gonorrhœa of the vulva, occurring in infancy, is attended with excessive purulent discharge, at times sanguinolent, and affects the entire vulva ; it is not confined simply to the external lips, but involves also the urethra and spreads upward into the vagina. It is chiefly diagnosed, in default of any positive knowledge of the case, by the intensity of the inflammation, by its tendency to involve submucous structures, and by its great extent and rapid spreading to all contiguous mucous surfaces. The excessive acidity of the secretion is by some considered of importance in differential diagnosis.

Vaginal Leucorrhœa.—In simple catarrhal leucorrhœa of the vaginal mucous membrane we have a discharge of an opaque white character, at times presenting the appearance of curdled milk, very acrid, and containing epithelial cells in various stages of degeneration. The condition of the vaginal mucous membrane depends greatly upon the severity of the inflammation ; in the uncomplicated catarrhal form, in unmarried females, we have very rarely any other appearance than that of simple redness of the mucous membrane and the presence of a discharge as above described. During the reproductive period, when mechanical injury, excessive secretion, or uterine displacement has given rise to severe congestion, the vaginal mucous membrane may show various grades of involvement, proceeding as far as absolute denudation of its superficial epithelial layer, the presence of pus giving the secretions a yellowish tint. Our own experience would rather lead us to believe that the so-called vulvar leucorrhœa is not strictly limited, as its name would imply, but that there may be a catarrhal inflammation extending up the vagina, in many cases even involving the cervix to a great extent, and from which possibly a very large amount of the secretion comes.

Cervical Leucorrhœa.—The leucorrhœa that we are called upon most frequently to treat is that having its seat in the cervical canal or the cervix itself. The secretion proceeding from the cervical canal is usually a glairy, tenacious mucus, resembling the white of an egg, extremely adherent, and alkaline in reaction. When examined under the microscope it is found to contain a number of epithelial cells, ciliated, some of which, however, have been denuded of all cilia ; many have undergone degeneration, and this is particularly the case in that form of leucorrhœa which proceeds from injury to the cervix following labor. In women who have not borne children the glairy mucus collects in quantity, and, when discharged, comes in contact with the acid secretion of the vagina and forms the curd-like secretion which has been described above. It is usually found in those cases in which the uterine canal is diminished in calibre or congenitally smaller than normal, the diminution being caused by displacement which may be either the result of injury, excessive growth, or arrest of development ; or cellulitis, with deposits on the ligaments, may produce a slight uterine prolapse with engorgement. In many cases a cervical leucorrhœa, which may be due to one of the above causes, is attended by the detachment of the epithelium of the infravaginal cervix, due possibly to the constant friction of the parts, together with the presence of an irritating secretion. In such cases the mucous membrane has an angry appearance, bleeding readily upon manipulation, and bearing upon it the impress of mechanical irritation. This condition is not by any means infrequent in cases of obstinate dysmenorrhœa from mechanical causes ; and in women who have borne children cervical leucorrhœa is a not infrequent condition. The secretion may also contain cells from the interior of the crypts of the mucous membrane ; the matter is at times discolored with blood ; indeed, from its appearance it is difficult to distinguish this from the discharge of gonorrhœa. The quantity of discharge depends much upon the surface affected ; the greatest amount is generally seen in women who have borne children, and in those in whom from difficult labor a tear in the cervix has taken place, as is evidenced by the ragged, granulating edges of the mouth of the womb, which can be readily exposed by means of a cylindrical speculum and readily replaced by a tenaculum. Again, catarrh of the cervix may result through continuity of structure, as from inflammation of the vagina, or it may be produced by instruments, or by excessive coition.

It is a noteworthy fact that the glands of the cervix during pregnancy undergo great development, and that the secretion is very profuse at this time. Even without pregnancy these glands may take upon themselves extra growth and excessive secretion, and the condition may result also from miscarriages or excessive coition. The discharge may be continuous, the uterus presenting no special alteration in appearance, or it may come in gushes at short intervals. The absence of general symptoms, such as menorrhagia, dysmenorrhœa, ovaralgia, and the presence of enlarged Nabothian follicles, together with a glairy mucus, will enable one to differentiate this condition from leucorrhœa having its seat in the body of the uterus.

Intra-uterine Leucorrhœa.—Corporeal and cervical endometritis are usually found in young women, more especially when the orifices of the canal are narrowed, and the condition is also met with in women who have ceased to menstruate. As a rule, the whole uterine canal is more or less affected. The discharge at first is glairy, like the white of an egg ; at times, when coming from the upper part of the mucous tract, it is quite liquid. When it has lasted for any length of time, or when it is the result of an inflammatory condition, as from violence or from growths, or the result of the product of conception following a miscarriage, the discharge becomes purulent or sanguinolent, and, if its exit is not possible, will accumulate in quantity and become offensive. In many cases of profuse leucorrhœa of this character are found columnar epithelium cells, partly ciliated, most marked just after a menstrual epoch. In amenorrhœa we frequently note a pale discharge taking place from the interior of the womb.

There is another form of leucorrhœa which is observed in women who have passed the childbearing period. The discharge comes from the endometrium, and is entirely independent of the presence of any neoplasm. The walls of the uterus in such cases are found excessively thin, the mucous membrane being converted into a pyogenic-like membrane, the internal os usually occluded,

and a large quantity of pus secreted, which may, if retained, become extremely fetid, constituting the so-called purulent endometritis.

Traumatism will produce this same condition of affairs in young individuals. The sanguineous discharge from the endometrium is usually due to hypertrophy of the mucous follicles.

General Diagnosis.—The diagnosis of leucorrhœa is dependent upon the presence of discharge from the genitals and upon the history of the case ; the presence of discharge from the genital tract indicates hypersecretion from the mucous surfaces either from simple congestion or from inflammation. Whether primary or secondary, the character of the discharge alone will not be sufficient evidence to absolutely decide the matter.

Specific leucorrhœa possesses certain characteristics which may, in advanced cases, make the diagnosis possible ; the local character of the inflammation, its involvement of the urethra, the purulent discharge, the appearance of the mucous membrane, and the history of the case would afford sufficient evidence. The presence of a micrococcus in the secretion, thought by some to be pathognomonic, and hence styled the gonococcus, is perhaps worthy of mention. Gonorrhœal disease may affect the mucous membrane of the cervix, extend within the uterine canal, and possibly affect the Fallopian tubes themselves.

When the leucorrhœa is dependent upon mechanical conditions, such as uterine hyperplasia with displacement, general constitutional symptoms will be associated with it, as pain in the back, pelvic dragging, constipation, or vesical irritation. In such cases the leucorrhœa is usually of the albuminous type, unless laceration of the cervix is present.

Infantile Leucorrhœa.—It must be borne in mind, in the general diagnosis of infantile leucorrhœa, that cases have occurred of extraordinarily early sexual development, simulating menstruation, and giving rise to a discharge from the genitals in the very young. Dr. Van Derveer, in the *American Journal of Obstetrics*, September, 1883, relates the case of a girl, four months old, who menstruated regularly ; and Henry Dodd (*The Lancet*, 1881) writes of a child who menstruated at twelve months, irregularly ; but after seven years, regularly every three weeks ; the child became pregnant when eight years and ten months old, and was delivered of a seven-pound child at term. Dr. Corte Jarena (*Le Réveil Méd.*, 1880, p. 202) records the case of a child who menstruated regularly at seven months of age. In most of these cases the mammary glands and external organs of generation were fully developed.

To discover the etiology of infantile leucorrhœa has always been a difficult matter. The disease has been attributed to rape, uncleanliness, masturbation, cold, worms, and gonorrhœa. It is possibly a condition very similar and analogous to ophthalmia neonatorum, an affection of the mucous membrane, a result of intense irritation, whether specific or chronic, extending rapidly, and affecting the mucous membrane throughout its layers. It is undoubtedly contagious, and is not dependent upon gonorrhœa in most cases. This, however, is not the place for us to question the specific character of leucorrhœa or the importance of the gonococci in differential diagnosis. They may be detected by treating the suspected pus after the method of Neisser, which consists in pressing the matter between cover-glasses, drying it over a spirit-lamp, staining with methyl-blue, passing through oil of cloves, and then mounting in Canada balsam. The gonococci are then readily recognized by the practised eye, even with a $\frac{1}{6}$ dry objective and D eye-piece ; for differential study, however, higher magnifying power is necessary.

The presence of swollen, sensitive labia, with purulent or muco-purulent discharge, drying in crusts upon the inner surface of the labia or thighs, would naturally excite suspicion, more especially as we know that rape may be accomplished without rupturing the hymen.

Purulent vaginitis occurs usually in children who have a tendency to eczematous eruptions, more especially among the poor, and is often found in several members of the same family. It is particularly difficult to treat, owing to the fact that the disease is usually much higher in the vaginal tract than one would suppose.

A non-purulent discharge from the female genital tract denotes the fact, as a rule, that we have to do with a simple catarrhal inflammation; it may also be the result of hypersecretion without any evidences of inflammation whatever ; in such cases the discharge will be watery, and will not be constant. All neoplastic growths occurring within the genital tract are accompanied by leucorrhœa as a symptom ; it is not, however, within the function of this article to detail their special symptoms.

Mechanical causes, such as pessaries, which abrade the mucous membrane or act as irritants, and irritating substances used as injections, will cause a leucorrhœa, mucous or purulent in character, according to the depth of the inflammatory process.

Another form of leucorrhœa, which must be considered in making a diagnosis, is that accompanying anæmia, pernicious anæmia, lymphadenoma, etc. Leucorrhœa is also not infrequently seen as an accompaniment of the rheumatic and gouty diathesis, during convalescence from the various low fevers, and in pulmonary phthisis, or local tuberculosis. In such cases the absence of disease of the genital tract, and the presence of some organic alteration elsewhere, will definitely fix the diagnosis.

The Prognosis depends so entirely upon the cause and the possibility of its removal, that each case becomes a law unto itself.

Treatment.—In the treatment of leucorrhœa we have to bear in mind the important fact that attention must be paid to both the local and constitutional condition of the individual. There was a time when attention was directed only to the general constitutional peculiarities of the individual, excluding the local affection altogether ; but, by the usual swing of the pendulum, the believers in purely local treatment soon gained the ascendancy. At present we are adopting a more moderate view, believing that the advocates of both forms of treatment are correct, and that the association of local applications to diseased mucous membranes, with such medication as will correct any constitutional vice that may exist is proper ; hence we shall consider the treatment under the two headings of Constitutional and Local.

Constitutional Treatment.—In all cases when leucorrhœa is a prominent symptom we shall find more or less anæmia coexisting, especially if the discharge has been of long standing, for then it may of itself, by excessive flow, have produced anæmia, and we shall be obliged to have recourse to the usual methods of correcting that condition. These consist in a generous and easily digested diet, attention to excretion and secretion—by which means effete matters are eliminated and nourishment absorbed in amounts large enough to counterbalance the loss—fresh air, exercise or massage, electricity, and forced feeding ; as adjuvants may be mentioned iron, arsenic, the bichloride of mercury in minute doses, cod-liver oil, and red wine.

A very important factor in the treatment of all forms of leucorrhœa is the necessity for the relief of abdominal engorgements. Although unquestionably present in acute inflammatory troubles of the female genital organs, it is usually in cases of a chronic type that we find passive congestion. By this term we understand obstruction to the venous flow either by uterine disease, rectal engorgement, or stasis of the portal circulation, with hepatic engorgement, so often seen in women of middle life and full habit, who take insufficient exercise, and who are probably of a gouty diathesis. No less a cause is the absolute folly of fashion's dictates, by which the young girl is faultily dressed, tightly laced, and has her heavy skirts belted around the waist, thus throwing all the pressure on the pelvic viscera, and then, dressed in this wise, taking sudden and violent exercise, as horseback riding or tennis playing. In such cases pelvic engorgement is almost always followed by uterine displacement, and a turgid state of the mucous membrane is bound to manifest itself in leucorrhœa, and this "white hæmorrhage" causes anæmia with its attending symptoms.

It will be readily seen that local applications alone in such cases are more than useless. Should, however, the attendant dysmenorrhœa be very great, and be due to uterine stenosis or flexions, appropriate local treatment will have to be adopted, and mere constitutional treatment for a case so far advanced would simply aid but not cure.

Simple turgidity of the uterine mucous membrane may give rise to dysmenorrhœa without any disease of the parenchyma; in such cases free treatment by laxatives and local depletents as well as tonics, together with the Weir Mitchell "rest cure," would be all that is required.

We might call attention to the value of the natural mineral waters in these cases, more especially the chalybeate, the saline cathartic, and the saline sulphur waters. The latter waters contain notable amounts of the chloride of sodium and the sulphate of soda and magnesia, and are of course actively cathartic. After the patient has gone through a thorough course of this kind, it may be well to change to the chalybeate waters for their tonic effect. The employment of the various waters as general or local baths also demands attention; cold sea-baths are applicable in many cases. When the sea-shore is beyond the reach of the patients, or during the winter months, the prepared salt can be used, and is almost equally beneficial. One ounce to the quart of water would about represent sea-water.

The St. Catharine's Spring, of Canada, is remarkable on account of the large amounts of sodium, calcium, and magnesium chlorides which it contains. It represents more than four hundred and fifty grains to the pint; this is more than three times the quantity contained in the brine-baths of Kreuznach, in Prussia.

The Hot Springs of Garland County, Ark., whose temperature is from 93° to 150° F., are of extreme value in these cases of leucorrhœa and uterine congestion; as are also the springs in Bath County, Va., whose temperature is about 110° F.

Among the many hundred springs that are of known value, it will be necessary for the physician to decide which particular one is the spring of all others for his patient. Among those that combine healthful climate with beautiful and attractive scenery, we may mention the French springs. The Salins, in Eastern France (Department of the Jura), are strongly saline (one hundred and fifty grains to the pint); they also contain a large proportion of bromide of potassium. By placing the patient in a bath of fifty-two gallons the cutaneous surface would be exposed to the action of seventeen pounds of salt and two ounces of the bromide of potassium; the temperature of the water at the springs is 53° F. For the uterine disorders having leucorrhœa as their external manifestation, which accompany the scrofulous diathesis, together with the glandular swellings and anæmia, these waters will be found to possess a peculiar tonic and stimulating effect. The arrangements for bathing are almost perfect—the water is heated to about 83° to 86°, and may be drawn from faucets or by douches of every description; there is also a large marble bathing pool containing 22,400 gallons. The invalid may be accommodated at a fine hotel, with concert-room and theatre, thus supplying mental diversion, an agent not to be despised in the treatment of these cases. Not very far from the above spring, in the high mountains of Savoy, one can be treated by the rich salt *warm* waters of the Salins-Moutiers. In the north-eastern section of the country are situated the springs of the Vosges, at the ancient station of Luxeuil. These waters are of two kinds, those that are mildly saline and those that contain iron and manganese; this latter combination is alone, of all the European springs, met with in this particular locality. The fifteen springs vary in temperature from 82° to 124° F.; like most of the Continental springs, the establishment is under government control. The spacious buildings, situated in a beautiful park, contain all that is requisite to the comfort of bather and invalid. The warm water moves constantly through the marble basins, thus assuring a clean, fresh bath notwithstanding the number of bathers. These waters of Luxeuil are particularly efficacious in the treatment of simple anæmia, of the leucorrhœa depending upon it, and of all the various nervous manifestations that follow or attend uterine disease. For the anæmic form of leucorrhœa the iron manganese waters are worthy of special note. The most popular and frequented baths are the following: the *Bains des Bénédictins, des Fleurs, des Dames, des Capucins.* The hotel accommodations are good and the scenery is delightful.

Near Luxeuil, but still higher in the beautiful valley, is the celebrated Plombières, a spring famed for the treatment of anæmia and nervous disorders.

The calcic and iron waters of Contrexeville, Vittel and Martignay, all in the Vosges group, are of particular applicability in those cases of leucorrhœa accompanied by enlarged liver, gout, or anæmia; the calcic waters are of great value in cases of obstinate constipation, they purge by direct medicinal action on the torpid organs, and do not produce indigestion.

At Royat are four springs, of which the Cæsar, useful in dyspepsia, chlorosis, and nervous affections, contains iron and carbonic acid, temperature 84° F. The St. Mart, alkaline and chlorinated with a temperature of 95° F., has a well-earned reputation in cases of uterine disease. In cases of chlorosis, amenorrhœa, and leucorrhœa the St. Victor is especially applicable; it contains iron, carbonate of lime, potash, and a trace of arsenic; temperature 68° F. The Eugénie is the most abundant mineral spring in the world, it flows at the rate of 2,700 gallons a minute, allows the patient to take the so-called "live" bath, that is, the carbonic acid gas reaches the patient just as nature created it. A point worthy of mention is the fact that all these waters contain the constituents of human serum in almost their identical proportions. It is said that two pints of the Royat waters represent almost exactly one pint of serum. Ems, in Germany, is the nearest approach in this particular to the waters of Royat. As would be supposed, these waters are to be prescribed in cases of anæmia, chloro-anæmia, uterine derangements and their concomitants, in fact, in any impoverished condition of the blood.

The waters of the St. Nectaire (Auvergne) springs are much used in the form of baths and local douches.

In the water of Châteauneuf the physician will find a happy combination for those anæmic and chlorotic women who cannot, on account of its strength, take Vichy, and who respond too rapidly to the Royat waters.

Patients suffering from catarrhal or congestive inflammation of the uterus will do well to visit Rouzat, upon the slope of the Dome Mountains, high above the sea-level and four miles from Riom. The waters are warm, 88° F., and chloro-bicarbonated.

In certain forms of leucorrhœa, when the discharge is very watery and profuse, we have seen decided improvement result from the use of Faradic electricity, one pole applied to the cervix and one to the back; probably, in such cases there is relaxation with engorgement of mucous glands, and the electricity acts as a vaso-motor tonic.

Local Treatment.—Infantile Leucorrhœa. In these cases a certain amount of constitutional treatment is also required, which it will not be necessary to recapitulate here. The local treatment should consist in first etherizing the little patient and making a thorough examination, especially if the case is at all severe and has lasted any length of time. The surface should be cleansed by irrigation throughout the whole vaginal tract, and it should be a rule, in all cases where applications are required to the mucous membrane of the vagina and uterus, to make the application *above the line where the mucous membrane seems diseased.*

Having thoroughly washed the mucous membrane, we can adopt one of several methods of treatment, care being taken not to injure the hymen. It has been recommended to use, in the Sims position, the large blade of Skene's urethral speculum. Several substances for application have been recommended; the use of iodoform by insufflation into the vagina, and as far up as the cervix, once every three or four days, is said to result in a cure after several applications. In some cases which are not so severe, the little patient can be placed in a bath and the external genitals and the vagina, as far up as possible,

thoroughly cleansed with Castile-soap, using either a handful of old linen or a mass of oakum in preference to a sponge; the water may be aided in its entrance into the canal by gentle pressure, after which the parts should be dusted with fine boracic acid, such as is used by aurists, and the external genitals greased with an ointment containing borax and oxide of zinc. Should it be impossible for the mother to use powder with the insufflator, small vaginal suppositories can be inserted containing iodoform, boracic acid, subnitrate of bismuth, tannin, or acetate of lead.

In more urgent cases, the mucous membrane may be wiped over with absorbent cotton, and the vaginal surface then thoroughly coated with a strong solution of nitrate of silver, twenty to thirty grains to the ounce; or we may select a solution of sulphate of copper, boracic acid, nitric acid, carbolic acid, and glycerine, the surfaces and the external parts being well greased with a stiff ointment, in order to keep the surfaces thoroughly lubricated and apart.

In very mild cases and in older children, washes may be of some service if they are used as injections into the canal; or vaginal suppositories, made as above stated, or containing belladonna, morphine, iodoform, cocaine, or salicin, may be employed. The simple washing of the external genitals with white oak-bark or alum is seldom satisfactory in any form of infantile leucorrhœa. Attention should be paid to the state of the rectum, a daily evacuation should be secured, and ascarides, if they exist, must be destroyed. Cod-liver oil and the syrup of the iodide of iron should always be given, if the condition of the alimentary tract will permit.

In cases of colpitis, the result of either gonorrhœa or some local irritation, the treatment is plain. The canal should be thoroughly irrigated, and then, if exceedingly tender, as it usually is in these cases, may be pencilled over with an eight to ten per cent. solution of cocaine, which will very soon anæsthetize it so as to allow a speculum to be introduced; the mucous membrane then can be thoroughly cauterized with the solid silver stick, or with a strong solution of nitrate of silver, or some of the other materials already mentioned, great care being taken that all diseased portions of the mucous membrane have been reached. If the disease has lasted some days, it will be found that the cervix is also affected, and it will be necessary, before a cure is brought about, to make a similar application to this surface; this is probably the reason why so many cases of leucorrhœa or gonorrhœa exist after the treatment has been supposed to have been most thorough. The mucous surfaces should then be kept apart by means of lint or cotton covered with oleaginous material, carbolized oil, or benzoated zinc ointment, and thoroughly irrigated—not merely syringed—by the patient with either a hot solution of the corrosive chloride of mercury, in the proportion of one to four thousand, or an antiseptic solution, such as listerine.

Injections of red wine are also efficacious, and if much pain exists belladonna and opium may be added to the injection.

Should it be found that the disease involves the uterine canal, applications should be made to the entire endometrium, even up as far as the fundus if the internal os is patulous.

The character of the application should depend entirely upon the extent of the inflammation of the mucous membrane. Ordinary simple catarrh, which is superficial, possibly may need only the mildest form of alterative and astringent applications, such as chlorate of potash, ferric alum, tannin, and the abundant use of hot water to diminish local congestion; or we may use iodine, or iodide or bromide of potassium directly to the mucous membrane.

The hygroscopic property of glycerine renders it most valuable in relieving congestions of the mucosa. Tampons of cotton or wool impregnated with glycerine should be inserted into the vagina to counteract any uterine displacement; and astringents such as tannin may be incorporated with the glycerine.

The leucorrhœa which accompanies the backache, headache, and lassitude of young girls at puberty is often due to congestion of the reproductive system from sexual excitement or dancing in heated rooms. Such cases need regulation of the bowels, fresh air, nutritious diet, massage, general electricity to the muscles, and chalybeates. If the leucorrhœa does not then disappear injections of mild astringents or of pure cold water may be used. These should always be given a thorough trial before any other local treatment is instituted.

In the majority of cases of uterine catarrh, that is, catarrh which is apparently limited to the cervical endometrium, the probability is that an extension has taken place and that the whole mucous tract is more or less affected. This can be judged by the severity of the case, the quantity of the discharge, and the character of the accompanying symptoms. There are two things to be borne in mind in the treatment; one is that a superficial catarrh of the corpus rapidly involves the uterine structure, producing hyperplasia and congestion, and thereby requiring not only very active local measures, but also constitutional treatment; the other is, that the mucous surfaces are corrugated, and that, therefore, the whole mucous tract can, with difficulty, be thoroughly cauterized; for this reason, before any active agent is used to thoroughly cauterize the uterine canal, previous dilatation by either tents, the rapid dilators, or bougies should be instituted.

Then, again, active cauterization should never be used as long as any symptoms of inflammatory trouble in the uterus or its appendages are at all evident.

Various materials have been used for direct application to the endometrium—the following are of recognized value: Iodized chloral-phenol, commercial carbolic acid, Churchill's solution of iodine, fuming nitric acid, or nitrate of silver, a drachm to the ounce of glycerine. These applications are usually to be made about once a week, except in the case of nitric acid. When this agent is used the canal must first be made entirely patulous, and the surrounding parts protected from the action of the acid, and ten days or two weeks after the application some of the milder astringents may be employed. In bad cases, where the cervical endometrium is principally involved, the saturated æthereal tincture of iodine may be used.

Intra-uterine injections are recommended by some, but should, however, be used with great caution. In many cases intra-uterine suppositories have been used with great benefit, and, when thoroughly soluble, they have the advantage of keeping the medicament for a long time in contact with the diseased surfaces.

At times certain appearances of the os will denote excessive venous congestion, associated with leucorrhœa. When this exists the congestion should be relieved by puncture. *John M. Keating.*

LEVICO is a spa in the Italian Tyrol, lying at the foot of Mount Fronte, in the valley of the Sugana. Its elevation is 1,500 feet, though the springs rise higher up, at a point about 3,000 feet above the sea. There are two springs, the stronger, the Vetriuolo, used only for bathing, and the weaker, the Ocra, employed internally. The following is the composition of these springs per thousand parts of water:

	Vetriuolo.	Ocra.
Cupric sulphate	0.0470	......
Ferric sulphate	4.3210	......
Ferrous sulphate	0.0290	0.4008
Manganese sulphate	trace	......
Aluminium sulphate	0.8428	......
Magnesium sulphate	0.1504	0.2630
Calcium sulphate	1.0520	0.1320
Sodium sulphate	0.0120	......
Ammonium sulphate	0.0105	......
Ferrous oxide	......	0.0671
Aluminium oxide	......	0.0472
Manganese oxide	......	trace
Silicic acid	0.0230	0.0230
Arsenious acid	0.0008	0.0099
Organic matter	......	0.0190
Total solid constituents	6.4885	0.9620

There is some free carbonic-acid gas.

The waters of Levico are recommended in the treatment of anæmia, chlorosis, diseases of the skin, rebellious forms of neuralgia, hypertrophy of the liver and

spleen, chronic diarrhœa, and uterine disorders. The season lasts from the end of May to the end of September. *T. L. S.*

LIBERTY HOT SPRINGS. Location, in Rio Grande County, Col., thirty-one miles west of Del Norte, a station on the Denver and Rio Grande Railroad.

Access.—By stage from Del Norte.

Analysis.—One pint contains :

	No. 1, 150° F. Grains.	No. 3, 140° F. Grains.
Carbonate of soda	5.060	10.532
Carbonate of magnesia	0.795	1.634
Carbonate of lime	0.952	
Carbonate of lithia	trace	trace
Chloride of sodium	2.139	2.430
Sulphate of potassa	trace	trace
Sulphate of soda	1.729	1.002
Silica	0.417	0.346
Organic matter	trace	trace
Total	11.092	15.944

Sulphuretted hydrogen gas, amount undetermined.

A valuable thermal water. *G. B. F.*

LICHEN. Lichen ruber (Hebra), Lichen planus (Wilson). Varieties : Lichen ruber acuminatus and lichen ruber planus. Galen's concise definition of lichen, viz., "Summæ cutis asperitas cum multa prurigine, squamis et furfuribus," has been applied too frequently to other different and distinct diseases to be of much signification at the present day. We owe to Wilson, in England, and more especially to Hebra, in Vienna, our first and present knowledge of this disease. Hebra recognized it as a separate and specific affection.

Lichen ruber acuminatus is characterized by small, red, conical, disseminated papules, having scales of epidermis upon the top, and which vary in size from that of a millet-seed to the head of a medium-sized pin. If the eruption is thick and the papules close together the hand, if run over it, is given the sensation of having the rough side of a fairly coarse sieve underneath it. The papules after the first eruption do not enlarge, nor do they become vesicles or pustules. The scales upon their points shine like satin, if the proper oblique light be allowed to fall upon them. Looked at thus they stand out in contrast to the surrounding skin, and the minute crusts reflect the light as satin does, in a manner quite characteristic of the disease. To the touch the papules are often more perceptible than to the sight, especially if, as frequently happens, they are scarcely raised above the surface of the skin and are small in size. The eruption is usually accompanied by itching of the most intense form, but this may, in rare instances, be less in degree and not much complained of.

The disease makes its appearance upon the whole body simultaneously, or upon separate places, such as the arms, legs, abdomen, thorax, etc. The papules, which appear separated at first, are arranged either in lines or in circles, or the spaces between the first ones seen are filled completely by new ones, until a continuous patch is made. If allowed to run its course it tends to become chronic ; the papules coalesce and increase in number over the whole body until the entire skin seems to be covered by one continuous scaly mass. The papules are still forming underneath, although they cannot be seen or felt, for the epidermis covering them has become too thick and hard to transmit any sensation to touch or sight. The constant scratching, as well as the formation of new papules underneath the epidermis, renders the skin thicker, less elastic, inflamed, and leathery. The joints of the limbs are half-bent, the skin over them having become so thick and non-elastic as not to allow of motion (see Fig. 2085). The lower eyelid is drawn down ; the hands are stiff, cold, and powerless ; the nails thickened and brittle ; the general health miserable, and the patient at last after perhaps many years of pitiable existence, dies from the gradual failure of all his vital powers.

Lichen ruber planus differs from L. acuminatus in its lesser degree of intensity and in its general appearance. The papules are not scaly; they are smooth, slightly concave and waxy, of the size of a millet-seed or head of a pin, and are first seen to be separated, although arranged in groups or patches. They appear mostly upon the inside of the elbow joint or wrist, under the knee, on the glans penis, and on the palm or sole. They may afterward slowly extend to the rest of the body, and there is generally intense itching. If left to itself the disease becomes chronic, and gradually extends beyond the areas first affected. According to some authorities, *e.g.*, Unna, either form of the disease may be ushered in or preceded by a chill and high fever, with rheumatic pains and general malaise.

The two diseases, though in many respects differing, are identical. Both forms may be present upon one patient at the same time. Microscopically they are identical, the hair-follicles and their immediate neighborhood being the seat of inflammation and infiltration. It is probable that there is colloidal degeneration of the walls of the capillary vessels.

Prognosis is favorable in both forms of the disease if

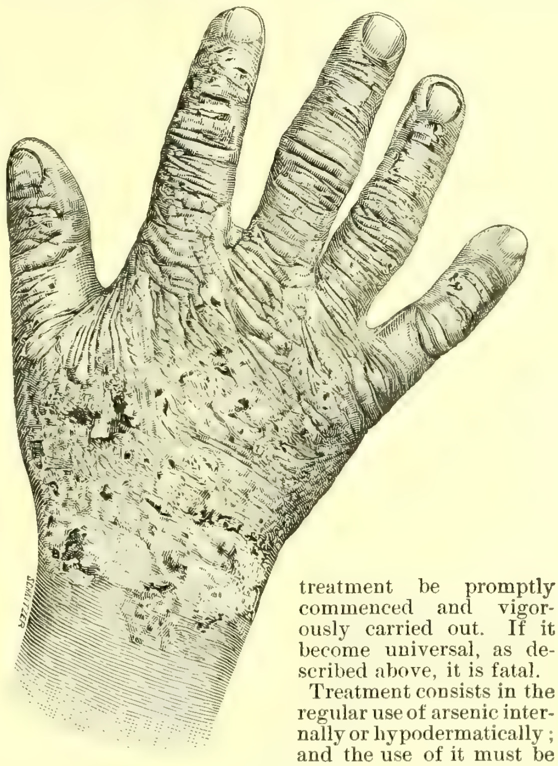


Fig. 2085.—Lichen of the Hand. (From a photograph by A. de Montméja.)

treatment be promptly commenced and vigorously carried out. If it become universal, as described above, it is fatal.

Treatment consists in the regular use of arsenic internally or hypodermatically ; and the use of it must be continued, with only the necessary remissions which poisonous symptoms of the drug necessitate, until the disease has entirely disappeared. There are two ways of pushing the administration of arsenic to the utmost limit which the system can bear. One is to begin with the minimum dose and gradually increase till symptoms of arsenical poisoning appear, and the other is to begin with the maximum dose at once and gradually decrease. The latter method is the better, as the system will stand more arsenic in a given time under it than by the first. This is, of course, a desirable result. The intense itching must be allayed by external applications, and is to the patient a very important indication for treatment.

Unna, of Hamburg, has recently tried successfully, and with more gratifying results to himself than from the arsenical treatment, the use of his so-called "carbol-sublimate inunction cure." His prescription is : ℞. Ungt. zinc. benz., 500 ; ac. carbol., ol. olivæ, āā 20 ; pulv. cretæ, 10 ; hydrarg. chlor. corrosiv., 0.5. This is to be rubbed into the skin all over the body, or spread upon cloths

and wrapped around the affected parts. It is especially recommended in L. acuminatus.

Tonics, general attention to the health, abstinence in the use of wines, liquors, and tobacco play a part in decreasing the liability to a fresh attack.

Robert B. Morison.

LIFE INSURANCE, LAWS OF. Life insurance, according to the definition given by Wharton and Stillé, is a contract by which the insurer, for a consideration, agrees to pay to a specified person a specified sum on the death of a person in whose life the person insuring has an interest.

It differs from other kinds of insurance in promising to pay a certain sum absolutely.

In fire or marine insurance the contract is one of indemnity, and is intended to cover a loss, whatever such loss may be proven to be. It also differs from other insurance in the fact that a time of payment will certainly come.

In the case of a building insured against fire, or a vessel insured against the perils of the sea, neither may ever require the payment of the policy, for there may never be a fire or a sea loss; but death inevitably comes, and the payment of a life policy must at some time be met.

There have been at times bitter prejudices against life insurance on the ground that it was immoral and placed a premium on death, but such is no longer the public sentiment, and life insurance is regarded as a natural and proper provision for the necessities of those dependent upon the insured. The business of life insurance has mainly developed during the past forty years, and England is the country where it originated. Now, however, the largest companies, as well as the greatest volume of business, are to be found in this country. The insured person may, of course, insure his own life for the benefit of anyone he wishes; but, in addition to this, any person may insure the life of another if he has a pecuniary interest in the continuance of the life of such person. A creditor may insure the life of a debtor; but if the insurance is so large as to make it appear like a wager on the chances of a person's life, the policy may be declared void. Such, for instance, is the insurance of a life for $3,000 when the indebtedness is only $70.

Persons cannot in all cases insure the lives of relatives. Thus a nephew cannot insure the life of an uncle, or a brother of a brother, unless there be a reasonable dependence for support in each case.

The right to insure being settled, great importance is placed upon the application made by the insured. He is usually required to answer searching questions, in writing, in relation to his habits and tendencies to disease, besides submitting to an examination by the medical examiner of the insurance company.

The litigation arising over insurance policies is often based upon some statements of the insured in his application, which the company alleges to be incorrect or wilfully false.

A distinction is made in regard to such matters between representations and warranties.

Take, for instance, the case of a person with intemperate habits and addicted to the use of opium, both of which are considered by all companies as tending to shorten life. If the insured says positively that he does not drink at all, or does not use opium, his statement will be considered a warranty, and the discovery of the frequent use of liquors or of opium would probably vitiate the policy.

If a person, on the other hand, represent himself as in good health, although in fact a secret disease was developing itself of which he was unaware, the statement will not be taken as a warranty, but as a representation made in good faith.

The same is true in regard to such a question as: "Have you ever had a serious illness?" The applicant may answer "No," forgetting or thinking of little importance some illness in former life, the effects of which had long since passed away. Such illnesses may have been serious at the time, but may in reality, as in the case of a successful recovery from scarlet fever, have improved the chances of long life. In such a case the negative answer will be held to be immaterial.

If, however, the person has had at any time a serious illness from any disease, the natural tendency of which is to shorten life or weaken the system, the negative answer may void the policy.

Any material misstatement as to age, residence, or occupation may void the policy, and it does not make any difference whether the misstatement was unintentional or not.

Important questions often arise in the case of assignments of policies by the insured themselves, or in cases of bankruptcy by virtue of law; but, as a general rule, it may be stated that the beneficiary of a policy has a vested interest in it which cannot be taken away, even by the act of the insured.

The policy may exempt the company from liability in case of negligence or misconduct. Under such a policy the company would not be liable for death from an overdose of medicine taken negligently. If the overdose is taken without any negligence on the part of the insured, the company is liable. In the case of a policy making misconduct an exception, there could be no recovery for death resulting from an illegal operation.

The great burden of litigation centres around cases where there is an allegation of suicide, for almost all policies exempt the companies from liability when the insured commits suicide or dies by his own hand. When the insured is alleged to have been insane, the construction of such a policy becomes important. The rule seems to be in England that the words, "by his own hands or act," cover all cases of intentional suicide, whether the insured was conscious at the time of the wrongfulness of the act or not, and the plaintiff cannot recover. The Supreme Court of the United States establishes a different rule, and says that the insured cannot be considered to die by his own hand "when his reasoning powers are so far impaired that he is not able to understand the moral character, the general nature, consequences, and effect of the act he is about to commit, or when he is impelled thereto by an insane impulse which he has not the power to resist." In New York, to enable the representatives of the insured to recover, there must have been such a mental disturbance that the person does not understand that the act which he commits will cause his death, or else he must be under the influence of some insane impulse which he cannot resist. It is not sufficient that his mind, at the time of the act, was so impaired as not to know its moral character. The New York decision has been generally followed in the other States. In Pennsylvania, Georgia, and Louisiana, the view held by the Supreme Court of the United States has been adopted.

It will be seen, therefore, that the courts of this country favor, to a material extent, the claim of the insured, whether he dies by his own hand or not. A form of policy, however, has been adopted by some companies which the courts hold to absolutely prevent a recovery in all cases of intended suicide. Such policies provide that they shall be void "if the insured shall die of suicide, sane or insane." But under such policies a recovery can be had in cases of unintended self-destruction.

Cases in the courts where the question of suicide comes up are frequent, and the Court of Appeals of the State of New York has just rendered (October, 1886) a decision in what is, perhaps, the most remarkable case of the kind ever before an American court.

Colonel Walton Dwight, of Binghamton, N. Y., in 1878, obtained policies on his life for the large sum of $250,000. He was a bankrupt, and was afterward shown to have borrowed the money to pay the first quarter's insurance. On the night before the second quarter's insurance became due, he died, having been sick for a short time previous. He was a man of immense strength, activity, and endurance, and his condition was not thought serious very shortly before his death. He had made his will in the meantime, and bequeathed specifically large portions of the insurance money to public institutions, churches, and citizens of Binghamton.

There was only one person with Colonel Dwight during the few moments prior to his death, but one or two others were almost immediately called in.

An autopsy was held, and the theory of suicide was claimed to be sustained by a red crease in the skin of the neck, as if caused by a rope. It was stated by the defence that this was caused by the position of the head subsequent to death. The coroner's jury rendered a verdict of death by natural causes.

A second autopsy was held some weeks later, when fifteen physicians were present; the marks on the neck were then visible.

This is a brief outline of a case which has attracted unusual attention, and has been strongly contested in the courts. The Equitable Life Insurance Company paid without question its policy of $50,000, but other companies refused to do so. In a test case a decision was rendered against the company; but now, after years of litigation, this has been set aside and a new trial ordered. This is a victory for the insurance companies, and it is doubtful if the case will ever be brought to trial again.

The medical testimony in favor of suicide by strangulation was not very conclusive, but all other circumstances were strongly corroborative of the probability of suicide, and the very large amount involved made the case a famous one.

The presumption of death in cases where exact knowledge cannot be obtained, is an important one.

There is a general rule of law that a person is dead who has not been heard of for seven years by those likely to know of his movements. This presumption does not, however, arise if the disappearance and failure to hear from him can be explained on any theory consistent with that of the existence of life. Aside from this rule there are facts which may warrant the inference of death before the expiration of seven years, such, for instance, are passage on a ship which is known to have been lost, exposure to special perils, etc.

There is occasionally the simulation of death in order to secure the insurance money. A well-known illustration of this is the case of Udderzook, who was executed in Pennsylvania in 1873 for the murder of a man named Goss. Goss's life had been insured, and there was a conspiracy between him, his wife, and Udderzook to obtain the insurance. A dead body was placed in a building where Goss was accustomed to work, and the building set on fire. The charred remains were declared to be those of Goss, and a demand was made for the payment of the policy. While this was under consideration Goss threatened to betray the conspiracy, and Udderzook allured him from his hiding-place and murdered him. For this crime Udderzook was tried, convicted, and executed, and the facts of the conspiracy were made known.

Accident insurance is a species of life insurance where the liability only arises in case of death by accident.

There have been frequent discussions in the courts as to what kinds of death such a term describes, and in one case it was held that a person who was under medical treatment for nervousness, and who took an overdose of opium by mistake, could not recover.

In another instance the policy exempted the company from liability in case of poisoning, and the insured, thinking a mixture was a harmless beverage, drank it and found it to be a deadly poison. In this case it was held there could be no recovery. *Henry A. Riley.*

LIGATURE. Latin, *ligatura*, from *ligare*, to bind. A cord or string of silk, flax, catgut, or other suitable material, for tying blood-vessels or other parts.

History of the Ligature.—The history of the ligature[1], [2] has been variable and eventful, and has always been intimately connected with the history of surgery, ever constituting a reliable barometer indicating the fluctuations of rise and fall in this art and science. Its use as a hæmostatic agent was not the result of reasoning or logical deduction, but was prompted by instinct. It was used and described long before the circulation of the blood was discovered. The discovery of the circulation, anatomico-pathological investigations, experimental researches, and clinical observations, have all been contributing to the rescue of this invaluable agent from the dark domain of empiricism, and have secured for it a position, as a remedial agent in surgery, second to none in points of importance, reliability, and frequency of use. The first account of the application of a ligature for the purpose of preventing hæmorrhage is given by Sus'rutas, a disciple of the divine Dhavantari, in his Ayur Vedas (B.C. 1500), who tied the umbilical cord in newly born infants with a string, eight inches from the navel, previous to cutting it. A number of writers, among them Platner, Holtze, Langenbeck, and Fischer allude to Hippocrates (B.C. 460–377) as the discoverer of the ligature. They base their opinion on the following passage from his works, translated into Latin by Fassius:[3] "Sanguinem e venis profluentem sistunt animi deliquium, figura aliorsum tendens, venæ interceptio, linamentum contortum, appositio, deligatio."

Archigenes (B.C. 100) made free use of the ligature after amputations. Celsus (B.C. 30–25, A.D. 45–50), in his works, refers to the ligature as a well-known remedy, and credits an obscure physician of the Alexandrian school with its discovery. Celsus used the ordinary linen thread, and gave the particular indications for its use, and described the manner of its application. In speaking of the operation for hydrocele he says:[4] "Nervus, ex quo testiculus dependet, præcidendus; post id venæ et arteriæ ad inguen *lino deligandæ* et infra vinculum abscindendæ sunt."

Galen (A.D. 131–211), although no practical surgeon himself, yet familiar with the literature of that day, frequently mentions the ligature, and gives particular directions to apply it to the proximal end of the bleeding vessel. For ligature material he advises silk and fine catgut. The definite closure of the vessel he attributed to the action of the tissues surrounding it, as is evident from the following quotation:[5] "Quæ namque caso in abscisis vasorum partibus coalescit, ea pro opercula est ac osculum eorum claudit." The name of Antyllus (A.D. 350) occupies such a prominent position in vessel surgery, and his method of procedure in case of aneurism is so familiar to every student in surgery, that more than a simple allusion to his name would appear superfluous.

Paulus Ægineta (A.D. 625–690) treats extensively of the ligature, quoting freely from the writings of Celsus and Galen. In practising ligation of vessels as a therapeutical measure in diverse affections, he passed two ligatures beneath the vessel, with the aid of a needle, cut the vessel between them, and, after permitting the requisite amount of blood to escape, closed each end of the vessel separately. Rhazes (A.D. 850–922) mentions, as a last resort to arrest hæmorrhage from large vessels, the ligature which he made of strong linen thread. The prolific writer, Avicenna (A.D. 980–1037), disposes of the subject of ligation of vessels briefly thus:[6] "Quod si (sc. vena) fuerit pulsatilis, tum melius est ut veles eam cum filo lini, et similiter si fuerit non pulsatilis, verum tamen multoties elevatur sanguis ejus." Aneurisms he treated in accordance with the teachings of Antyllus. He limits ligation to arteries, believing that bleeding from veins is arrested spontaneously or yields to the use of the customary styptics. Avenzoar (A.D. 1113–1162 or 1196) and Averroes (1198) were familiar with the ligature. The latter, in his commentaries on the writings of Avicenna, directs that in performing arteriotomy the vessel should be surrounded by two ligatures before it is divided. Roland (1252), a pupil of Roger, of Parma (1214), again mentions the use of the needle in applying the ligature, a practice followed by most of the prominent Italian surgeons at that time. Bruno, of Castel Longobrugo (1252), pointed out the difference between arterial and venous hæmorrhage, and gave the advice, in cases where the bleeding could not be arrested by any other means, to seize the artery or vein with a small hook and carry a thread with a needle around the vessel and tie it firmly. Guy de Chauliac (A.D. 1300–1363) prefers the ligature when the artery is deeply seated, in which case it is brought well into view, and that end is firmly tied which is the nearer to the heart or liver. Lenardo Bertapaglia (died 1460) modified the intermediate ligation by passing the

needle armed with a double thread, not *under*, but *through*, the artery, tying both ligatures firmly over each other. Giovanni Vigo (1460–1520), the founder of the school of surgery in Rome, was acquainted with the direct or immediate ligature, but gave preference to the intermediate method of ligation. Alfonso Ferri described the ligature needle used at that time in applying the intermediate ligature—it was about three inches in length and curved only at the point, with the eye at the opposite end; the point presented four sides with obtuse angles, so as to prevent injury to the vessel or its adjacent parts. This needle was armed with a double ligature, and was introduced about two to three fingers' breadth from the margin of the wound, passed underneath the vessel, and made to emerge on the opposite side of the wound, and the ligature was then firmly tied in several knots. Angelo Bolognini (1508), founder of the school at Bologna, also practised percutaneous ligation of vessels, using silk as a ligature material. Jacques Houllier (1493–1562), in wounds of the arteries, relied on digital compression, and when this failed and the vessel was deeply located he advised that it be gently drawn forward, slightly twisted, and, after ligating both ends, divided completely at the point of injury. In Germany we find the first mention of the ligature by Hans von Pfolsprundt. Hieronymus Brunschwig (1450–1533) practised and described Bertapaglia's method of ligation.

Hans von Gersdorf (1517), a military surgeon of great experience, frequently applied the intermediate ligature in cases of vessel wounds, but preferred styptics and the actual cautery in amputations. Walther Ryff tied the proximal end of the vessel by isolating and seizing it with a small hook and then applying firmly a silk ligature. It will be seen, up to this time, that the ligature had for the most part been used only as a *dernier ressort* in cases of wounds of vessels, while styptics and the actual cautery were still relied upon as the safest and easiest methods of arresting hæmorrhage. To Ambroise Paré (1517–90) surgery owes a great debt of gratitude, not as the discoverer, but as the first and most devoted champion of the ligature. Through his influence and untiring zeal the ligature gradually found its way into popular favor, and displaced the barbarous treatment by styptics and cautery. He practised both the immediate and intermediate ligation, according to the location of the vessel and circumstances of the case. His first operations were performed about the year 1552. In a German translation of his work on Surgery,[7] published in the year 1601, I find the following directions: "Wo auch dieses nicht helffen wolte, so muss man die Haeffte, wofern deren eins oder mehr vorgangen, widerumb aufffthun, und under der verletzten Ader, gegen ihrem Anfang oder Wurtzel zu, mit einer Nadel und Faden durchhin fuhren, die Ader sampt einer solchen Portion oder Stücklein Fleisches desselbigen Orts, wie viel nemlich die Gelegenheit geben und erleiden mag, fassen und zubinden. Denn also hab ich oftmal sehr grosse und gewaltige Verblutungen, auch in denen Wunden, durch welche ganze Arm oder Schenkel abgehawen worden, gestillt, wie an seinem ort sol gemeldet werden. Dieses aber zu verrichten, werden wir vielmal genötiget, die ganze Haut, so über der Ader ligt, auffzuschneiden und zu entblössen. Denn wenn eine auss den Blut oder Lufftadern des Halses (Jugularium) durchschnitten were, und sich die beyde Ende, beydes hinauff und hinabwertz von einander gezogen, und also verborgen hetten, muss man die gantze Haut unter welche sie sich verschlossen, eröffnen, die Ader entdecken, mit einer Nadel und Faden darunter hinfahren und also zusammenbinden, wie ich dan selbst viehlmahl sehr glücklichen und wohl verrichtet. Du solt aber dieses Bandt oder Faden nicht eher auflösen, biss dass du sihest, das die Ader mit Fleisch überwachsen, und der Ader Mundlöchlein verstopfet sey, damit das Blut nicht widerumb und von neuwen zu rinnen anfange."

For fear of secondary hæmorrhage, Paré favored the ribbon ligature, made of a number of threads; at the same time he aimed to include portions of tissue surrounding the vessel, and removed the ligature as soon as healthy granulations covered the exposed portion of the vessel. He used the ligature with a view simply to approximate the inner walls of the vessel for a sufficient length of time for union to take place, when its further presence was considered useless and even detrimental. The contemporaries of Paré were slow to acknowledge the superiority of the ligature over the rude, but time-honored, cautery. On the one hand, ignorance and prejudice combined in checking progress, while, on the other, it must be acknowledged that Paré's ligature was an exceedingly imperfect thing, which, when used according to his directions, could not fail to frequently disappoint the most ardent admirer. It required centuries to establish it in the confidence of the profession.

Jacques Guillemeau (A.D. 1550–1613), Paré's pupil, friend, and successor, labored faithfully and earnestly in the interest of the cause of his illustrious master. He was one of the first who resumed the operation of ligation of arteries in their continuity for the cure of aneurism. He applied the ligature on the cardiac side, opened the sac, and allowed it to heal by granulation. Pierre Dionis (died 1718) states that at his time the cautery was used almost exclusively at the Hôtel Dieu after amputations, although he resorted to the ligature frequently, and in some instances even practised immediate ligation. In 1733, Petit (1654–1750) writes of the ligature:[8] "La ligature cause des grandes douleurs, des tressaillements convulsifs, et quelquefois la convulsion du moignon, qui souvent est mortelle, ou par elle-même ou parcequ'elle occasionne l'hémorrhagie par les mouvements extraordinaires que le malade ne peut s'empêcher de faire." Fabricius von Hilden (1560–1634) and Scultetus (1595–1645) introduced Paré's practice into Germany. The former made use of the hemp ligature, but restricted its application to young healthy persons. Cornelius Von Solingen (died 1692) practised immediate ligation after the example of Dionis. Anton Nuck (died 1692) only made use of the ligature in operating for aneurism, after the method of Antyllus. In England the ligature was introduced by Wiseman (1566–1625), and was eagerly adopted after the discovery of the circulation by Harvey, in 1619. Fabricius ab Aquapendente (died 1620) applied two ligatures to arteries, and divided the vessel between them, so as to allow both ends to retract. Marcus Aurelianus Severinus (1580–1656) was the first to tie the femoral artery near Poupart's ligament. Cesare Magati (1597–1647) followed the advice of Galen and Avicenna, and tied the vessel only on the cardiac side. Kirkland (1721–98) attributes the definitive closure of vessels after ligation to the inherent contractility of the vessel-wall. White and Aikin expressed a similar view, as becomes apparent from the following passage: "That the arteries, by their natural contraction, coalesce as far as their first ramification."[9] John Bell (1760–1820) concurred in this view, but added another important element, adhesive inflammation in the vessel-wall, induced by the ligature.[10] Larrey (1766–1842) observed that in many cases after ligation no coagulum formed, and, in consequence, asserted that definitive obliteration of the vessel can take place independently of it, and is then due to contraction of the vessel-wall.

Richerand (1779–1840) believed that the ligature brings the inner walls of the vessel in contact, and that direct adhesion takes place, the result of adhesive inflammation. Garengeot (1688–1759) feared the cutting through of the ligature, and, for the purpose of preventing this accident, advised the use of a broad, ribbon-like ligature. Claude Ponteau (1725–75) abandoned the use of the broad ligature, but, to guard against the same evil, included within the ligature a sufficient amount of paravascular tissue. Lorenz Heister (1683–1758) used a stout ligature, and tied over a small cylinder of lint to prevent premature cutting through. J. Z. Platner (1694–1747) made use of a similar contrivance, but always applied a double ligature, with a third (reserve ligature) on the cardiac side, to be tied in the event of secondary hæmorrhage. Alexander Monroe (1697–1767) protested against the intermediate ligature, and emphasized the importance of direct ligation. He used broad ligatures, and tied only with sufficient firmness to approximate the inner

walls of the vessel. William Bromfield (1712–92) isolated the artery, drawing it out on the surface of the wound with a hook of his own construction, and which still bears his name, and applied a flat ligature. In France, Deschamps (1740–1824) advocated the superiority of immediate ligation by means of a broad ligature, on the ground that when the intermediate ligature is used the interposed tissues disappear very rapidly, leaving the ligature loose around the artery, thus favoring the occurrence of secondary hæmorrhage. Abernethy (1763–1831) applied a double ligature in tying an artery in its continuity, and divided the vessel between them, claiming that in doing so he was able to relieve the tension in the peripheral portion of the vessel, and, at the same time, to enable both ends of the artery to retract into the tissues. He also condemned the reserve ligature, as it would necessitate more extensive isolation of the vessel, thus cutting off nutrition and provoking a higher degree of inflammation and suppuration. August Gottlieb Richter (1742–1812) introduced the immediate ligature into Germany. On December 12, 1785, John Hunter (1728–93) for the first time tied the femoral artery *in loco prædilectionis* for popliteal aneurism. He applied four ligatures at short distances apart, of which number only the most distal one was tied firmly; the remaining ligatures were tied in such a manner that the lumen of the proximal end of the artery represented a cone, with the base toward the cardiac side of the vessel. Hunter anticipated that this method of operation would favor the formation of a thrombus, and thus afford additional security against secondary hæmorrhage. His expectations, however, were not realized, as secondary hæmorrhage occurred on three different occasions, and the patient did not recover until seven months had elapsed. He did not repeat this operation, and subsequently used only one ligature. Desault accidentally made the observation that, in the ordinary method of ligation with the round ligature, the two inner tunics of an artery are ruptured. This fact was verified by Jones, who, in 1806, made a series of careful experiments to determine this point. The classical work of Jones exerted a potent influence in establishing the claims of the ligature, not only in England, but wherever surgery was practised. He claimed that obliteration of an artery, after ligature, can take place independently of the formation of a thrombus, by the traumatic inflammation and plastic exudation induced by the ligature. In his experiments on animals he applied several ligatures in close proximity. He called particular attention to the deleterious effects of suppuration on the process of cicatrization in the blood-vessels, and, for the purpose of guarding against this event, advised the removal of the ligatures immediately after they had ruptured the internal coats, or before suppuration was established. He believed that provisional closure of the vessel was accomplished by the lacerated tissues within the lumen of the vessel, and that the healing process within the vessel was the same as in any other wound, and produced the definite obliteration. In tying large arteries he advised the double ligature and division of the vessel between. B. Travers adopted the views promulgated by Jones, but substituted the temporary for the momentary ligature. He recommended the removal of the ligature as soon as plastic inflammation was fully established, and before suppuration had had time to take place. The period of time in which the ligature would accomplish this object he placed at forty-eight to ninety hours, according to the size of the vessel which had been ligated. Jones and Travers deserve to be called the discoverers of the temporary ligature upon a scientific basis. On February 14, 1817, Travers for the first time put his theory into actual practice. He ligated the brachial artery for aneurism, and removed the ligature after fifty hours. The case proved successful. The next case, the artery being the same, did not terminate so favorably; secondary hæmorrhage set in and proved fatal. J. Hutchinson's case, operated upon in a similar manner, also terminated in death by recurring hæmorrhages. Sir Astley Cooper applied the temporary ligature in two instances. The results not meeting his expectations, he abandoned it. Among the most formidable opponents of the temporary ligature may be mentioned Hodgson, Vacca Berlinghieri, and C. J. M. Langenbeck, who claimed that it was impossible to determine the exact length of time after which it would be safe to remove the ligature, and that the necessary manipulations for the removal of the ligature would interfere with the prompt healing of the wound. In Italy, Antonio Scarpa (1747–1832) strongly advocated the employment of the temporary ligature. He used the broad ligature and tied over a cylinder of lint for the purpose of bringing and keeping in apposition a large surface of the inner walls of the vessel. His experiments have demonstrated that obliteration of a vessel by adhesive inflammation can, and does, take place without division of the coats. He compared the inner surface of blood-vessels with serous membranes, and credited it with the property of undergoing the same pathological changes when subjected to traumatism. He ascertained that adhesive inflammation follows about four days after the application of the ligature, while the time required for suppuration to arise requires from one to two days longer; consequently he determined the time for removal of the ligature in accordance with the general condition of the patient. In young, robust persons he removed the ligature on the fourth day, and in old or decrepit persons he allowed it to remain for six days. P. von Walther asserted that definitive closure of vessels after ligation takes place within forty hours, and urged that the ligature should be removed after the lapse of this time. In Germany, Victor von Bruns was the next and last to bring the temporary ligature before the notice of the profession. He removed the ligature after two or three days, according to the size of the vessel, and supported his claim for the superiority of this method of ligation by the results of a large clinical experience. Pécot compared the methods of Jones and Scarpa by way of experiment, and came to the conclusion that the round ligature, if applied with sufficient firmness to sever the inner coats of the artery, excites adhesive inflammation earlier than if the broad tape ligature is used. Ponteau attributed great importance to the connective tissue around blood-vessels in the process of obliteration, hence he advised that an abundance of this tissue should be included within the ligature. Delpech (1777–1832), in France, and C. J. M. Langenbeck, in Germany, arose against Scarpa. Langenbeck regarded the adhesion of the inner vessel-walls of prime importance in effecting permanent closure, while to the thrombus and lymph-coagulum he assigned a less important rôle. The older German surgeons were in the habit of using hemp or linen ligatures. The silk ligature was first proposed in that country by Ph. Fr. von Walther. For the purpose of preventing the ill effects of the customary ligature, a variety of ligature materials were proposed, such as chamois-skin by Physick (1814), catgut by Sir Astley Cooper, silkwormgut by Wardrop, elastic rubber strings by Levert, tendons by Paul Eve, human hair by Porta. Metallic ligatures were brought forward as being less irritating than the ordinary ligature; gilt iron wire was proposed by Ollier, fine iron wire by B. v. Langenbeck, and silver wire by Wagner and Sims. Levert experimented with all kinds of metallic ligatures—lead, gold, silver, and platina—and always obtained primary union of the wound. Metallic ligatures were always cut short and remained permanently in the wound. Until the end of the eighteenth century the ends of the ligature were brought out through the wound. The first attempts to cut short the ligature and leave it permanently in the wound were made by Lawrence, who, in 1814, published the results of his experience. For ligatures he used fine dentist's silk. According to Samuel Cooper, however, the priority of this procedure should belong to a certain Haire, of Essex, who is said to have practised it in 1786. Hennen adopted the practice in 1813, and within four months followed it in thirty-four cases without observing any unfavorable results. Delpech and Guthrie also indorsed the practice. The introduction of antiseptic surgery has, however, wrought the greatest improvement in the ligature, and the founder of antiseptic surgery, Sir Joseph Lister, has also furnished

us with the ideal ligature—the aseptic ligature. What has been sought for centuries has at last been found—a ligature which will arrest the circulation with safety and certainty, which will produce a minimum amount of traumatism until the process of cicatrization is completed, and which, when its work is accomplished, will gradually disappear by absorption and substitution. Since the introduction of the antiseptic treatment of wounds and the aseptic ligature surgery has received a new impulse; results have been obtained which were never realized before; operations have been performed successfully which were previously beyond the grasp of even the most ambitious; and, more than all, those horrible spectres, hospital gangrene, erysipelas, pyæmia, septicæmia, and secondary hæmorrhage, which haunted the surgeons of only fifteen years ago by night and by day, have almost completely disappeared from hospital as well as private practice. For all this we are indebted to Lister. A variety of other animal tissues have been made into ligatures and rendered aseptic, and have been recommended at different times as substitutes for the catgut ligatures. Among them we may enumerate silk, silkworm-gut, whale and deer tendon, peritoneum, coats of blood-vessels, and nerve-tissue. With the exception of the first two, all of these ligature materials, if rendered perfectly aseptic, will, after a certain time, undergo absorption, but it is questionable if any of them possesses any advantage over well-prepared catgut. Czerny is entitled to a great deal of credit for the improved silk ligature. He has demonstrated that when silk is made perfectly aseptic, by boiling and immersion in carbolized water, it can be safely left in the tissues, where it becomes encysted.

In regard to the relative position of the ligature to the subjacent blood-vessel, two distinct classifications are made: I. Intermediate ligature, ligature *en masse*. II. Immediate or direct ligature. In the former instance a varying amount of paravascular tissue is interposed between the ligature and the blood-vessel, while in the latter case the vessel is isolated and the ligature applied directly.

I. Intermediate Ligature, Ligature en Masse.—All of the older surgeons were in fear of a too early separation of the ligature, and aimed to prevent secondary hæmorrhage, as the result of such an occurrence, by including adjacent tissues, thus protecting the vessel against undue pressure. The object of this practice was simply to apply the ligature as a provisional mechanical agent to arrest the flow of blood in a vessel, without any theory as to the permanent closure of the vessel. The ligature was passed underneath, with points of entrance and exit some distance from the vessel, and firmly tied. This method was practised by Paré, and through his influence and example it was adopted by all of the prominent surgeons until nearly the end of the eighteenth century. Guillemeau, Thévenin, Garengeot, Le Dran, Louis, Dionis, and Petit were faithful followers of Paré, and, with few unimportant modifications, followed his directions to the letter. Since the definitive closure of vessels has been made an object of study and experiment this method of ligation has been abandoned, and is only resorted to in exceptional cases where isolation of the vessel or vessels is impossible from the nature or location of the wound. At the present time it is resorted to more particularly in cases of obstinate parenchymatous hæmorrhage which cannot be controlled by compression; also in cases where isolation of the bleeding vessel is impossible on account of inflammatory or neoplastic deposits around it; and lastly, in cases of advanced degeneration of the tissues of the vessel-wall, where obliteration of the vessel cannot be secured without imminent risk of causing a solution of continuity of all of its coats. In such cases a curved needle is armed with a stout catgut ligature and is passed through the tissues some distance from the vessel, including thus a circular portion of paravascular tissue; the ligature is then drawn sufficiently tight to arrest bleeding, when it is tied in a surgical knot and its ends cut off short.

II. Immediate or Direct Ligature.—The experiments of Jones led the way to the immediate or direct ligature. Jones and his followers placed great stress on the laceration of the inner tissues of an artery by the circular constriction of the ligature in effecting provisional and definitive closure of the lumen of the vessel. The simple round ligature was gradually adopted by all surgeons who aimed at division of the internal coats by the ligature. The size of the ligature has also undergone considerable modification. Bell used fine, oiled ligatures, which he supposed would apply themselves accurately to the artery. Some united from two to as many as eight (Arndt) ligatures into one string. Lisfranc used moderately broad ligatures, but he claimed that in tying the knot they were changed into round cords and would as effectually divide the inner coats as the round ligature. Lawrence spoke highly of the use of very fine silk, dentist's silk, in tying arteries of any size. Velpeau used ligatures proportionate in size to the vessel to be ligated. Hodgson used the fine round ligature. A. Cooper was also in favor of the round single ligature. The circular constriction of Jones, with a single round thread, by degrees won the favor of surgeons, and firmly maintained its position as the best method of ligation until the advent of the aseptic ligature. The advantages presented by this method during the pre-antiseptic period were: 1. Effective and safe provisional closure of vessel. 2. Promotion of the process of definitive closure of vessel. 3. It favored the spontaneous elimination of the ligature by diminishing the amount of tissue included in its loop. The circular constriction of a blood-vessel by a round thread brings in apposition a sufficient surface of the intima, and, in the event of primary union, the resulting cicatrix affords sufficient resistance to the blood-current and effectually guards against secondary hæmorrhage. As the aseptic ligature, in aseptic tissues, never produces suppuration or other destructive changes which would interfere with the prompt formation of the intravascular cicatrix or weaken the vessel-wall, it should include a minimum amount of vascular tissue and should never be made to destroy the continuity of any of the tunics of the artery.

Forms and Number of Ligatures.—1. *Scarpa's Aplatissement.*—Scarpa's ligature was intended by its author to fulfil the two essential indications in obliterating the lumen of a vessel: (1) To arrest the circulation temporarily by mechanical pressure without lacerating the tissues of the vessel. (2) To approximate and keep in constant and accurate contact a comparatively large surface of the inner vessel-walls for union to take place by adhesion. His leading idea was that the intima resembles serous surfaces, and for rapid union to take place only a moderate amount of irritation is necessary, and that the injury inflicted by the circular ligature is too severe to obtain the most desirable result. He used ligatures two lines in width and tied over a small cylinder of linen. The ligature was usually expelled spontaneously about the fifteenth day; but if this did not occur, and the ligature lay loose upon the vessel, it was taught that it should be removed at this time. Scarpa's theories found many admirers, who introduced modifications in the operation to suit their individual ideas. Förster substituted for the cylinder of linen, charpie and cork; Deschamps, agaricus; Desault, small plates of wood; Cline, cork; and Roux, small rolls of diachylon plaster. In England this practice was advocated by Crampton, and in France it was represented more particularly by Boyer and Roux. Some exponents of the theory of aplatissement, while believing in the doctrine, objected to the introduction of foreign bodies into the wound, which they regarded not only as useless but as injurious to the healing process. Jameson used ligatures made of strips of raw chamois skin, which he claimed would, by their pliability and elasticity, hold in approximation the inner vessel-wall without inflicting injury on its tissues. Without means to prevent suppuration, it can be readily understood that the expectations held by the originator of this method of ligation and his followers were not realized, and it was by degrees displaced by the round ligature.

2. *Double Ligature.*—The double ligature is mentioned by Celsus and Ætius. Rolandus of Parma speaks of the double ligature as applied to the vena organica (jugu-

laris). John Bell and Maunoir not infrequently applied two ligatures in close proximity. In ligating arteries in their continuity Abernethy always applied the double ligature after isolating the vessel freely, claiming that, even if the intermediary isolated portion sloughed, the ligatures would successfully guard against secondary hæmorrhage. As an important advantage of this method he mentions that the vessel could be divided between the ligatures, thus relieving tension and allowing both ends of the artery to retract into the tissues, occupying then the same favorable position as vessels divided during an amputation. The double ligature has been frequently employed in experiments for the purpose of studying the process of cicatrization in blood-vessels after ligature, and will be again referred to in the section treating of that subject.

In regard to time, ligatures may be classified into: 1, Momentary; 2, temporary; 3, permanent. The first two varieties aim at obliteration of the lumen without loss of continuity of the vessel, while until recently the permanent ligature was always expected to divide the artery before it could be eliminated as a foreign body from the wound.

(1) *Momentary Ligature.*—A series of experiments on animals made by Jones satisfied him that frequently definitive closure of an artery could be obtained by drawing the ligature tightly and removing it at once. The rupture of the internal coats in many instances produced satisfactory closure by mechanically interfering with the circulation and causing the formation of a thrombus, the definitive obliteration following as the natural consequence of the traumatism. To insure these results more constantly, he made several of these circular constrictions in close proximity, so as to inflict a greater amount of traumatism and secure a larger surface for cicatrization. Jones called attention to the superior advantages offered by this method of ligation over all other methods, as it would secure obliteration of vessels without incurring the necessity of leaving a foreign substance in the wound. Unfortunately, however, the results obtained were so uncertain that he did not dare to recommend its adoption in practice. In many instances, as late as the third or fourth day, the artery was found permeable, a sufficient proof that the operation, with all its other advantages, lacked reliability. Porta made fifty experiments with the momentary ligature on dogs, sheep, and goats, with the result that partial or complete obliteration of the vessel by thrombus or lymph-coagulum followed in only ten instances, while in all of the remaining cases only division of the inner coats could be demonstrated. Maunoir attempted to accomplish the same object by different means. He crushed the internal coats of arteries with a forceps of his own construction, and expected the same series of changes to occur in their interior as the result of the laceration of tissues; but his results must have been equally unsatisfactory, as the procedure does not appear to have been adopted to any extent in practice.

(2) *Temporary Ligature.*—The temporary ligature was introduced for the purpose of obviating the deleterious effects of the presence of a foreign body upon the healing of a wound and the process of cicatrization in the blood-vessel. While the ordinary ligature remained for a period of time varying from three to twenty days, it was argued that the average time necessary for the ligature to remain was much less, hence various contrivances were invented which were intended as substitutes for the ligature and which could be removed with greater facility after the necessary time had elapsed; such were the pressure-forceps designed by Deschamps, Desault, Percy, Assalini, Koehler, Porter, Billroth, L'Estrange, Richardson, Crampton, Nunnelly, Wolfe, Jeoffresson, and Speir. A similar function and sphere were assigned to the percutaneous acu-pressure of Middeldorpf, the *ansa fili metallici* of B. v. Langenbeck, the filo-pressure of Dix, the *ansa hæmostatica a tergo* of Schmitz, and more recently the amovable ligature of V. v. Bruns. The laborious researches of Jones prepared the way for the temporary ligature. Travers believed with Jones that vessels are obliterated by inflammatory adhesive exudation and union between the inner coats, but affirmed that the inflammatory process requires a longer period of time to secure the requisite firmness in the adhesions. His first experiments were directed toward ascertaining the length of time required for a sufficiently firm adhesion to take place. The experiments were made on the carotids of horses and asses. The ligature was applied either in the form of a loop or tied over a tape placed parallel with the artery for the purpose of facilitating its removal. The ligature was removed after one, two, and six hours, and the animal killed from twenty to thirty hours after the operation. In fifty per cent. of the cases where the ligature remained for one hour the vessel was not obliterated. In all cases in which it was allowed to remain from two to six hours the experiments proved successful. From these experiments he concluded that six hours is the longest time required for the ligature to remain, and that by this time definitive occlusion will have always been accomplished. With a view to determine whether the closure of the vessel is perfect at this time, or whether obliteration is effected after the removal of the ligature, he made another series of experiments, dividing the artery on the peripheral side after removing the ligature.

These experiments satisfied him that definitive closure takes place *after* the removal of the ligature, and is effected by an exudation of plastic lymph. If the ligature remained for twelve hours, and the artery was cut on the peripheral side, no hæmorrhage followed its removal. He reduced his theory to practice by ligating the brachial artery in a man suffering from aneurism and removed the ligature fifty hours after the operation. No hæmorrhage followed, and the patient recovered. He next tied the femoral for popliteal aneurism, and removed the ligature twenty-seven hours later. Pulsation soon returned below the seat of operation. The disappointment due to the failure in this case deterred him from giving the temporary ligature further trial, and he returned to the ordinary ligature. This method was tested by a few English surgeons, but, not producing more encouraging results, was soon completely abandoned. Scarpa, in Italy, was the next advocate of the temporary ligature. His pathological views regarding the use of the ligature and the process of obliteration of vessels, as well as his method of ligation, are given elsewhere. Delpech claimed that a few days after ligation the ligature is found loose on the vessel, and consequently could exert no influence for good, and therefore should be removed, like any other foreign body, so as not to interfere with the normal healing of the wound. Velpeau also regarded the temporary ligature with favor. P. von Walther studied the effects of the temporary ligature on animals. With a ligature instrument of his own device he aimed to divide the inner coats of the vessel, and removed the ligature after from forty-eight to seventy-two hours, when definitive closure was always found. R. N. Smith constricted the vessels with an iron wire passed through a silver tube, and found arteries of the fourth and fifth size obliterated after six hours. The femoral artery was found permanently closed after two days. Victor von Bruns originated his method of filo-pressure in 1868.[11] The silk ligature which he used was passed around the artery and brought out of the wound through a silver cannula with a crossbar, to which it was fastened. Arteries of the size of the radial he found closed after eighteen hours, while larger arteries required from one to three days. For six years this method was used exclusively in all cases requiring ligation, in Bruns' clinic, with entire satisfaction. Only in two cases did secondary hæmorrhage occur; in one instance the common carotid was ligated during an operation for the removal of a cancerous tumor of the thyroid gland, and the ligature was removed on the fifth day; in the second case the femoral artery was ligated, and the ligature was removed on the third day. The great objections against the temporary ligature have always been that the wound could not be completely closed, or had to be reopened at the time of removal of the ligature, thus increasing the risks of suppuration and preventing primary union of the wound,

circumstances which the ligature was intended to obviate. Absence of suppuration and primary union of the wound are the most reliable safeguards against secondary hæmorrhage after any method of ligation, and a method which cannot secure these results with some degree of certainty must be considered as faulty in principle and practice, and this can be said without hesitation against the temporary ligature as described above. The aseptic animal ligature must be considered as a temporary ligature in every sense of the word, only that the material of which it is composed is removed by healthy active granulations instead of by the hand of the surgeon, an advantage which it would be difficult to overestimate, and which neutralizes all valid objections against the temporary ligature. The ligature of the future, then, will be the aseptic animal ligature.

(3) *Permanent Ligature.*—The permanent ligature is composed of a material which will remain for the most part unchanged in the tissues of the body, and is either permanently retained (encysted) or spontaneously expelled. Before the aseptic ligature came into use, the ligature usually cut its way through the remaining tissues of the artery in from three to twenty days, by a process of molecular death, and was spontaneously expelled, thus destroying the continuity of the vessel in every instance. Hodgson held that the ligature, as usually applied, divides the two inner coats of the vessel, and destroys the vitality of the circularly constricted portion of the adventitia, which separates like any other slough and comes away in the loop of the ligature. The same explanation is given by Guthrie, Brodie, and Gross. Bruns, however, maintains that the constricted portion, under the pressure of the ligature, undergoes molecular necrosis, a process necessarily attended by suppuration. He also claims that in animals, if the ligature is cut short, it cuts through the tissues and is encysted in the cicatrix. Porta studied the fate of ligatures in the wound experimentally. He made 300 experiments, using catgut, silk, hemp, linen, and horse-hair ligatures, cutting them short. The animals were killed in from a few days to three years after the operation. Of the 300 ligatures, 64 were completely absorbed (of 80 catgut, 33; of 120 silk, 19; of 50 linen, 10; of 40 horse-hair, 2). Of the 236 ligatures which remained in the wound, only 26 were found lodged in an abscess cavity. He claimed that the ligature destroys the continuity of the vessel by interstitial absorption. P. von Walther in his numerous experiments with the temporary ligature found the adventitia divided only in one case. He removed the ligatures at variable periods of time (from one to one hundred and ten hours) after operation. P. Bruns [11] made fifteen experiments to determine the effect of the ligature on the coats of vessels, and confirmed the observations of Walther. If the constricted portion of an artery is examined some time after the application of the ligature, it is not always easy to determine whether complete division has taken place or not. A few days after ligation the artery in close proximity to the ligature is thickened, the swelling on each side effacing the depression made by the ligature and shutting the ligature out of sight. The traumatic periarteritis produces a connective-tissue proliferation which covers the ligature and both ends of the artery in a similar manner as the provisional callus after fracture surrounds the broken ends of the bone. If the inflammation does not proceed beyond the process of tissue-formation, the granulation tissue is converted into cicatricial tissue, which forms an additional connecting medium between the ends of the artery, and by forming at the same time a capsule around the ligature the latter becomes permanently encysted. If the end of an artery is tied, the vitality of the ligated stump will depend on the manner in which the wound heals; if suppuration takes place, it will in all probability separate as a slough, and will escape with the ligature in the wound secretions; if, on the other hand, the wound heals by primary union, it will either remain in organic connection with the vessel and form new vascular communications with the adjacent tissue, or, in the event of a cutting through of the ligature, it may still retain its vitality and remain in the tissues, or finally it may be removed by gradual absorption. John Bell and Otto Weber were convinced that the end of the ligated vessel invariably separates and dies. There is, however, good reason to believe that the ligated artery stump, in the absence of suppuration, will retain its vitality and will again unite with the surrounding tissues from which it receives its nutrition. P. Bruns made a few experiments in this direction.

Experiment No. 1: Double ligation of carotid artery of the dog; division of artery between ligatures. The animal was killed, and parts were examined fourteen days after operation. The ends of the artery were separated 2 ctm., the interspace was bridged over by a band of connective tissue, in which were embedded both ligated stumps a short distance from the closed ends of the artery.

Experiment No. 2: Vessels and operation the same. The separated ends of the artery embedded in the intermediate connective-tissue string.

Experiment No. 3: Femoral artery; operation the same; local conditions the same, only that the bridge of new connective tissue was larger and firmer. The separated ends of the artery somewhat reduced in size.

Experiment No. 4: Femoral artery; operation the same. Separated pieces much smaller, and incorporated in the newly formed connective tissues.

In all of these experiments it appears that the ligature cut its way through the tissues of the artery, thus completely separating the ligated stumps, and still they retained their vitality through the influence of the surrounding living tissue. The ligatures were undoubtedly drawn very tight, and as the operations were done without antiseptic precautions, the reaction was in excess of that which is necessary to obtain obliteration of the vessels, and these circumstances will go far toward furnishing an explanation of the uniformity with which the constricted portion of the vessel gave way under the ligature. The use of the aseptic ligature and antiseptic wound treatment tend to preserve the continuity of the ligated vessel, as has been abundantly proved by clinical experience and experimental research. In many of my specimens it can be seen that weeks and months after the operation the ligatures remained in their original location and occupied the same relative position to the vessel as immediately after the operation, the ligature, in every instance where suppuration was prevented, being surrounded or encapsuled by a dense capsule of connective tissue.

If under antiseptic precautions the end of an artery is ligated, the stump of the artery retains its vitality in a similar way, and is nourished in the same manner as the pedicle after ovariotomy, with the only difference that in the former instance the local conditions are perhaps more favorable for the preservation of the vitality of the ligated parts.

Aseptic Ligatures.—In his first communication to the profession on this subject Lister alludes to the advantages of the aseptic ligature as follows: "If the antiseptic ligature be employed, it merely inflicts a wound or injury upon the vessel without introducing any permanent cause of irritation. The injured part, therefore, becomes repaired after the manner of a subcutaneous wound, without passing through the process of granulation and suppuration, which is induced by the employment of the ordinary septic ligature." [12] It may now be truly said that some form of aseptic ligature is used at present by almost every surgeon, and that while the merits of the antiseptic treatment of wounds are still denied by many, few or none would dare to use the ordinary ligature, or, in so doing, would realize that their duty toward their patients had not been conscientiously discharged. Perhaps no other surgical procedure has ever enjoyed the confidence of the whole profession throughout the civilized world to the same extent as the aseptic ligature. This universal faith in the reliability and safety of the aseptic ligature is only a natural outgrowth of the superior results following its use. Protracted suppuration in wounds—the result of retained ligatures—secondary hæmorrhage, and suppurative inflammation of vessels have been gradually diminishing in frequency, and bid fair, under the in-

fluence of the aseptic ligatures, to be almost completely expunged from the future category of wound complications. Nussbaum very appropriately remarks : "Catgut is, without doubt, Lister's greatest discovery." [13] And again : "How pleasant it is to cut the ligatures short and leave them, unconcerned, to their fate in the wound ! In ovariotomies, etc., their value cannot be overestimated. The manner in which catgut adheres to an artery, forming connections with it and the surrounding tissues, assisting at the same time in forming a firm ring around the coats of the artery, are exceedingly welcome occurrences, guarding against secondary arterial hæmorrhage in ligating in the continuity of a vessel, and rendering even the application of a ligature in close proximity to a large collateral branch devoid of danger. All this, silk cannot do." Before the introduction of antiseptic surgery, suppuration at the seat of ligature was almost a necessity. As suppuration interfered seriously with the hyperplastic processes in the tissues of the arterial tunics, secondary hæmorrhage was of frequent occurrence, because the adhesion between the surfaces of the interior of the vessel-walls were not sufficiently firm to resist the intra-arterial pressure at the time of the separation of the ligature. It was on this account deemed necessary by the older surgeons, in deligating an artery in its continuity, to apply the ligature at least an inch distant from the next collateral branch, so as to favor the formation of a thrombus. The aseptic ligature marks a new era in the surgery of blood-vessels. Ligating a vessel under antiseptic precautions presents the following advantages :

1. The ligature remains undisturbed in the wound, becoming either absorbed or encysted after having fulfilled the purpose of a provisional hæmostatic.

2. Prompt obliteration of the vessel takes place by proliferation of new-tissue elements from pre-existing cells, independently of the formation of a thrombus; in fact, thrombosis is often wanting. The constricted portion of the vessel does not necrose ; it is infiltrated, like the catgut, with living tissue.[14] Bardeleben makes a similar assertion.[15] In all operations with the aseptic ligature small size of the clot, and its frequent entire absence, is in remarkable contrast with the results observed after the ordinary septic ligature. The importance of the thrombus as an active agent in the definitive closure of vessels has vanished before the brilliant results obtained with the aseptic ligature. John A. Lidell, in speaking of vein ligature, says : "If a ligature of animal origin, such as carbolized catgut, has been applied, the approximated walls grow directly together, and the ligature itself disappears by absorption or is replaced by new connective tissue." [16] A discrepancy of opinion still exists regarding the time in which the catgut ligature is absorbed. The results of experiments in this direction have not been uniform. Lister ligated the carotid artery of a calf with carbolized catgut, and on examining the parts, thirty days after operation, he found only small portions of the ligature remaining, the rest having been absorbed, its place being occupied by new tissue. Czerny operated on rabbits, and examined the parts from one to thirty days after operation. After a number of days the ligature was always found loose on the vessel, softened and infiltrated with cells. Fillenbaum applied a double ligature to the carotid artery of a dog, and killing the animal fourteen days subsequently, found only microscopical remnants of the ligatures. Schuchardt experimented with guinea-pigs, and if the ligature was allowed to remain for five weeks, only traces of it remained. P. Bruns[17] operated on dogs four times, tying the femoral and axillary arteries, no antiseptic precautions being used, and the specimens were examined after ten days. In two cases the catgut ligatures had undergone but little change ; in the third case the ligature could not be detected with the naked eye, but the microscope showed traces of it ; in the fourth case two ligatures had been applied to the femoral artery, 4 ctm. apart, and in this instance the proximal ligature showed no change, while of the distal ligature only the knot remained. He also ligated the carotid artery three times, and examined specimens after twenty days had elapsed, and found only in one instance traces of the ligature on making longitudinal section of the vessel. In two cases he examined the ligatures after thirty days, the carotid and axillary arteries being the vessels tied, and found only microscopical traces. In four more operations he tied the axillary and femoral arteries, and examined after forty days, and on careful search found remains of the ligature in but one case, while in the other three the microscope revealed only traces. From these experiments he concluded that the catgut ligature, from the first to the tenth day, is either not changed at all, or that the changes are not constant; absorption is constant from the twentieth to the thirtieth day, and after the fortieth day only microscopical remnants can be found. M. Arnaud, in a series of careful experiments, gives these results in regard to the absorption of carbolized catgut ligatures : [18]

Catgut disappeared once in	4 days.
Catgut disappeared twice in	7 days.
Catgut disappeared once in	9 days.
Catgut distinctly visible once in	4 days.
Catgut distinctly visible once in	9 days.
Catgut distinctly visible once in	11 days.
Catgut visible, but softened and infiltrated, once in	16 days.

A most valuable contribution to our knowledge of the behavior of catgut in the different tissues of the living body we owe to Von Lesser, of Leipzig.[19] The time required for absorption, although variable in the same animals and in the same locality, will depend on : 1, The quality of the ligature ; 2, the size of the ligature ; 3, the nature of the tissue with which it is kept in contact ; 4, the presence or absence of suppuration. P. Bruns claims that catgut is dissolved by pus, hence it will disappear in a shorter time in wounds that suppurate. In my experience I have observed the contrary. In suppurating wounds I have seen the catgut remain unchanged for an exceedingly long time, and after weeks have seen the ligature come away in the secretions, having undergone but little change. The absorption of the catgut ligature is accomplished by a process of softening and infiltration of cellular elements, and is consequently accomplished in the shortest space of time in wounds in which the process of granulation is not impaired by suppuration. The immediate and remote effects of the catgut ligature on the vessel also deserve consideration. The impression prevailed at one time that the catgut ligature does not destroy the continuity of the artery. This assertion has, however, met with opposition. P. Bruns,[11] in his experimental work, has made special search in this direction in thirteen ligations of arteries in their continuity. In the three specimens obtained ten days after operation, he found the artery completely severed in one instance, while in the other two cases a fine thread of adventitial tissue was found in the loops of the ligatures. In the remaining ten cases, in which only traces of microscopical remnants of the ligatures could be found, three different conditions of things presented themselves. In three cases the vessel was completely divided in the same manner as occurs after the ordinary ligature is used, only the intermediate space between the vessel-ends was less than after the silk ligature had been employed ; the space measured only from one and a half to three millimetres, and was filled in with connective tissue. In six cases a solution of continuity had apparently not taken place, and its occurrence was ascertained only by close examination. The place of ligature presented a somewhat prominent circular ring ; on making a longitudinal section the intima and media were found severed, and their margins directed toward the interior of the vessel, shutting off its lumen on both sides by a concave or funnel-shaped end. The interspaces between the two blunt ends was occupied by a solid intermediary substance about the thickness of the ligature and continuous with the adventitia. The intermediary substance was composed of young connective tissue, interspersed with particles of the catgut ligature. In one case the continuity of the vessel was perfect, all of its coats being entire. Evidently the ligature was not tied with the same degree of firmness as in the other cases. The lumen was only narrowed by the ligature and rendered impermeable by a

thrombus. Bruns is willing to admit that in case the catgut ligature is drawn only sufficiently tight to interrupt the circulation, all of the coats of the artery remain intact during the healing process, and the continuity of the vessel is preserved in the strictest sense of the word. He also asserts that in the cases in which division of the vessel has taken place, and a bridge of connective tissue corresponding to the diameter of the ligature has been formed, this process may *practically* be regarded as similar to the process of healing, without loss of continuity of the vessel-tunics. Stimson[20] agrees with Bryant, that the catgut ligature not only primarily divides the two inner coats of an artery like the ordinary silk ligature, but that subsequently the adventitia also gives way under the pressure of the ligature, thus completely interrupting the continuity of the vessel. They affirm that the bridge of intermediary connective tissue may impart an appearance as though no division had occurred. The results of my experience have demonstrated to my satisfaction that it is not necessary to tie with sufficient firmness to divide any of the arterial coats, and yet prompt obliteration of the artery will ensue, and that in such instances the coats of the vessel are transformed into a solid string of connective tissue, the best possible result which can be obtained after ligature. Even in case the ligature is tied with sufficient force to rupture the inner coats, the constricted adventitia may retain its vitality and form part and parcel of the intermediary connective tissue, uniting the two ends of the vessel; and still further, if the vitality of the adventitial coat is suspended, and it is removed by a slow process of molecular disintegration and absorption, it is replaced by elements which are converted into a similar tissue, thus practically preserving the continuity of the vessel. In the event of suppuration, the advantages of the aseptic catgut ligature are lost, and the ligature escapes with the discharges, either entire and unchanged, or in fragments after it has undergone softening and disintegration. Ligatures made of any other animal tissue rendered properly aseptic are disposed of in the wound in a similar manner as catgut, and it has not been proved that any of them possesses any advantages over the well-prepared catgut ligature. Mr. Barwell,[21] in tying large arteries, uses a broad ligature made of the strong middle coat of the aorta of the ox. His idea is to approximate the intima without rupturing it. In sixteen cases of ligation of large vessels this method proved successful. In one case of ligation of the femoral artery hæmorrhage occurred at the time of operation from a small opening near the ligature; at the request of Mr. Barwell two more ligatures were applied within an inch of the first ligature, and the case terminated favorably. Mr. Barwell still maintains the novel belief that his ligature material is not absorbed, but is organized and becomes a part of the living tissue around it. Aseptic ligatures made of materials which are not capable of being absorbed remain in the wound and are encysted. All of these ligatures are more prone to destroy the continuity of the vessels than animal ligatures, but they do not do so invariably. Czerny's silk, for example, which is used next in frequency to catgut, is infiltrated with cellular elements, and, after a long time, is partly absorbed and completely encysted.

Practical Suggestions.—The results of my own experiments,[22] as well as the literature on the subject, tend to prove that all kinds of ligatures, provided they have been made aseptic, always become encysted in aseptic wounds. All ligatures, however, which permanently resist absorption destroy the continuity of the vessel, and on this account, instead of adding strength to the paravascular cicatrix, weaken the vessel-walls at the seat of ligation. I have never observed a single case, in hospital or private practice, where the catgut ligature failed to fulfil in the most satisfactory manner the purposes of a provisional hæmostatic agent until the definitive cicatrix had become sufficiently firm to resist the intra-arterial pressure. In place of severing the tunics of the ligated vessel, the catgut ligature is gradually displaced by organized tissue, which increases the resisting capacity of the vessel, providing an additional safeguard against secondary hæmorrhage, if from any cause definitive obliteration is retarded. In enumerating the superior advantages of the catgut ligature, Nussbaum says: "The most careful microscopical examinations have shown that catgut increases to a considerable extent the resisting capacity of an artery in forming firm connective-tissue connections with the vessel."

The aseptic animal ligature possesses two distinct and important advantages over all permanent ligatures. 1. It does not necessarily destroy the continuity of the vessel. 2. It gives additional strength to the extra-vascular cicatrix. These advantages recommend the animal ligature more particularly for the purpose of tying an artery in its continuity. I am firmly convinced that in many of my experiments the internal tunics of the arteries remained intact after ligation, and yet cicatrization progressed in a satisfactory manner; hence it is no longer necessary to tie the ligature so firmly as to crush the tunics of the vessel. All that is necessary is to tie with sufficient force to approximate the inner surfaces of the intima, with a view to insure effective provisional obliteration of the vessel, when cicatrization will follow as a necessary result, provided the vessel-tunics are in a healthy condition. If cicatrization in a vessel takes place from the fixed cells of its tunics, without the formation of a thrombus, it will be seen that in many instances a vessel can be ligated with safety in its continuity, close to a collateral branch, when existing circumstances dictate such a course. Objections have been made by different surgeons against the safety of the catgut ligature, as it has been claimed that the slipping of the knot has frequently given rise to secondary hæmorrhage. To guard effectually against this accident it is only necessary to make a surgeon's knot, which will securely hold the ligature in place until definitive closure of the tunics of the vessel has taken place. One of the constant rules usually given by all authors in vessel surgery was to make a small opening in the sheath of the vessel, of only sufficient size to permit the passing the ligature needle around it. It was feared that a more free opening in the sheath, and a more extensive isolation of the vessel would lead to necrosis of its tunics on account of the cutting off of the vascular supply. That this idea still prevails is evident from one of the most recent text-books on surgery. Lidell calls special attention to this point in the following language: "The risk of sloughing, however, arises mainly from isolating the artery too much, or from separating it too extensively from its sheath, while dissecting to expose it, or while preparing to pass a thread around it whereby the minute vessels which nourish its coats are too extensively destroyed; hence the danger of passing a spatula or the handle of a scalpel under the artery, and of dragging it out of its bed when tying it.[23] All of these fears are unfounded when the operation is performed under antiseptic precautions. In all of my experiments I did all that is here cautioned against. I isolated the arteries and veins from their sheaths for an inch or more, and dragged the vessel near to the surface of the wound in applying the second ligature, and yet I never observed any sloughing except in the cases in which the operation was followed by suppuration. I am strongly in favor of opening the sheath freely, so that the operator can not only feel, but *see* what he is doing, and I am convinced that by pursuing this course there is less harm done than by operating in the dark.

My experiments on the veins have taught me another important and practical lesson, viz., their tolerance to traumatic insults. In not one of the cases was death produced by the operation, although in a few of the animals both the jugular and femoral veins were tied at different times. I never observed progressive phlebitis, embolism, or pyæmia. Veins like those of the peritoneum may be contused, torn, lacerated, cut, punctured, burned, and ligated with immunity, if infection is avoided. Veins are exceedingly prone to infection, but if infection can be prevented their injuries are repaired with wonderful rapidity. As regards the time required for definitive obliteration to take place, the results of the experiments would indicate that, in the case of arteries of the size of

the carotid or femoral, from four to seven days are necessary, while in the jugular vein the same object is accomplished in three to four days. The double catgut ligature may be resorted to with advantage in the human subject in ligating large vessels in their continuity, more especially if the operation is done near a collateral branch, as it approximates the inner surfaces over a larger area and thus furnishes a more extensive surface for cicatrization. The practicability and utility of the double ligature are, however, rendered most apparent in the treatment of varicose veins. For many years I have successfully used the subcutaneous double catgut ligature in the treatment of varicocele. In operating on varicose veins of the lower extremity the intervening portion can readily be rendered bloodless by applying an Esmarch bandage before tying the ligatures. The entrance of blood into the vessel between the ligatures, through small collateral branches, can be prevented, and the process of cicatrization materially assisted by applying an antiseptic compress over the seat of the operation before removing the elastic bandage. *N. Senn.*

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[20] The Antiseptic Catgut Ligature, Amer. Journ. Med. Sciences, 1881, p. 131. [21] International Encyclopædia of Surgery, vol. iii. New York.

[22] Experimental Researches on Cicatrization in Blood-vessels after Ligature, Transactions of the American Surgical Association, vol. ii., 1885; see also article on Healing of Arteries after Ligation, Acupressure, and Torsion, by J. Collins Warren, Wood's REFERENCE HANDBOOK, vol. i. [23] International Encyclopædia of Surgery, vol. iii., p. 90.

LIGHTNING, THE EFFECTS OF. The frequency with which persons are struck by lightning varies much in different countries, but is greatest in the temperate zones, where thunder-storms are the most frequent. In the higher degrees of latitude they occur less often, and are nearly absent in certain parts of the tropics. In the United States and in most countries of Europe deaths from lightning-stroke occur with moderate frequency, and injuries from lightning, which do not prove fatal, are still more common. The total number of deaths from lightning in France, in fifty years, from 1835 to 1885, was 4,609. According to the English Registration Reports, the number of deaths from lightning in England and Wales for a period of twenty years, from 1865 to 1884 inclusive, was 416. Hofmann reports that in 1870, 202 persons were killed by lightning in the United States. The number of deaths from this cause in Massachusetts during fifty years, from 1855 to 1884 inclusive, was 101. Out of 82 persons thus killed 25 were females, 57 males.

The effects of lightning upon the object struck are manifold and various, and we see very different results produced, according to the varying circumstances. These results depend both upon the form of the lightning, that is, upon its *quantity* and *intensity*, and upon the receptivity or conductivity of the object struck.

Three forms of lightning are commonly described: The sheet lightning, the zigzag lightning, and the ball lightning. Sheet lightning appears in the form of a broad flash, is usually paler than the other forms of lightning, and extends over a considerable surface, with rapidly changing, feebly marked outlines. It may be either simple or compound, in the first case there being only the simple flaming flash, while in the second, a tense, thin, burning flash is combined with it. Zigzag lightning, on the other hand, is more vivid and dazzling, more intense, and consists in appearance of a sharply defined line of fire passing from one point to another, forking and forming well-marked zigzags in its course. Ball lightning is so rare and so terrible that we have few trustworthy accounts of it. It is said to consist of a fiery globe of a reddish tint, rotating on its axis, which slowly traverses the ground, sometimes at an elevation of a few feet, and which, in some cases, explodes with a loud noise and emits vivid flashes of lightning in all directions.

The various forms of lightning have been more or less closely imitated artificially by various observers, and certain other forms of powerful electrical action have been produced. From experiments made with very powerful currents of electricity on animals, certain deductions have been drawn in regard to the action of the different forms of lightning.

Dr. B. W. Richardson, in his experiments with the immense induction coil of the Royal Polytechnic Institution, the primary wire of which is 3,770 yards, and the secondary wire 150 miles long, succeeded in producing four forms of electrical spark, each of which produced different effects on the living organism. The third and fourth forms, however, varied more in degree than in kind. These four kinds are as follows:

1. The simple discharge, in which the secondary wire is simply charged from the primary wire. The spark thus produced, which in this case was twenty-seven inches long, consists of two flames—of a line of thin, blue, tense flame, surrounded by a thick, burning flame, which can be blown aside with a bellows. This form has been likened to the sheet lightning. A single shock of this character on the external surface of the animal body is harmless. There is sometimes a slight singing of the hair or fur, and general muscular contraction ensues, but the animal remains uninjured. If the shock be many times repeated a peculiar anæsthesia is produced which will last for a considerable time. Even when passed directly through the tissues, as by needles run into the flesh, this form of electricity does not injure.

2. The second form is the interrupted current. It differs from the first merely in the fact that the latter is a constant current, and continues steadily and equally while in action; but in this form we have a continual series of changes, rapid alternations of current and no current. It is produced by means of a vibrating or mechanical break. The spark is blue, intense, forked, almost continuous. This form has been likened to the zigzag lightning. When applied to the external surface of the animal body this, like the preceding form, is found to be harmless, but the muscular contraction thereby produced is persistent or nearly so. If conducted through the body, the muscular contraction becomes more pronounced, and, as the current is continued, the muscles of respiration are affected (contract) and death may occur from asphyxia.

3. The third form of electrical discharge is that obtained from a Leyden jar directly charged from the induction coil. This form is not yet recognizable in lightning. When received on the exterior of the body this form does not kill, but if it once succeeds in piercing the surface one or two shocks usually cause death. This shock, when not fatal, may cause a state of insensibility, in which the body lies prostrate and is analgesic, but may still be capable of recovery. There are frequent convulsive movements, and contusions are often found.

Richardson supposes that when death occurs the shock has affected the centres which govern the involuntary acts: (1) The respiratory, and (2) the circulatory. When

death does not occur, it affects nervous centres governing voluntary acts and common sensibility.

4. The fourth form, which may be known as the intensity discharge, is produced by charging a number of jars in cascade, that is, Leyden jars connected together *in series*, heterologously. The spark is not flaming and not burning; as it falls on the animal body it does not pass harmlessly over the surface, but penetrates, and always kills. It leaves no mark on the body, which retains the position which it was in before being struck. This action seems to be due to its intensity, and we find many cases of lightning reported in which similar results are said to have occurred.

M. Planté, with his enormous secondary battery and condenser arrangement, has succeeded in producing a form of electricity closely resembling ball lightning. "The effect appears to consist of a kind of brush discharge through films of moisture or vapor, which form an apparent globe of fire rotating on its axis" (Sprague).

The second factor which acts to determine the effect of lightning upon the person struck is the condition of the person at the time of the accident.

Position.—Persons are naturally more liable to be injured by lightning, if, during a thunder-storm, they find themselves in the vicinity of objects which are good conductors of electricity and are not so placed as to convey the electricity away from them, either to the earth or elsewhere. Lightning conductors do not act as protective agents because they attract or convey a discharge from the clouds, but because they supersede or prevent the condition of polarization or tension in the space to be protected. People may, however, be struck by lightning almost anywhere. Most frequently this occurs out of doors, and in that case usually under trees; but it may occur to persons who have sought shelter under hay-ricks, behind piles of sheaves, or in sheds. Not rarely a person has been struck in the open field, or plain, where there was no object of height in the vicinity, or on the road, or even in the street, or on the quay. Sailors or persons on board ship are peculiarly liable to be struck, unless the vessel be properly protected. When inside buildings, the persons struck are usually near an open door or window, where there is a draught, and through which the lightning enters, and the danger is increased if there be some metal object in the vicinity.

Out of 30 cases of lightning-stroke, taken at random, I find that 20 occurred out of doors; in 8 cases the people struck were under trees, in 2 behind ricks, in 3 cases the persons were in an open field or on the prairie, in 3 on the streets or road, in 2 in the garden, in 1 case the persons struck were sitting on a rock in an open field near a metal bell, and the last case was that of a soldier on guard. Three cases were on board ship, and 7 in buildings; 1, however, where the persons stood at an open barn-door, 1 where they were only under a shed. In 3 cases the people injured were at church; in 3 cases only, in a house. People carrying with them, or on their persons, metallic objects during a thunder-storm, thereby render themselves more liable to be struck, and if struck to be more seriously injured. As the liability to be struck by lightning varies according to the place and surroundings of the person, so the amount of injury likely to be received is affected by the character and condition of his clothing and the objects which he may have about his person or in contact with him. Thus, if the clothing be of such character as to be a good conductor, the lightning may pass along it, leaving the body only slightly injured, or possibly untouched. When wet, clothing conducts better than when dry. If the person struck has about him metallic objects, the lightning will probably pass through these objects rather than along the adjacent skin; but where the metallic conduction ceases, and the lightning passes from the good-conducting metal to the badly conducting body, that is, where the lightning meets with resistance in its course, there it is likely to produce more serious effects. In other words, the greater the resistance, other conditions being equal, the deeper and more severe is the burn. Thus we find that the lightning, in its course from the head to the feet, not infrequently meets with a chain, a metal band, or a a truss, and almost invariably follows this, at least in part, and causes a deep burn where it again transfers itself to the skin. The same thing occurs in the case of a watch, of keys, coins, metallic buttons, shoe-buckles, and the like.

Action of the Lightning on the Clothing.—Clothing may be treated by the lightning in the most various ways, and this often without reference to the injuries of the body underneath. It may be uninjured, while the person himself is killed or injured (Nick, Alexander), or, on the other hand, the clothing may be torn to pieces, or even carried away entirely, while the portion of the body to which it belongs is unhurt. In rare cases the sufferer is stripped entirely naked, as in that of Wilks, where absolutely nothing was left on except part of the left arm of a flannel vest. In this case the patient was much burnt and otherwise injured. As a rule, however, when a person is badly burnt by lightning the clothing also is more or less injured. It may be burnt or pierced or torn into large or small pieces, or even into the finest shreds; any solid portions may be broken, bent, or crushed. When, as most frequently occurs, the patient is first struck by lightning in the head, we usually find an irregular hole in the hat or cap corresponding to the injury. The head covering, however, may be totally destroyed (Griffin), or we may find several holes in it (Heusner). In Van Horn's case the hat was riddled with minute holes.

The clothing about the body—coat, vest, shirt—may be burnt, torn to pieces, or carried entirely away. The pieces may be large or small, or the article injured may be reduced to fine shreds or fibres (Claes, Van Horn).

The trousers may be the conductors of the lightning from the waist downward, or it may pass along the limb, or the current may be divided and go in both ways. The wetter the trousers the better conductors, and hence the more likely is the current to pass along them. Thus they may be entirely destroyed, or partially burnt and torn, or wholly spared.

Of all portions of the clothing injured, however, the coverings of the feet are the most commonly and the most seriously so, because here the lightning usually makes its exit from the body, and the resistance is greater here than elsewhere. The injury may be of various kinds. The boot or shoe—and of course the stocking—may be simply pierced as by a bullet (Davies). More often a large hole is torn in it, or it may be torn to pieces, or even reduced almost to lint, as in the case of Decerez, where the foot was entirely uninjured. If a wooden shoe be worn it may be broken to pieces (Gabart). In Dressler's case the shoe was torn into little pieces, shrivelled, and burnt, yet the foot was unhurt. The whole shoe may be carried off, or the sole alone taken, which latter may be cleanly divided from the upper leathers.

The shoe-buckles may or may not be injured.

Metallic objects which are in the pockets or about the person may be bent, broken, or otherwise injured. More rarely they are fused. Iron objects are often magnetized.

Symptomatology.—The effects of lightning on the human body are so various, and the combinations of symptoms so manifold, that to attempt to give more than a general sketch of them would be impossible. We will therefore first describe in a general way the results of lightning-stroke, and afterward take up the more important symptoms in detail. For our present purpose we will divide the cases of lightning-stroke empirically into three divisions—the mild, the severe, and the fatal. Of course in nature these three divisions run into each other, and many cases stand on the border-line.

1. *Mild Cases.*—In the mild cases the patient when struck is dazed, and may or may not lose consciousness for a short time. He may or may not have the impression of a blow or of a dazzling light, and he may or may not be knocked down. On recovery of his faculties he usually experiences temporary anæsthesia, paræsthesia, or paralyses of one or more extremities, which rarely last more than twenty-four hours. The anæsthesia and paralysis,

which is almost always partial, generally occur together, though the former may be superseded by hyperæsthesia. Vomiting and nausea sometimes occur. The external injuries in these cases are usually slight, and consist of burns, contusions, and the red stripes and dendritic marks so often described.

2. *Severe Cases.*—In this group, the more severe cases, the patient is knocked or thrown down with violence, sometimes being carried several feet, and loses consciousness, as a rule, at once. The external injuries are likely to be severe, and consist of burns, contusions, wounds, or fractures, and sometimes ruptures of internal organs are produced. The burns frequently commence at the head or upper portion of the body and descend to the feet, covering a large portion of the trunk, either the chest and abdomen or the back, or sometimes all three. Hæmorrhages from the nose, ears, and mouth sometimes occur. The loss of consciousness may be temporary, or it may last several hours or even days, gradually passing into delirium. Convulsive movements are not uncommon, and epilepsy and even tetanus and catalepsy have been known to occur. When the senses return there frequently remain a dulling or obtuseness of the faculties and a loss of memory, which pass off gradually. Cases of insanity, however, are known. After a severe stroke the patient usually sinks rapidly into a state of collapse. The skin is pale and cool, the pulse rapid and feeble, sometimes irregular, the respiration hurried and labored, the eyes fixed, and the pupils dilated. Sometimes, however, the pulse is slow, and rarely the pupils are contracted. Vomiting and nausea sometimes occur. Paralyses of all kinds are found, sometimes involving all the limbs, sometimes only some peripheral nerve ; paralysis of the third nerve is not rare, and we sometimes find paralysis of the sphincters or of the bladder. Dysphagia, aphonia, and hiccough are rather rare. Amblyopia or amaurosis is not uncommon, and often temporary. Deafness is a frequent symptom, often due to perforation of the membrana tympani.

As the symptoms of collapse disappear, restlessness and fever may take their place ; but the latter is, as a rule, secondary to the injuries received. Recovery is the rule. A certain amount of paralysis, deafness, and at times some mental trouble, may remain permanently.

In women who are struck during the menstrual period menstruation may cease. In women who are pregnant, abortion or premature delivery may or may not occur.

3. *Fatal Cases.*—In these death is usually instantaneous, but it may occur after several days, or even weeks, from secondary causes. When immediate, it may be caused by shock, by apoplexy, as in case of rupture of the middle meningeal artery ; by rupture of the heart, by the direct effect of lightning on the brain, or possibly by asphyxia. In certain cases it is probably the result of indirect injuries.

In studying the effects of lightning on the human body we shall, in the first place, consider the external injuries and those that may fairly be classed as surgical ; then the symptoms, both subjective and objective, which seem directly referable to the action of lightning, and, finally, the pathology and the lesions of the internal organs.

External Injuries ; Surgical Injuries.—External injuries, under which we class also fractures, ruptures of muscles and tendons, and, in general, those injuries which require surgical treatment, may be divided into primary and secondary, according as they are produced by the direct action of the lightning itself, or indirectly by the means of intermediate agents. As belonging to the latter class we consider contusions, ecchymoses, sprains, fractures, wounds or injuries of whatsoever character, which may be caused by the forcible contact of any object displaced by the lightning. Thus, for example, if a person has his thigh fractured by the falling branch of a tree which has been struck, such accident is evidently a secondary effect of lightning. In the same way all accidents arising from the forcible impaction of the person himself against any object must be regarded as indirect. Such impaction occurs when the person, as frequently happens, is thrown down violently or cast a number of feet. It is plain that many external lesions may thus be caused indirectly by lightning, and that various forms of fractures and ruptures of internal organs may thus occur.

The direct external injuries produced by lightning are burns, contusions, lacerations, and wounds of various forms, discolorations of the skin, dendritic and metallic, and perhaps loss of hair.

Burns may be of any or all degrees. Their position is determined by the point at which the lightning strikes, by the bodily position of the person struck at the time, and by the arrangement of the dress and the presence of metallic substances. In the large majority of cases the upper portion of the body is the part first touched by the lightning, and it descends thence along the body and lower limbs to the ground, departing usually through the foot or its covering. Out of 65 cases noted I find that in 44 the head, forehead, face, or neck seem to have been the parts first reached by the lightning, and in them the first lesion appeared. In 2 of these cases, however, the face was only superficially burned, the more serious lesions beginning on the chest or shoulders ; counting in these cases, we find 12 in which the lightning apparently struck first the chest, shoulders, or upper back. In 7 cases the upper extremities were first touched ; in 3 cases only the lower extremities, and in 1 case the lower abdomen. It depends merely on accident, or on the position of the person at the time, which side of the body is struck. In our cases the lightning struck 21 persons on the right side and 23 on the left.

The course of the lightning on the external surface of the body can usually be traced in a general way as follows : Beginning at the head, neck, or shoulders, the lightning causes a deep burn at the point where it first comes in contact with the body. If the head be the point struck, when the line of conduction passes along the external surface we usually find the hair of the head and face singed or burnt, and a deep burn, contusion, or laceration at the point of first contact. The skin of the face is frequently spared, though the eyes may be affected and sight destroyed. If the lightning enters the mouth, the mucous membrane of the pharynx will be burnt. Descending from the head a deep burn is made upon the chest, and from this a broad, red stripe, becoming more and more superficial, extends downward to the inguinal region. Here, as sometimes also occurs in the neck, the tightness of the clothes about the body offers resistance to the electricity, resulting in a deep burn in the groin, sometimes affecting the external genitals and singeing or burning the hair off the pubis. Thence we often have burns on the thighs, which are apt to be deeper in men near the knee, where the trousers are tighter ; and again, if the lightning follows the skin, burns on the calf or shin, until finally the point is reached on the ankle or foot where the lightning leaves the body. At this point there is always a deep hole or burn. If the sufferer be struck in the nape of the neck or back, the burn usually runs down the back, involving the greater portion thereof, to the nates and then acts as before described. Deep burns are produced wherever resistance is offered to the current, and the greater the resistance, other things being equal, the deeper the burn. This is usually the greatest at the points where the lightning touches or leaves the body. The burns vary in intensity from very deep to extremely superficial. In some cases the track of the lightning is only marked by the singeing of the hairs on the skin. Most of the red stripes so frequently mentioned are probably burns. In the more severe cases we find them running all the way from blisters to deep, charred masses involving the subcutaneous tissue, and holes may be burnt down to the bone. In Heusner's case about twenty whitish-gray spots, varying from the size of a lentil to that of a ten-cent piece, were found on the soles of the feet. They had a punctured centre, surrounded by a ring of loosened, partly singed, epidermis.

We find burns thus not only of all degrees, but of all forms and in all places. The only sign on the body may be a slight blister, or the larger portion of its surface may be more or less burned.

As the lightning ordinarily runs from the point of first contact with the skin to the ground, its course necessarily depends on the position of the individual struck at the moment. As previously mentioned, its course is influenced not only by the clothing but also, as a rule, by any metallic objects which may be on or near the skin.

Burns are found in nearly all cases of lightning-stroke, the only exceptions being where the person is very slightly affected or where the force of the shock is such as to cause instant death without leaving external marks.

Contusions and Ecchymoses.—Although many of these are produced indirectly, there seems to be good proof that in certain cases they may be produced by the lightning itself. They occur often, but not invariably, at the point struck, and are probably due to the rupture of small blood-vessels in the tissues. They are usually of small size, but Powell's case seems to be an exception, though from the description it is not certain that this was not a burn. Sometimes we find a distinct swelling containing fluid blood, as in the case of Märcklin.

Wounds.—These, like contusions, may be caused both directly and indirectly. The latter class of cases we shall not consider. Those of the first class are produced, like all other severe external injuries, most frequently and most severely at the points of entrance and exit of the electricity. They may be clean-cut wounds, as if made with a sharp knife, or holes punched out, as it were. They may be lacerated, ragged, and their edges contused or burnt. They may reach the bone, or extend only into the soft tissues. They may exist in almost any portion of the body, but are most frequent about the head, neck, and arms, and in the feet or ankles.

Dendroid or Dendritic Marks.—These are dark-colored, reddish marks, not disappearing on pressure, which are found upon the bodies of those struck by lightning. They are sometimes in the form of stripes or lines, more or less dichotomously branched, and from this shape, that of the branches of a tree, they have derived their name (δενδρον, a tree; ειδος, form, shape). Similar marks may, however, exist in many shapes, as stars, arabesques, flowers, sheaves (Jack), generally irregular figures. They usually disappear within twenty-four hours.

Many theories have existed in regard to the method of their origin. By the earlier writers they were supposed to be due to the presence of neighboring objects, which were photographed, as it were, by the lightning upon the skin. Stricker considered them only as traces of a light burn, and this view seems to have been supported by others. Although certain cases may in this way be explained, yet there are others in reference to which this explanation does not seem to be sufficient. Richardson has shown that the blood is the best electrical conductor of all the tissues in the body, and it has been supposed that these marks were merely the impressions of the blood-vessels on the skin, due to the action of the lightning on the blood within them. The marks, however, do not by any means always follow the course of the vessels, and Heusner, who cut some out and examined them carefully, could find no exudation of blood or other changes in the cutis. He suggests that they depend simply upon a paralysis of the capillary vessels or a loosening of the deeper layer of the epithelium. Mackay, who has given the subject careful study, concludes that the lightning breaks up into branches upon the surface of the skin, perhaps analogously to what occurs in the formation of Lichtenburg's figures, and that a capillary coagulation takes place below it, following closely the distribution of the electric fire upon the surface. "This coagulation of the blood is not necessarily such as is dependent on the presence of fibrine, and in this instance it would probably be coagulation of albumen by heat."

Metallic Staining.—In certain cases where metal has been in contact with the skin at the time of the lightning-stroke, the skin has become permanently stained by the reception of the finely divided metal. This may be an important proof of death by lightning. It is, however, rare. Richardson has succeeded in producing this metallic staining artificially on animals. He found two conditions necessary; the metallic conductor must be sufficiently fine to offer resistance to the electrical current, and the electrical current itself must be an accumulative discharge of low tension.

Loss of Hair.—It is said that loss of hair all over the body may occur as the result of a stroke of lightning, but this seems somewhat doubtful, except in those cases where the hair is burnt off. One case is related where the hair is said to have dropped out.

Fractures.—These are not uncommon, but are generally secondary. Those of the cranium are most frequent. The only immediate evidence of their existence may be hæmorrhages from the nose and ears, which are often mentioned. Direct fracture of the cranium is probably rare.

SYMPTOMS.—The various symptoms which may occur when a person is struck by lightning are so many and so different that the mere enumeration takes considerable space. They can, like the external signs, be divided into the direct and the indirect. The former are those which are caused by the direct action of the lightning itself, as, for example, loss of consciousness; the latter those which are its indirect result, as the fever due to an extensive wound. It is only with the former that we have to deal; the others are merely concomitant phenomena of certain conditions of the body.

We shall consider in detail only the more prominent symptoms, and in the first place those relating to the brain and nervous system, as these are the most frequent and the most direct results of the stroke.

Loss of Consciousness.—This occurs in all serious cases. It usually comes on immediately, and with such suddenness that the person has, on recovery, no recollection of what has happened. The sufferer falls at once to the ground. Occasionally, however, there is a momentary interval after the stroke, and one man was able to run to the door of his room after his dog and to call to him before he fell (Eggleston). The duration varies; it may be only momentary, or it may last for hours, or even days. It may pass into delirium. On the return of consciousness the patient, in the more severe cases, usually remains dazed and confused for some time. The memory is often weakened, and on recovery from the confusion a certain obtuseness or blunting of the intellectual faculties may continue. As a rule these symptoms in turn disappear, though a permanent condition of feeble-mindedness has been reported in some cases. Mania has also been observed.

This loss of consciousness must not be confounded with that due to commotion or concussion of the brain, or to fracture of the skull from secondary causes.

Paralysis.—Paralysis of all the extremities may occur, as in Bernard's case, where it was accompanied by loss of sensibility and of muscular sense; for several days the patient suffered from dysuria and constipation, and he had amaurosis of the right eye.

Hemiplegia is not rare. In Bonnet's case the patient was struck in the head by the lightning, which pierced his hat and caused a lacerated wound in the left temple but did not injure the aponeurosis. On recovery from unconsciousness he was found to have a paralysis of the left side of the body, including the face, accompanied by a diminution of sensation on the same side. The sensation returned in two days, but a partial hemiplegia remained permanently. In the case of Durand, a medical student, who was struck by lightning while sleeping at an open window, there was a nearly complete right hemiplegia, with exaggerated sensation on the same side, and some affection of speech. Deglutition and mastication were difficult, and there was persistent hiccough. The intellect was unaffected, but the memory was slightly diminished. There were photophobia and hyperacusis. Improvement took place in two weeks, and the patient finally recovered entirely.

Paraplegia of the lower limbs occurs in about the same number of cases as hemiplegia (3 out of 75 cases). It is usually temporary, lasting only a few hours, and may be accompanied by anæsthesia and paralysis of the bladder, which are likewise of short duration.

Brachial paraplegia is not uncommon, and paralysis

of one extremity, or of some portion thereof, is comparatively frequent in mild cases.

The affected parts are, as a rule, cool, pale, numb, and frequently anæsthetic. Recovery is the rule.

Cranial Nerves.—Optic neuritis, with consequent atrophy, may follow a stroke of lightning, and affections of the acoustic nerve undoubtedly also occur. Paralysis of the ocular muscles, ptosis, and paralysis of accommodation are not very rare (Vossius). Paralysis of the seventh nerve with loss of sight, both temporary, has been noted.

Difficulty in deglutition and mastication, as in Durand's case, may be due to a partial paralysis of the muscles on which these functions depend, or may be due to other causes. In the case of Mackintosh there was dysphasia, dysphagia, and a peculiar metallic taste in the mouth. In Eggleston's case deglutition seemed to produce a spasm of the pharyngeal muscles and general convulsions. Aphonia, apparently due to paralysis of the vocal chords, sometimes occurs.

Paralysis of the bladder may occur with paraplegia, and retention of urine has been reported in connection with paralysis of one lower extremity. It is doubtful whether it ever occurs with hemiplegia.

Disturbances of sensation, aside from pain, are among the more common symptoms. Anæsthesia occurs either with or without paralysis; in either case it is usually transitory, rarely lasting as long as a week. When it occurs with paralysis it disappears before the paralysis. Hyperæsthesia is more rare. A great sensitiveness to electricity is said to remain in some cases (Minonzio). Paræsthesiæ are not uncommon. The most usual form is a sensation of numbness, which may be general or local. In Jenkins' cases, where it was general, it was accompanied by tingling and lasted several days. There was no objective diminution of sensation. Numbness, when local, usually occurs with paralysis, and is often accompanied by a painful sensation of cold. Jack states that after the great accident at Grosshau, where the church was struck by lightning and many of the congregation were injured, about thirty of the sufferers complained of a painful pulling and stretching in the joints, especially the elbows, and those of the hands and feet, and of a sensation of numbness and weakness therein. Chauveau relates a case where formication in the arms was a prominent symptom, the patient having been struck in the head.

Neuralgia.—Pain is usually a secondary symptom, but it may occur as a neuralgia, or without any objective lesion. In Knapp's case it was present in the arms, in company with paralysis and anæsthesia, and lasted three months. In Tzschirmer's case the pain in the arms and chest was so severe that he supposed the posterior roots of the brachial plexus to be affected. Sciatica is known to occur, and some of the severe headaches mentioned may be neuralgic.

Convulsions.—Epilepsy may be brought on by lightning, as in Macaulay's case, where the attack was preceded by the aura of a figure approaching the patient. Epileptiform attacks, accompanied by foaming at the mouth and strong adduction and flexion of the thumbs, sometimes occur. Clonic spasms of the body are sometimes seen, and convulsive movements of the limbs are not infrequent. In Valerian's case, where the foot was perforated by the lightning, the lower extremities were not only the seat of severe pain but were thrown into clonic spasms on the slightest touch. Tetanus is said sometimes to occur.

An interesting case of catalepsy following lightning-stroke is reported by Richardson.

The mental condition of patients after a lightning-stroke is liable to be depressed for a time, usually not long, and their intellectual faculties may be dulled. On the other hand we sometimes have restlessness or delirium, or the sufferer may be disturbed by dreams of objects on fire. The delirium seems usually to take the form of a delirium of terror (Angstdelirium), and insanity is said to have been produced by lightning.

Vertigo and reeling may occur together, and be due to various causes. The latter sometimes exists in conjunction with rupture of the membrana tympani. In Jenkins' case it was probably due to some injury of the head.

Respiratory Symptoms.—The respiration is sometimes decidedly affected, and becomes labored, rapid, and feeble. Cyanosis is not uncommon, and the patient may appear asphyxiated. These symptoms coincide with those noticed in animals when subjected to shocks of certain forms of electricity. They are generally accompanied by the symptoms of collapse.

Circulatory Symptoms.—Shortly after the shock the skin usually becomes pale and cold, and the pulse rapid, feeble, and often almost imperceptible, frequently irregular. In other words, the well-known symptoms of collapse appear. The pulse, instead of being rapid, is sometimes very slow, in one case the beats being only four to the minute. Later we have gradual recovery, and the force of the heart-beat becomes normal, unless secondary symptoms arise. Fever is reported in certain cases to have followed the shock of a lightning-stroke, but we have no details, and cannot be sure that it was not secondary. Palpitation may occur.

Gastric and Intestinal Symptoms.—These are generally of a secondary importance. Vomiting and nausea are not uncommon, and the vomitus sometimes is said to have the odor of sulphur. Hæmatemesis and hæmorrhage from the bowels have both been reported.

Eye Symptoms.—Paralyses of the third nerve have already been referred to, and ptosis, paralysis of the ocular muscles, mydriasis, myosis, and paralysis of accommodation have been noted in various cases.

There are numerous cases of amaurosis reported. Usually the loss of sight is only temporary, but absolute incurable blindness has been observed. The cause is sometimes optic neuritis, sometimes hæmorrhages into the retina. Leber saw partial optic atrophy, Reich a severe rupture of the choroid and commotio retinæ.

Leber, in 1882, collected 9 cases of cataract—5 bilateral, 4 unilateral. They became complete in from six or eight weeks to one or two years. They may be total or seated in the anterior or posterior wall. Leber's theory is that cataract is caused by a coagulation of the capsule of the lens.

Keratitis, due to burn, may occur, and pain in the eye and photophobia are common symptoms.

All these are the result of the direct action of the lightning, and are not due to intense light (Leber).

Vossius has published a very interesting case, with the following symptoms: Singeing of the eyelashes, superficial affection of the cornea resembling a burn, recurrent irido-cyclitis, spasm of the muscles of accommodation, optic neuritis; later, anterior polar cataract and partial atrophy of the disk. The field of vision was slightly narrowed for green. Anerythropsia has been mentioned as a symptom produced by lightning.

Symptoms Referable to the Ear.—Deafness is very common. Increased sensitiveness to sound has been noted. The only pathological condition actually found seems to be rupture or perforation of the membrana tympani, which is moderately frequent, but may be secondary.

FATAL CASES.—We now pass to the consideration of the fatal cases. The immediate cause of death may be the destruction of some vital part, shock, or *possibly* asphyxia. In regard to the method in which the lightning acts physically, the most plausible view is that of Richardson, who believes that when death is instantaneous it is due to the sudden expansion of the gaseous part, or atmosphere, of the blood, combined, in extreme degrees of shock, with a sudden conversion of animal fluid from a liquid to a gaseous condition.

Death usually occurs at once, but it may take place later from secondary causes. The latter cases are not under consideration here. Since death from lightning is often only apparent, and the patient may lie in a condition which so closely resembles it as to deceive relatives and friends, and even at times the medical attendant, it is important to know what are the reliable *signs of death.* These are only three: (1) Rigidity of the muscles; (2) coagulation of the blood; (3) decomposition of the tis-

sues. When the first two do not occur we must wait for the latter before permitting burial. Partial or local rigidity of the muscles is not sufficient; the rigidity must be general, and the muscles of the chest must be affected. If the coagulation of the blood be complete, the inference is justifiable that the restoration of life cannot take place.

Rigor Mortis.—It was stated by John Hunter, and long believed to be true, that rigor mortis is absent in death by lightning, and that this absence may be considered a diagnostic sign thereof. Other writers, however, have of late years held, on the contrary, that death by lightning is rather characterized by the rapidity with which rigor mortis takes place. The truth seems to lie between these two views, and to be that in death by lightning rigor mortis may or may not be present, and that there is nothing diagnostic in its presence or absence. Rigor mortis occurs in cases of death by lightning in the same way in which it occurs in other cases, and is only absent where some other factor, as cold, acts to prevents its appearance. Richardson thinks it possible that in certain cases it may be increased by lightning. It has been suggested that absence of rigor mortis occurs where there are no external lesions, but where burns, bruises, or wounds are present there is marked rigor mortis and coagulation of the blood. Nick's case would seem to prove the fallacy of this.

Coagulation of the Blood.—It has been observed by nearly all writers that the blood of a person struck by lightning does not coagulate readily, and that the arterial blood becomes dark-colored. This occurs during life. Sullivan states that in certain cases of complete disorganization after lightning-shock, the blood is left fluid and incoagulable, and its color is changed to a deep black.

There is no proof that any more rapid decomposition occurs in the bodies of those killed by lightning than in those of persons who have died from any other cause.

AUTOPSIES; CONDITIONS OF THE INTERNAL ORGANS.—*Brain.*—The brain and its membranes may be anæmic (Powell) or congested. The vessels are frequently distended with blood which is dark and fluid. Effusions of blood have been found beneath the dura mater and in the brain-substance itself, due to rupture of the middle meningeal artery. Rupture of the brain may occur, and Phayre reports a case in which a whole hemisphere was entirely destroyed and changed into a dark homogeneous fluid mass.

Lungs.—"The lungs are usually found natural, left filled with air, of a pink color and free from any traces of congestion" (Sullivan). They are, however, sometimes congested, non-crepitant in parts, and their vessels distended. Extravasations sometimes occur.

Heart.—The right side of the heart and the great vessels are usually distended with dark fluid blood, but sometimes they are empty (Case XII. of Stricker, Schaffer). Blood may or may not be present in the cavities of the left side. Rupture of the heart may occur. Ecchymotic spots are sometimes found in the pericardium.

Alimentary Canal.—The walls of the stomach may be softened or ruptured, and in one case, where the patient lived several days, the stomach was found to be gangrenous internally over a large surface, while externally it was inflamed and livid (Sullivan). In another case large blackish plaques, corresponding to external contusions, were found on the small intestines, and an active peritonitis existed.

Liver.—Congestion of the liver appears to be moderately common. Rupture of the liver may occur. It is said that the gall-bladder may at times be ruptured.

Spleen.—The spleen may be congested or ruptured. It is usually normal.

The peritoneum may be in a condition of active inflammation or it may present a series of ecchymotic spots, which are often arranged in a line mapping out the course of the current. More usually it is normal.

The kidneys are usually congested.

The spinal cord and medulla are apparently not affected.

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See also Taylor's Medical Jurisprudence.

William N. Bullard.

LILY OF THE VALLEY (Muguet, Codex Med.). This familiar and favorite little flower, *Convallaria majalis* Linn.; order, *Liliaceæ;* a native of many parts of the northern hemisphere, and everywhere cultivated, has been on the list of medicines and in the pharmacopœias for generations, but had become about obsolete until a few years ago, when its diuretic power and its influence over the heart suggested its employment as a substitute for digitalis. It does not require description. Its flowers and roots have been both used, and possess similar properties.

The peculiar constituents of Lily of the Valley are *convallarin*, a purging crystalline substance, and *convallamarin*, a bitter, half-crystalline whitish powder; both are glucosides, the former decomposing into convallaretin, and the latter into convallamaretin. Convallamarin is a rather active poison (fatal to doves in dose of 1 to 2 mgm.) of the digitalis character; in small doses increasing the urine and strengthening the heart's action. Although less reliable and useful in cardiac weakness than digitalis, it is still worth remembering when that drug acts unkindly, or when, after taking it for a long time, it is desirable to change for a while.

Convallaria may be given in substance. Dose, about a gram (1 Gm. = grs. xv.), or, as is more commonly done, the same amount of a good fluid extract may be substituted; the same conditions indicate its use as do that of digitalis.

ALLIED PLANTS.—See SQUILL.

ALLIED DRUGS.—The following list of cardiac tonics is copied from Brunton's Materia Medica: *Digitalis* and its constituents, *Erythrophlœum* (Sassy Bark), *Strophanthus* (*Iné*), *Adonis vernalis*, Squills, Hellebore, Antiarin (from *Upas Antiar*, a Java arrow-poison), Caffeine, and Strychnine. They all paralyze the heart in large doses. See DIGITALIS. *W. P. Bolles.*

LILY, WATER. Two species are still official in France, and were so formerly in other countries of Europe. *Nymphæa alba* Linn., the White Water Lily of the Old World, is a plant of the size and general appearance of our own Water Lily, *N. odorata* Ait. Its flowers (*Nénuphar blanc*, Codex Med.) are employed now and then to make a mild "refrigerant," sedative syrup, of no particular value. The mucilaginous, starchy, and mildly bitter and astringent rootstock was formerly considered to be anaphrodisiac, but is now obsolete. *Nuphar luteum* Smith, the European Yellow Pond Lily, which is also rather like our Yellow Pond Lily, has similar properties to the above. Its large, thick, spongy, farinaceous rhizome (*Nénuphar jaune*, Codex Med.) is astringent, bitter, mucilaginous, and nutritive, and is occasionally employed internally in diarrhœa, etc., and externally as a poultice. It is also eaten in some parts of Northern and Eastern Europe in times of famine. Neither of the above plants have any importance in medicine.

ALLIED PLANTS.—The order *Nymphæaceæ* contains about thirty-five species of the largest and most beautiful aquatic plants in the world. Many of them are cultivated for ornament; a few are used in medicine, and two or three employed more or less as food.

Our own species of *Nymphæa* and *Nuphar*, *Nymphæa odorata* Ait., the sweet-scented water lily, and *Nuphar advena* Ait., the yellow pond lily, have both been put to

medical use ; their rhizomes have the same mildly astringent and mucilaginous properties as the above. *Nelumbium speciosum*, in the same order, is the Egyptian and Indian Lotus (but not that of Homer and the "Lotus Eaters"). Its seeds, "Egyptian beans," and its rootstocks, are edible. The great Brazilian Water Lily, *Victoria regia* Lindl., is occasionally cultivated in hot-houses for ornament.

ALLIED DRUGS.—Marsh-mallow and other bland substances. Also the milder astringents. *W. P. Bolles.*

LILY, WHITE (*Lis blanc*, Codex Med.). All parts of the common garden White Lily, *Lilium candidum* Linn., order, *Liliaceæ*, "Fruit, Bulb, Flower," are recognized by the encyclopædic Pharmacopœia of France, but none of them has any medicinal value. The flowers impart their delicious odor to lard or oil, and from them fragrant pomades or distilled waters are made ; the scales of the bulb, when bruised and mixed with water, are one of the numerous substances of which poultices can be made.

ALLIED PLANTS.—See SQUILL. *W. P. Bolles.*

LIMPING, DIAGNOSTIC SIGNIFICANCE OF. It is not proposed in this article to discuss exhaustively all the different pathological conditions which may produce irregularities in locomotion, but merely to indicate briefly some of the more common causes of limping, in order to a correct appreciation of the value of this symptom from a clinical standpoint. In many cases, especially in children, it is impossible to obtain from the patient a clear statement of the subjective symptoms, either because they are so slight as to escape recognition, or for the reason that they are often imaginary, or are not correctly appreciated even when severe, and hence the clinical importance of the objective symptoms. This is especially true of limping, which is often the first, or perhaps for a long time the only, sign of commencing disease of some portion of the locomotor apparatus.

A limp is defined by Voillemier as an inequality in the oscillations of the body during progression, to which Le Dentu ("Jaccoud's Dictionnaire de Médecine et de Chirurgie Pratiques," art. Claudication) adds the qualification that the characteristic phenomena of the type observed are repeated at each step.

In studying a limp it is necessary to consider to which of three categories it belongs—whether the inequality in the oscillations be in a vertical, lateral, or antero-posterior sense. It is seldom that the irregularity is in one direction only, but it is usually of a mixed type, as, for example, when lateral oscillations are present in a case of vertical or antero-posterior inequality. It is also important to observe whether the limp occurs at the beginning of a step or during the act, as in the former case there is an absolute inequality in the length of the limbs, while in the latter there is some trouble which interferes with the normal mechanism of locomotion. The rhythm of locomotion is also to be noted. There may be little actual oscillation, but one limb is favored more than the other, and the step taken with that side is of much shorter duration than is that made with the sound limb. A limp may be constant, occurring whenever the patient takes a step, or it may be intermittent, either regularly or occasionally. In commencing hip disease, for example, there are often long periods during which no claudication is perceived, and the limp returns after a longer or shorter interval, either spontaneously or after a misstep or some other slight traumatism. Again, in other affections a limp may be present in the morning, when the patient first rises from bed, or at any other time after a rest, but disappears after exercise, or it may become evident only after a long walk, or toward evening when the patient has been actively engaged on his feet during the day. The time of day at which a limp occurs is often an important point in the differential diagnosis of certain forms of chronic joint disease. And another point, which is not always easy, is to determine upon which side is the offending member. For example, in the case of a woman whose limbs are hidden by her skirts, there may be absolute shortening on one side, but in the endeavor to equalize the two sides the knee upon the sound side is flexed, and with each step the sinking down occurs on that side. Or, again, in the case of a painful affection of one limb, the weight of the body is thrown over to the other side, and at first sight it would appear that this was the affected member.

Among the causes of limping we have to recognize troubles of the bones, articulations, integument, muscles, or nerves of the affected limb, in addition to an absolute difference in length due to atrophy or hypertrophy on one or the other side.

Affections of the bones may cause a limp in one of several ways. In the early stages of osteitis, or periosteitis, stepping on the diseased limb causes pain ; the patient favors the leg as much as he can, and endeavors to throw the weight of the body as quickly as possible over to the sound side. The rhythm of locomotion is in such case markedly altered, and there is a manifest inequality of the lateral oscillations. Here the claudication occurs during the step. In necrosis there may be a production of new bone in excess, and thus the diseased member is made longer than its fellow. In other cases there is lengthening of the bone, due to irritation at the epiphyseal end and consequent abnormal growth. Tumors developing in a long bone may also cause an increase in length. When there has been early union of the epiphyses, the growth in the bone is retarded and shortening results. A similar condition of shortening may follow disease of the articular end of the bone, operations, fractures with longitudinal displacement of the opposing fragments, and tumors causing a retardation of growth or loss of substance of the bone. There is here a difference in length of the two members ; the limp occurs at the beginning of the step, and is marked by exaggerated vertical oscillations, without necessarily any noticeable disturbance of rhythm. This is one of the least deforming varieties of claudication, and may, if the difference in length of the two members be not too great, be almost perfectly concealed by extension of the foot upon the shorter side, or by the wearing of a high-soled shoe.

Lesions of the joints are among the most common causes of lameness. Here the limp may be caused by pain, by restriction to normal articular motion, or by weakness of the joint unaccompanied by either pain or restricted movements. When due to pain resulting from injury or disease, the limp is of the same character as that symptomatic of inflammatory bone lesions, but is often more marked in proportion as the joint sensitiveness is greater. In commencing joint disease, or in hyperæmia of the articular structures before any actual inflammation is present, there is often a limp or a "favoring" of the member, which is unaccompanied by pain, and is due to reflex influences or nature's effort to protect the joint. The limp in this case is similar in character to that caused by painful affections, but is wholly involuntary, and the patient himself is often unable to explain why he walks lame. When the articular motion is restricted the limp will vary in character, according to the joint affected and to the variety of deformity present. In anchylosis of the hip in extension, the limp is characterized by a peculiar balancing of the body in an antero-posterior direction. As the weight rests on the sound side the anchylosed limb is thrown forward and the body backward, and then, as the weight is transferred to the anchylosed limb, the body goes on in advance while the leg on this side remains behind. Sometimes the limp consists in a sort of rotation, now to one side and now to the other, as the axis of rotation is transferred from one limb to the other. The body is turned half around on the sound limb, and then the motion is reversed by rotation on the heel of the anchylosed side. This may occur when but one hip is anchylosed, but is the only possible mode of progression without crutches when there is anchylosis in extension at both hip-joints. When one hip is stiffened in flexion, the vertical position of the body is maintained by compensatory lordosis of the lumbar spine, but the limb is shortened by reason of its position, and there is an exaggeration of the vertical and also of the

lateral oscillations. When the spine is also rigid the body cannot be held erect, and there is an inclination forward. In such cases oscillations in each of the three directions occur during locomotion.

When the knee is stiffened in extension the normal shortening produced by flexion cannot take place, the limp occurs during the step and is characterized by increased vertical oscillations, but the sinking down occurs on the sound side, or rather there is an absence of the normal depression on the affected side. If the joint is held in the position of flexion the limb is shortened, and claudication occurs at the beginning of the step.

In anchylosis of the ankle with extended foot (talipes equinus) the limb is elongated, and the characteristic limp of inequality in length takes place. When it is stiffened in flexion (talipes calcaneus) the limp occurs during the step, and is occasioned by the absence of normal lengthening which should take place from extension of the foot in walking. In talipes varus, in addition to the limp due to unequal length there is usually a lateral oscillation from unsteadiness of support. In talipes valgus, besides the limp caused by imperfect extension of the foot, there is commonly also an altered rhythm in the steps, depending upon the pain felt in walking.

When joint disease is active and pain is present, as well as restriction to motion from reflex muscular spasm, there is a mixed limp, due to the elongation or shortening of the limb from position, and to the pain caused by intra-articular pressure and attempted motion. The rhythm is altered, and lateral and vertical, and sometimes also antero-posterior, oscillations are produced.

In unreduced traumatic dislocations there is shortening or lengthening of the affected side, and the limp characteristic of this condition is produced. In congenital dislocation of the hip the limp is peculiar. It occurs at the beginning of the step, and is prolonged during its progress. The sinking of the body seems to continue as long as the weight rests upon the affected limb, and at the same time there is a very marked lateral deviation. In bilateral dislocation the gait is waddling and extremely awkward.

In cases of relaxed and weakened joints, resulting from previous inflammation, with effusion and distention of the articular structures, or from any other cause, the gait is uncertain. There is not always a true limp, but there is apt to be a more or less marked lateral or vertical oscillation, not necessarily occurring at every step, but taking place irregularly whenever the articulation gives way. In genu extrorsum the gait is waddling, and in knock knee it is commonly of a shuffling character, but unless the deformity is unilateral no real limp is usually present.

Claudication is of very common occurrence in Pott's disease of the spine. If the psoas muscle is contracted, the thigh becomes flexed and a limp is caused. Limping may also be excited by the peripheral pains of spinal caries, or there may be paraplegia, more or less complete, with consequent interference with normal locomotion.

Lesions of the integument may occasion the limp of pain, as is seen in the case of irritable ulcers of the leg, or of corns or other painful cutaneous affections of the feet. Under this head might come also the painful limp caused by tight or badly fitting shoes. Cicatrices near a joint may give rise to a condition similar to anchylosis, and the resulting limp will be that characteristic of this impairment of articular function.

Contractures of the muscles are a not uncommon cause of claudication, the particular variety of which will depend upon the deformity produced. The characters of the limp, varying according to the joint whose motion is restricted, have been described under the lameness from articular troubles, and need not be again referred to. It should not be forgotten that there may be pain accompanying the muscular contractures, and in such cases active joint disease might erroneously be diagnosed.

Paralysis may cause limping in any of several ways. In the early stages, before alterations in the form and nutrition of the limb have taken place, there is the limp due to impaired function. When the flexors of the thigh are affected the limb must be thrown forward by a rotating motion of the body around the sound side ; when the muscles on the anterior surface of the thigh are involved there is a similar throwing forward of the leg by the thigh ; in paralysis of the flexors of the foot the toes droop and the limb is practically lengthened, so that the patient is obliged either to raise himself on the sound side while bringing the affected limb forward, or to throw the latter outward and swing it around to the desired position ; when the calf muscles are the ones paralyzed the normal lengthening during the step is prevented, and the characteristic limp is produced. After the disease has existed for a time there is more or less atrophy, and, in children, arrested growth with its consequent shortening ; usually, also, muscular contractures occur and lead to impairment of joint-function. The most usual forms of paralysis met with in children are infantile paralysis and infantile hemiplegia. It is impossible in an article of this nature, and it would also be wearisome to the reader, to define at greater length the almost endless variety of claudication caused by paralyses of the different muscles, and to distinguish between the various forms of paralysis. The spastic paralyses and the ataxic gait of tabes dorsalis need only be referred to here, since they do not cause a true limp, although they modify very materially normal locomotion.

A painful limp may be due to sciatica or other forms of neuralgia. The other nervous causes of claudication have been discussed under the heading of muscles. In hysterical joint-affections the limp is similar to that caused by the true disease there simulated.

Malingerers frequently feign a limp. This may be seen at times in army practice, but is perhaps more common among children and youths of both sexes in boarding-schools. The scholars are forced to take the necessary out-door exercise by marching through the streets in procession, with teachers and monitors stationed at proper intervals to see that no breach of decorum is committed. Such forced exercise under restraint is regarded as a bore, and the scholars not infrequently attempt to evade it by simulating lameness. The deception may usually be easily detected by comparing the character of the limp with the cause as alleged by the pretending sufferer.

The treatment of claudication is, of course, that of the causal affection. If there is a shortened limb nothing can be done except to equalize the two members by means of a patten or cork-sole attached to the shoe. Any remediable deformity should be treated, and weakened muscles should be supplemented by properly constructed apparatus and elastic bands.

In conclusion, a word may be said by way of caution against neglecting the warning given by claudication. It is often the first sign of serious trouble which may be averted if discovered in time, but which will work irremediable mischief if allowed to progress unnoticed or untreated. This is especially true in the case of hip disease in children. A limp is almost always the first intimation which the disease gives of its presence ; but, as the claudication is unfortunately often intermittent, the parents, and even at times the physician, are wont to disregard it or to think it is only a "bad habit," and it is not until pain and deformity supervene that the true cause of the limp is recognized. No limp, however trivial, occurring in a child, should ever be lightly passed over. The little patient should be carefully examined and all his joints tested, and he should be watched so that any trouble that may arise may be recognized in its incipiency.

As an instance of a peculiar cause of claudication may be mentioned a case reported by M. Terrillon at a meeting of the Paris Société de Chirurgie, on June 4, 1886. He exhibited a patient whose leg he had amputated for gangrene of the foot. The interesting point in the case resided in the fact that the gangrene had been preceded by intermittent claudication. Dissection of the amputated limb showed that the posterior tibial artery was, although patent, reduced to almost the size of a hair.

Thomas L. Stedman.

LINDEN FLOWERS (*Flores Tiliæ*, Ph. G.; *Tilleul*, Codex Med.). Of the European Lindens, or Lime-trees, two species supply the official Linden Flowers. They are both large, fine trees, with light, soft, tough timber, much employed in carpentry and joinery, and yielding a fine, pure charcoal like that of willow, used in drawing and in dentifrices. The bark is very strong and fibrous, and is used, especially in Russia, in the manufacture of mats and cordage. The leaves are unequal at the base, usually deeply cordate. The inflorescence consists of few-flowered axillary clusters, each apparently growing from the middle of a long, narrow, adnate, floral leaf. Flowers small, yellow or greenish, regular. Calyx valvate, of five sepals. Petals five, imbricate. Stamens numerous (in the two following species), cohering at the base in five clusters opposite the petals. Carpels five, united into a five-celled, ten-ovuled, globular, superior ovary. *T. ulmifolia* Scopoli (*T. Europœa* Linn., *T. parvifolia* Ehrh.,) is the commonest and most widely distributed. It has smooth leaves and erect flower clusters (by a half-turn in the bract); grows in abundance throughout Europe, especially in Russia. *T. platyphylla* Scopoli (*T. grandifolia* Ehrh., *T. Europœa* Linn.) has much larger, velvety leaves drooping cymes, and winged fruits. Both species are extensively cultivated, both abroad and here, for ornament.

Linden was, of course, known to the ancients. The leaves and bark have long been employed as well as the flowers, the latter at least as early as the sixteenth century. The family name of Linnæus (Linné) is said to be derived from the Swedish name of these trees.

Linden flowers, when dried, besides the characters given above, have a fragrant, agreeable odor, and a pleasant, mucilaginous taste. The bracts always accompany them, but are comparatively useless.

COMPOSITION.—*Wax, mucilage, sugars, mannit,* and a small percentage of *essential oil.* The trees exude a sort of manna in the summer, of which bees are very fond.

USES.—They are scarcely used in this country, but in their home are popularly used in making an agreeable "antispasmodic," soothing, and sudorific tea, as elder-blossoms are here. They have no active properties, and, like many other "herbs," owe much of their effect to the abundance of hot water which they flavor.

ALLIED PLANTS. — Several other species of Linden grow in Europe, and are sometimes gathered instead of the above; they are less agreeable and fragrant. The American Linden, *Tilia Americana* Linn., furnishes our white- or bass-wood. It resembles the European trees in habit and inflorescence, but has five petaloid scales opposite the petals, and to which the stamens are attached. Its medical properties are no more marked than those of the above. *W. P. Bolles.*

LINSEED (*Linum*, U. S. Ph.; *Lini Semen*, Br. Ph.; *Semen Lini*, Ph. G.; *Lin*, Codex Med., Flaxseed), *Linum usitatissimum* Linn., the universally known and cultivated Flax, is a slender annual, with an upright, round, wiry stem, simple below, and only slightly branched above, and alternate, sessile, linear-lanceolate, smooth leaves. The woody part of the stem is hard and brittle, but the bark is of a most remarkable flexibility and toughness, and has been prepared and manufactured into cords and cloths from time immemorial. The flowers of Flax are of perfect regularity and symmetry. Calyx of five sepals. Petals five, lilac, forming an open, bell-shaped corolla, convolute. Stamens five (and five abortive ones). Ovary five-celled, ten-ovuled. The flowers are very delicate and pretty, and the whole effect of the plant in blossom is graceful and wand-like. Flax is a native of the Old World, but has been in cultivation so long that its wild state is wholly unknown. There is no plant of which the proofs of its ancient use are so substantial; linen coverings are folded around Egyptian mummies more than twenty-five centuries old. It has also been found in the relics of the prehistoric Lake Dwellers of Switzerland. It is frequently mentioned in the Bible, and has been known from the earliest times of ancient Greece and Rome. The employment of the seeds is also of very ancient origin.

DESCRIPTION.—Linen itself, although not official or generally considered an article of *Materia Medica,* is of so

FIG. 2086.—Flowering Stem of Linum Usitatissimum. (Baillon.)

frequent use in bandages and other forms of surgical dressing as to deserve to be noticed. It is prepared from the stems and branches of Flax by a complicated process of separation. The plants are gathered by pulling, so as to save also the little root, and stacked or packed in parallel bundles or sheaves. The capsules and leaves are then sepa-

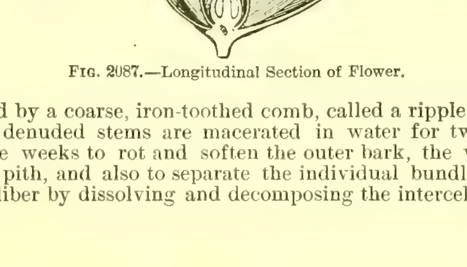


FIG. 2087.—Longitudinal Section of Flower.

rated by a coarse, iron-toothed comb, called a ripple, and the denuded stems are macerated in water for two or three weeks to rot and soften the outer bark, the wood and pith, and also to separate the individual bundles of the liber by dissolving and decomposing the intercellular

substance holding them together; this process is called "rotting." The stems, still in parallel bunches, are then "broken" by passing between fluted rollers or some such contrivance, by which the wood and brittle fibres are broken up and loosened, and these impurities scraped or rubbed off by a process called "scutching;" the resulting product is "Flax." In the further preparation the flax is combed or "heckled," as it is called, by drawing it through a coarse, iron-toothed card (the "heckle"), and thus separating the short and tangled fibres from the long and parallel ones. The former are called "Tow," the latter "Linen." All three of these forms have been used in surgery: Flax fibre drawn across a cut, and fastened on either side by collodion, has been employed to draw and hold wounds together; fastened in the same way at one end to a part, and twisted into a cord at the other, it has been used for extension, but there are better means for both these ends. It is used as a packing for some syringe pistons. Tow, chiefly in the form of oakum, that is, soaked in tar, is considerably in favor to make deodorizing and absorptive pads or cushions for suppurating parts; prepared earths, *Sphagnum*, absorbent and antiseptic cottons and fabrics are, however, more in favor at present. Linen fabrics in the form of bandages, compresses, and lint have long been used for all sorts of surgical dressings, but are very largely at present superseded by cotton textures, which for most purposes are equally good. A cotton roller is more plastic, softer, and more apt to keep its place than one of linen. Cotton compresses are warmer than linen ones, which is not always an advantage. Linen lint, however, that is, the so-called "patent" or woven lint, of which Taylor's best is the most perfect example, is much superior to any made by using cotton. It is a soft, loosely woven cloth, with a heavy flocculent nap on one side, beautifully bleached and clean, and so tender that it can be easily torn in either direction or pulled into woolly bits. Picked, scraped, and ravelled lints, made, as their names indicate, from old linen cloths, are now mostly of domestic employment, having been superseded in the hands of physicians by the lint just mentioned and the now beautifully prepared "absorbent cotton."

FIG. 2088.—Flower, after the Removal of the Perianth.

FIG. 2089.—Pistils of the Same.

FIG. 2090. — Transverse Section (diagrammatic).

The seed of Flax (*Linum*, U. S. Ph.) is a shining, brown, oval, lenticular body, about four millimetres in length, pointed at one end, and rounded at the other. It contains a large, whitish, oily embryo, and no albumen. The outer cells of the testa swell enormouly in water, and cover the seed with a thick, viscid layer of mucilage when it is soaked in water. Taste of the seeds mucilaginous, oily, and slowly, slightly bitter.

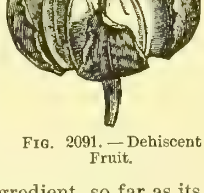


FIG. 2091. — Dehiscent Fruit.

COMPOSITION.—Flaxseed contains in the shell the *mucilage* just noticed, and which is the most important ingredient, so far as its value for poultices goes, giving it that peculiar elastic tenacity that makes flaxseed applications so plastic. The kernel of the seed contains a peculiar, drying, *fixed oil* (*Oleum Lini*, U. S. Ph., Linseed Oil), to the extent of thirty per cent. or so, for which the seeds are mostly valued. This is "a yellowish or yellow, oily liquid, having a slight, peculiar odor, a bland taste, and a neutral reaction. When exposed to the air it gradually thickens, acquires a strong odor and taste, and finally solidifies." Linseed-oil is used in enormous quantities in mixing paints and printers' inks, and for other purposes. In medicine it is occasionally given as a substitute for cod-liver or other oils, and occasionally used in making liniments, as "Carron Oil."

FIG. 2092.—Section of the Seed.

USES.—Linseed is chiefly, if not entirely, used in medicine as the material of which poultices are made, for which, by its elasticity, its low conducting power for heat, and its retaining qualities for water, it is exceedingly well adapted. Carron Oil, *Linimentum Calcis*, U. S. Ph., formerly so popular as an application for burns, is a mixture of equal parts of Linseed Oil and Lime Water.

The following is the only preparation of Linseed: Ground Flaxseed (Linseed or Flaxseed Meal) is simply the seed reduced to powder, without having the oil removed. It should be recently made, and contain not less than twenty-five per cent. of oil. An inferior article resembling it is made from the oil-cake left after the oil is expressed.

ALLIED PLANTS.—The genus *Linum* includes upward of a hundred species, of which nearly half a dozen contribute to the yield of flax, and of which several are pretty garden-flowers. The order *Linaceæ* includes but little more than the genus.

ALLIED SUBSTANCES.—Linseed-oil, in its medical relations, may be compared to the fixed oils in general—cotton-seed, poppy, nut, almond, olive, as well as the animal oils. As a mucilage it is related to Quince, Elm, Irish Moss, Iceland Moss, Tragacanth, Gum Arabic, etc. Compare Linen fibre with Cotton, Hemp, Jute, etc.

W. P. Bolles.

LIPIK is a thermal station in Slavonia, Hungary, lying at an elevation of about 500 feet above the sea. There are several artesian wells, giving water at a temperature of from 104° F. to 145° F. The composition of the different waters is very similar. The following is the analysis of the well last bored. Each litre contains:

	Grammes.
Sodium iodide	0.021
Potassium bromide	trace
Sodium chloride	0.616
Sodium carbonate	1.547
Magnesium carbonate	0.153
Calcium carbonate	0.095
Ferrous carbonate	0.016
Sodium sulphate	0 201
Potassium sulphate	0.195
Organic matters	0.044
Total solid constituents	2.888

The gases are nitrogen and carbonic acid. The waters are employed both internally and externally in the treatment of scrofulous affections, constitutional syphilis, gout, rheumatism, renal calculi, and congestive uterine affections. A course of the waters generally takes about three weeks. The season extends from May 1st to October 1st.

T. L. S.

LIPOMA. The lipoma is a tumor which is formed of fatty tissue, and generally takes its origin from such parts of the body where fat is physiologically present. Microscopically the tissue of the tumor differs slightly from ordinary fat. The cells are, as a rule, larger, and the nucleus is more distinct. All fat-tissue is composed of groups of cells, separated by bands of connective tissue, along which the blood-vessels traverse. In the lipoma these lobules of fat are larger and more distinct than the normal, and the tumor generally has a marked lobular appearance. The larger lobules of the tumor may be further subdivided, so that the surface has a rough, uneven appearance. Virchow has given this the name of *lipoma tuberosum*.

Rarely this lobulation of the tumor is not seen at all, and it presents a smooth, round appearance, and on section appears perfectly homogeneous. Microscopically such tumors may not show any trace of lobulation.

The growth of the lipoma is usually sharply circumscribed, and it is surrounded by a firm connective-tissue capsule, which is connected with adjoining parts by loose connective tissue, so that the tumor with its capsule is freely movable and easily rolled out by operation. In other cases the capsule is wanting and the tumor, though forming a connected mass, may have some of its lobes pressed between muscles or beneath fascia, and when dissected out may have almost the appearance of a bunch of grapes. To the touch the lipoma is usually like fatty tissue, soft and elastic, but when surrounded by a firm capsule may be so hard as to simulate a fibroma. When the tumor is round, and the fat-cells very large and fluid, it may give very distinct fluctuation and be mistaken for an abscess. On section the tumor has all the appearance of fat; it is soft, and generally distinctly lobular. The microscope is never necessary for diagnosis, for the macroscopic appearance is characteristic. In size they vary more than almost any other tumors. In the kidney they are found sometimes no larger than a pin's head, and may form immense pendulous masses in the subcutaneous tissue, weighing from fifteen to twenty pounds.

The histogenesis of the lipoma is no clearer than that of many other tumors. Förster assumes that they arise by a hyperplastic growth from fat-tissue, and grow by simple division of the fat-cell and the oil-globule which it contains. The tumor appears oftenest in places where fat is normally present, as in the subcutaneous tissue, and in those places where it is next in order most frequent, as in the submucous coat of the stomach and intestines. Although there may be no very evident amount of fat present, still careful search, in well-nourished individuals, will usually show some small islets of fat from which the tumor could have arisen. Lipomas are also found in places where no physiological fat is present. They are not very uncommon in the kidney-parenchyma, just beneath the capsule, and they have also been seen in the meninges of the brain, in the cerebral nerves, and even in the brain itself. Virchow does not believe that they arise from a simple hyperplasia of the fat, but from the connective tissue, which is first changed into round cells in which fat is formed, as in the embryo. They do not arise at random from the connective tissue, but usually from such places where the connective tissue has the physiological property of forming fat. The near connection which exists in the embryo between the fatty and mucous tissue would explain the connection so often found between the lipoma and the myxoma. Cornil and Ranvier also hold the view that the tumor arises from the connective or mucous tissues.

The varieties of the tumor are due to the relative quantities of its component parts. In some cases the connective tissue between the lobes is so much developed that the tumor has a distinctly fibrous feel, and on section a large amount of fibrous tissue is found. In other cases the blood-vessels may be strongly developed, giving to the tumor a distinctly telangiectasic character. The connective tissue may be the seat of the deposit of lime salts, or small osseous masses may be found in it. It may also be soft and almost mucous in character. All these varieties, especially when they are very pronounced, may be considered as mixed forms of the tumor, and accordingly we may have fibro-lipoma, myxo-lipoma, etc. Mixed forms with tumors other than the simple histoid varieties are seldom encountered. In rare cases the connective tissue is very rich in cells and has an embryonic character, and these forms have been considered as lipo-sarcomas, but they have nothing of the malignity and rapidity of growth which characterizes the sarcoma.

Usually the connection of the tumor with neighboring parts is an extremely loose one, and when it is seated on parts where the skin over it is loose, it descends lower and lower. It is no uncommon thing to find a tumor at the waist, which some years before was seated on the shoulder. The original vessels of the tumor do not become stretched and follow it down its course, but as it descends it forms new vascular connections.

Many of the lipomas are distinctly polypoid. The tumor may begin as a slight prominence, which becomes more and more pronounced until it hangs from a pedicle. Such forms are physiological in some places, as along the colon, where they form the appendices epiploicæ. In some cases tumors may take their origin in these structures, and instead of a small polypus there will be formed large masses which may occupy almost the entire abdominal cavity, and will, in turn, have smaller masses dependent from them. The lipomas of the subcutaneous tissues have a marked tendency to the polypoid forms. They may be found of the most varying size and form in different parts of the body, and are either smooth and round or rough and uneven. The skin over them is pale, smooth, and shiny. They are attached by a pedicle in which the vessels run, and which becomes thinner as the weight and size of the tumor increases. The weight of the tumor, which is the chief moment in causing the change of place, has, according to Virchow, nothing to do with the polypus formation, but the chief cause for this lies in the tension of the skin at the part. Polypoid lipomas appear most often in places where the skin is tight and little inclined to yield. The skin which lies immediately over the tumor becomes gradually thinned and allows the tumor to press forward. These forms may attain a large size, and constitute, with the myxomas, the most frequent forms of skin polypi. Polypoid lipomas are also found in the stomach and intestinal canal. The large polypoid tumors found in the jejunum are most frequently lipomas. The laxity of the mucous membrane allows them easily to press into the lumen of the bowel. After they have reached a certain size the peristaltic movements of the bowels, which are rendered more active by the presence of the tumor, tend to drag it further and further down. Although not of any special pathological importance in themselves, they may so drag upon the bowel as to induce invagination with fatal consequences. In some cases the pedicle may become so thinned that the vessels are obliterated, and destruction of the tumor follows. This rarely happens in those of the skin, but is not uncommon in those which originate in the appendices epiploicæ, and here it is generally brought about by an accidental twisting of the pedicle. Such cast-off lipomas form a majority of the free bodies found in the abdominal cavity.

Virchow has formed a special class of the capsular lipomas. These are formed around various organs by the enormous development of the fat which surrounds them. In the eye the intra-orbital fat can be the seat of such a general hyperplasia, but it is best marked in the internal organs, as in the heart and kidneys. The latter organs may be surrounded with a thick layer of fat, as part of a general polysarcia, but it is especially in chronic inflammations, as in the contracted kidney in hydronephrosis and stone, that this fatty covering is most developed. The mammary gland is also disposed to such a fat formation. The connective tissue around the organ is physiologically prone to fat formation at puberty, and this tendency seems to be again developed by any long-standing irritation. The fat is much increased in carcinoma and in chronic mastitis. A part of the typical picture of the scirrhous carcinoma of the mamma, especially in the earlier stages, is the enormous mass of fat surrounding the tumor, which sends long, thin prolongations into it. Even in cases where the gland is normal this diffuse increase of fat is occasionally met with, and may cause the gland to reach an enormous size. Virchow mentions a case where one gland weighed $30\frac{1}{2}$ pounds, and the other $20\frac{1}{2}$ pounds, and the weight of the woman after the amputation of both was only 101 pounds. When the omentum is incarcerated in a hernia there is often a great increase in its fat. Although Virchow has included such cases with the lipomas they do not properly belong to the tumors at all. The lipoma is a circumscribed growth, and can easily be removed, even when it adjoins fatty tissue.

The atypical nature of the lipoma which stamps it at

once as being something entirely different from simple hyperplasia of fatty tissue, even though this may be circumscribed, is seen in its nutrition. This is not influenced by any of the conditions which influence the nutrition of the fat generally. If the bearer of a lipoma is attacked by any wasting disease, as consumption, with the result of almost total disappearance of the subcutaneous and other fat, the growth of the tumor is not influenced. Its cells continue to grow and build up fat when all the fat in the rest of the body has been absorbed. The local hyperplasias forming Virchow's capsular lipomas undergo the same fate as the fat elsewhere.

True lipomas are rarely seen in the large internal organs. Of these the kidney is most frequently the seat of this formation. Here the tumor is found in the cortical substance, usually just beneath the capsule. It is not surrounded by a capsule, and its growth is not sharply circumscribed.

Lipomas frequently are multiple. There may be as many as several hundred in the same individual, appearing as small polypi scattered over the skin. In such cases they may greatly resemble the multiple fibromas; and under these circumstances Virchow assumes that there is a general deposition on the part of the fatty tissue to tumor-formation.

The lipomas are thoroughly benign tumors. They may be dangerous only from their situation. Their growth is slow and circumscribed, and metastases have never been seen. Extirpation is easy. When they have the form of large polypi of the skin they may become ulcerated and gangrenous from the friction of the clothing or other injuries.

Retrogressive metamorphoses are not uncommon. The most frequent of these is calcification of the stroma. The fat may also undergo a saponification and become changed into a more or less firm substance.

The diagnosis is usually easily made. The form of the tumor, its consistency, its place of origin, and rate of growth are all things which will separate it from most other tumors. *W. T. Councilman.*

LIPPSPRINGE is a health-resort in Westphalia, not far from Paderborn, lying in a sandy plain at an elevation of about 400 feet above the sea, and well protected by forests on the north and east. The climate is mild and equable, a moist westerly wind prevailing. There are numerous mineral springs in the place, but only one, the Arminiusquelle, is much used. The following is the composition of two of these springs, expressed in grammes per litre, according to the analyses of Witting and Brandes .

	Arminiusquelle. 70° F.	Inselsquelle. 66° F.
Calcium carbonate	0.686	0.205
Magnesium carbonate	0 078	0.025
Ferrous carbonate	0.018	0.002
Sodium chloride	0.112	0.340
Calcium chloride	.....	0.009
Magnesium chloride	0.104	0.005
Sodium bicarbonate	0.258	.....
Sodium sulphate	0.677	0.035
Calcium sulphate	0.553	0.025
Magnesium sulphate	0.104	0.010
Iodides	trace	trace
Total solid constituents	2,590	0.656

The gases are nitrogen, oxygen, and carbonic acid.

In addition to the use of the water for bathing and drinking, inhalations of the nitrogen issuing from the spring are practised. Lippspringe is visited principally by sufferers from affections of the respiratory organs, catarrhal laryngitis and bronchitis, and incipient phthisis. The season extends from the middle of May to the middle of September. *T. L. S.*

LIQUORICE ROOT (*Glycyrrhiza*, U. S. Ph.; *Glycyrrhizæ Radix*, Br. Ph.; *Radix Liquiritiæ*, Ph. G.; *Réglisse*, Codex Med.), *Glycyrrhiza glabra* Linn.; Order, *Leguminosæ*, is a large perennial herb, with a cluster of upright-branched stems a metre or so high, alternate odd-pinnate leaves, and axillary racemes of small, lilac-colored papilionaceous flowers. The root consists of a thick, woody crown, at the top of a long-branching principal or tap root, giving off long, slender, cylindrical, horizontal, stolons from near the surface of the ground. The bark of the roots and stolons is red or orange-brown externally, the wood bright lemon yellow. Liquorice is an extensively cultivated, and therefore variable plant. Var. α *typica* is nearly smooth, has the under-surface of the leaves glandular and sticky, and linear-lanceolate calyx lobes. It is indigenous in the south of Europe, and furnishes the sweet Spanish, Italian, etc., liquorice. Var. γ *glandulifera* is pubescent or roughly glandular. It is indigenous in Southeastern Europe and Eastern Asia, and is a probable source of the Russian Liquorice. Besides these, another species, *G. echinata* Linn., a larger, coarser plant, with short, thick, capitate flower clusters, with about the same geographical range as the last, may also be a source of Russian Liquorice.

Liquorice root was familiar to the ancients, and by them used for the same purposes as at present—to allay

FIG. 2093.—Liquorice Plant. (Baillon.)

cough and irritability of the throat. It has been cultivated for at least five hundred years.

All subterranean parts of the plant are collected, the long, deep-running roots often more than a metre in length, and the equally long but more uniform and cylindrical stolons; these latter, like the main root-stock, have a central pith, which the root-branches lack. All these are cleaned and dried, and packed in parallel order in boxes or bundles for the trade. True or Spanish Liquorice, from the South of Europe, is "in long cylindrical pieces, from one-fifth of an inch to one inch (5 to 25 mm.) thick, longitudinally wrinkled, externally grayish-brown, warty; internally tawny yellow, pliable, tough; fracture coarsely fibrous; bark rather thick; wood porous but dense, in narrow wedges; medullary rays linear; taste sweet, somewhat acrid." It is never peeled. The inferior Russian or Hungarian Liquorice is a much finer-looking article, being carefully peeled, and in even, straight pieces; its taste is, however, less sweet, and often decidedly bitter.

Composition.—The only important principle is its peculiar sweet substance, *glycyrrhizin*, an amorphous, yellow, intensely sweet powder, soluble in hot water, but not in cold without the addition of an alkali. It is a glucoside, and may be resolved, by boiling with dilute hydrochloric acid, into an uncrystallizable sugar, and an amorphous, bitter substance, *glycyrrhetin*. It is said to be present in the root combined with calcium. Proportion about six per cent.

Action.—Liquorice has no physiological action beyond that of sugar, and may be taken to any extent. It is, like other sugars and syrups, soothing to the mucous membrane of the fauces, and hence much employed in coughs by itself, or as a vehicle or ingredient of cough mixtures. Syrups of Liquorice and the ammoniated glycyrrhizin have been extensively used as vehicles to cover the bitter taste of quinine, which they do in an imperfect manner. The ammoniated glycyrrhizin may be rubbed up with the quinine in powder, or the quinine may be mixed with a syrup of liquorice at the instant of taking.

Administration.—Several preparations are officinal. Fluid Extract (*Extractum Glycyrrhizæ Fluidum*, U. S. Ph.), in which the Liquorice is exhausted with diluted alcohol and ammonia, the latter to make the active principle more soluble. The Pure Extract (*Extractum Glycyrrhizæ Purum*, U. S. Ph., so called to distinguish it from the crude Italian Stick Liquorice), in which the drug is exhausted with water and ammonia, and the percolate evaporated to a semi-solid consistence. It is useful for pill-masses and as a vehicle; it is also an ingredient in the Compound Mixture of Liquorice (*Mistura Glycyrrhizæ Composita*, U. S. Ph.), or old Brown Mixture, in which paregoric and wine of antimony are the active ingredients. *Glycyrrhizinum Ammoniatum*, U. S. Ph. (ammoniated glycyrrhizin above mentioned), is prepared by extracting the liquorice with ammoniated water, precipitating the sweet principle with sulphuric acid, washing, redissolving in ammonia and water, precipitating again, and dissolving until it is sufficiently pure. It is in dark brownish-red, shining, brittle scales, of a very sweet, liquorice-like taste, and no odor; it is soluble in water and alcohol. Compound Liquorice Powder (*Pulvis Glycyrrhizæ Compositus*) is, properly speaking, a preparation of senna. Besides these should be mentioned the commercial "Stick" or "Black Liquorice," prepared on a large scale in many of the countries and islands of the Mediterranean. It is chiefly used by children as a confection, but is also in extensive demand for coughs, colds, and sore throats.

Allied Plants.—See Senna.

Allied Substances.—Sugars, Manna, Honey, Saccharin, etc.

W. P. Bolles.

LITHÆMIA. λίθος, a stone, and αἷμα, blood (uric acid diathesis, oxaluria, phosphaturia). In his "Clinical Lectures on the Diseases of the Liver" Dr. Murchison describes, under the heading of "Functional Disorders of the Liver," a morbid condition for which he suggested the name of lithæmia. This designation, which has been in vogue since 1877, is a very suitable one, as it is based upon some undeniable clinical facts, and does not presume an oxalic or uric acid diathesis, terms of which we have heard so much and for so long a time, but concerning which we have proved so little.

If a patient suffer from anorexia, flatulence, and discomfort after eating, pyrosis, inactive bowels, intermittent pulse, and mental depression, with or without frequent micturition and nephralgia, his urine will generally be small in amount, very acid, and of high specific gravity, and will precipitate uric acid crystals on cooling. Under the microscope the sediment is seen to consist of lithic acid crystals, mixed with those of oxalate of lime. In many cases the sediment consists almost entirely of octahedral crystals of the latter substance.

The coexistence of this form of urinary sediment with the above-described symptoms led Prout and Golding Bird to refer these several disturbances of the gastric, nervous, and circulatory systems to one common cause, under the term of oxaluria, or the oxalic acid diathesis.

Among the earliest writers who expressed themselves as sceptical concerning the existence of this oxalic acid diathesis was Owen Rees, who said, as long ago as 1845, that the presence of oxalate of lime in the urine was connected with the formation of uric acid in excess, and with a state of the system in which a considerable quantity of urea is also excreted. Still later, in the Croonian Lectures of 1856, he affirmed that oxaluria was not indicative of a diathesis, but that the oxalate of lime was formed after the urine had been secreted by the kidneys, and was derived from the uric acid and urates contained in it.

In order to prove that lithic acid is the only source and origin of oxalic acid and the oxalates in the urine, it will be necessary to trace the formation of oxalic acid. In the first place, perfectly fresh urine shows no trace of oxalate of lime crystals, and it is only after exposure of the urine to the air that they become visible in the sediment. Chemists of the highest reputation have inquired into the relation of oxalic acid to lithic acid and the lithates, and all concur in the assertion that oxalic acid is one of the products of the oxidation of the first-named substance. This is sufficiently proven by the following facts: Lithic acid is converted into oxalic acid and urea by the addition of oxygen and water. When mixed with a fermenting agent and an alkali, lithic acid is decomposed into oxalic acid and urea. Lithic acid, when oxidized with nitric acid, yields a large quantity of oxalic acid and ammoniacal salts. It is well known that Peruvian guano, which is almost pure lithate of ammonia, becomes very largely converted into oxalate of ammonia in the hold of the ship during transport.

These facts, which could be multiplied, prove the correctness of Dr. Rees's opinion that oxalate of lime is derived solely and directly from the decomposition of uric acid and the urates. But the subject has been still further and successfully investigated by Ed. Schunk, F.R.S., Beneke, Ebstein, and other German observers. As regards oxaluric acid, the results of these investigations leave hardly any doubt that it is formed by the oxidation of lithic acid, which is its only source. The conversion of this acid into oxalic acid and urea may take place in any part of the urinary apparatus, after the urine has been once secreted, or in the urine only after its exposure to the air for a time. The oxaluric acid, after its combination with ammonia, rapidly undergoes decomposition when brought into contact with acid or alkaline salts, and, therefore, in the presence of the phosphates in the urine, will become converted into oxalic acid and urea; and the oxalic acid again would, at the moment of formation, unite with or decompose the lime-salts always present in the urine. Thus oxaluric acid may be regarded as the vehicle by which the oxalic acid escapes from the system in the least injurious form.

All urine, therefore, whether from healthy or diseased persons, may at times contain oxalate of lime crystals, which are consequently not significant of nervous depression, irregular pulse, or any form of dyspepsia. Oxalate of lime in large quantities in the urine signifies nothing else than the uric acid diathesis, or lithiasis, a state of the organism which we prefer to call, with Dr. Murchison, lithæmia. It is a condition in which oxidation is imperfectly performed, and the formation of insoluble combinations of lithic acid and the lithates, instead of the readily soluble urea, is the result.

Dr. Murchison's theory was based upon the clinical facts that uric acid is found in the blood of gouty persons (Garrod), and uric acid and urates in various tissues of the same, leading to circumscribed necroses, etc. (Ebstein), and that, in the urine of individuals of gouty heredity or with gouty tendencies, uric acid and the urates are also to be found in large quantities. He assumed, therefore, that these persons were to be regarded as suffering, though in a lesser degree, from the same underlying hæmic troubles as the gouty. He says: "When oxidation is imperfectly performed in the liver, there is a production of insoluble lithic acid and lithates, instead of urea, which is the soluble product from the last stage of oxidation of nitrogeneous matter. Again, when more food is taken into the blood than is necessary for the nutrition

of the tissues, the excess is thrown off by the kidneys, lungs, and skin in the form of urea, carbonic acid, and water, or in the imperfectly oxidized forms of lithic acid and oxalic acid. Under these circumstances an excess of work is thrown upon the liver and other glandular organs, and one result is that a quantity of albumen, instead of being converted into urea, is discharged by the kidneys in the form of uric acid or its salts. But what in most persons is an occasional result of an extraordinary cause, is in some almost of daily occurrence, either from the food being always excessive in amount or unduly stimulating, or from some innate (often hereditary) or acquired defect of power in the digestive organs, in virtue of which their normal functions are liable to be deranged by the most ordinary articles of diet. This functional derangement of the liver in certain individuals, particularly the offspring of gouty parents, may manifest itself by various symptoms of indigestion, by disturbances of the circulation and of other physiological functions, but especially by deposits of lithic acid, lithates, and pigments in the urine."

This state of lithæmia, with its concomitant condition of lithiasis (gravel), and deposit of oxalate of lime crystals, exhibits all the characteristic and typical symptoms of the oxaluria of Prout and Golding-Bird, viz., more or less frequency of micturition, occasional sense of heat or even scalding along the urethra, dyspeptic symptoms of varying character, flatulent disturbances after eating, irregular and frequently intermittent pulse, with occasional attacks of palpitation, sluggish bowels, depression of spirits, restless nights, and unrefreshing sleep, with its attendant feeling of weariness and languor. These symptoms are most commonly met with in persons of indolent habits and in dyspeptics, and they are not rarely seen in those whose occupation, literary or professional, subjects them to great mental strain, and deprives them at the same time of the exhilarating influence of fresh air and exercise. Among other causes may be mentioned continued worry and anxiety, malaria, lead-poisoning, etc.

The nervous phenomena in lithæmia have also been described by Murchison, but have been more comprehensively dealt with by Da Costa, McBride, Lyman, Hudson, Potter, C. L. Dana, L. C. Gray, and others. These authors have shown that many cases of neurasthenia and other functional disorders of the nervous system are caused by a lithæmic state of the body, and that it is of diagnostic importance to examine carefully the urine of neurasthenic patients for evidences of excess of lithic acid or phosphates. Dr. Dana has devised suitable apparatus for the latter purpose. The main symptoms are: Vertigo, cephalalgia, insomnia, neuralgia, paræsthesia, tinnitus aurium, nervousness, muscular cramps and twitchings, spinal irritation, vaso-motor disturbances, and fever; also delusions and hysterical, asthenic, and even epileptiform symptoms.

In my opinion, it is often difficult to distinguish between cause and effect; that is to say, nervous exhaustion from excesses or disease may be productive of lithæmic conditions through loss of innervating force; or, on the other hand, the functional disturbance of the nervous system may be solely and directly the effect of the lithæmic condition.

Lithæmia associated with neurasthenia is of rather frequent occurrence in this country, and is seen in both sexes, early and late in life. Repeated examinations of the patient's urine, and a searching inquiry into the etiology of the case, are necessary in order to arrive at a correct understanding of the condition, and to mark out a proper line of treatment.

The prognosis is generally favorable as regards an improvement in the condition, but eventual cure depends upon the success we may have in removing the underlying cause. I need hardly say that this cannot always be accomplished.

Treatment. — In considering the treatment of this group of functional disorders, it is most essential to keep in view that it is not the kidneys that are at fault, but rather those organs that minister to perfect assimilation, and that are engaged in the separation of the excrementitious material from that which is to be utilized in the economy of the body. However, as the functional disturbances of the stomach, liver, etc., may be caused by habitual over-feeding combined with sedentary habits, in otherwise healthy persons, or may be due to a gouty disposition or diathesis, hereditary or acquired, or may occur as the result of frequent excesses, or of mental or physical overwork with consecutive failure of proper innervation of the organs of the body, it would be most erroneous to adhere to a dogmatic course of treatment for all cases of lithæmia. We must individualize and adapt treatment to the etiology of a given case, if we desire to obtain positive results.

In cases of plethoric and gouty lithæmia occurring in individuals blessed with a vigorous constitution, it will be just the thing to prescribe a glass of bitter water before breakfast, a simple diet of moderate quantities of plain food, some hydrochloric acid with or without pepsin after meals, Turkish or Russian baths, and exhilarating daily exercise on foot or horseback. By such means the oxalate of lime crystals will soon be made to disappear from the urine, the uric acid will be greatly diminished, and the headache, vertigo, palpitation, and despondency will also vanish. Such patients may also be sent to Carlsbad or Vichy, where they will drink the alkaline waters, follow a restricted diet, abstain from stimulants, take plenty of outdoor exercise, and be free from all care and anxiety, and from whence they will return in good health and spirits, full of praise of the wonderful virtues of the springs.

This form of lithæmia prevails in England and other European countries, and is generally, if not exclusively, referred to by European writers. Undoubtedly, the condition of modern society on this side of the water is such as to favor the development of many cases of this form also, but I think that I am not mistaken in the assertion that the asthenic or neurasthenic form of lithæmia is the one that we are more frequently called upon to treat here. Now, whether the neurotic or myopathic symptoms develop in consequence of lithæmia in persons of delicate constitution, or whether neurasthenic individuals are, as I suspect, liable to fall into the lithæmic state, by which their previous malaise is aggravated, the treatment of such patients, in order to be successful, must be different from that of the former class.

Change of scene, foreign travel, an exacting course of treatment at Carlsbad or Vichy, much outdoor exercise, will not only not improve their condition, but will make them worse, and particularly as regards their nervous symptoms. They require generous quantities of good and nutritious food, rest of mind and body, and general massage. They may take drives and just so much active exercise as will not increase the irritable weakness from which they always suffer. To correct gastric acidity and flatulence in such cases we have given, with advantage, powders containing nux vomica, bismuth, and soda before meals, and good pepsin with some hydrochloric acid after eating. Quite often tonics, such as vinum ferri amarum or pilulæ ferri peptonatis, are of good service when more or less marked anæmia is present. While Turkish or Russian baths are generally contra-indicated in these cases, as they are often followed by headache, tinnitus aurium, palpitation, and fatigue, the patient will feel refreshed after a tepid half-bath with cold affusions in the morning, before breakfast, alternating perhaps with galvanization of the cerebro-spinal system or with general faradization. When purgatives are required, an occasional dose of rhubarb and aloes, or rhubarb and blue mass, will answer better than the bitter waters.

Lithæmic subjects are generally better off without stimulants, and particularly beer and acid wines are positively hurtful. When patients of the neurasthenic type crave or need stimulants, they might have an ounce or so of brandy or whiskey, diluted with a tumblerful of water, Selters or Apollinaris, between meals, or take a glass or two of very light Burgundy or Bordeaux with their food.

Food containing much sugar or starch should be avoided. My experience coincides with that of many American observers, that our lithæmic patients do better on a diet rich

in nitrogenous food, with some well-prepared vegetables and bread, than when following a vegetarian's regimen. The question of allowing coffee and tea need not worry the physician. In my opinion good coffee or good tea, in small quantities, does not hurt the stomach of these patients nor interfere with perfect digestion.

Leonard Weber.

LITHIUM. I. General Medicinal Properties of Compounds of Lithium.—As lithium is chemically closely allied to potassium, so its salts exert practically the same kind of physiological influence as the corresponding salts of potassium. The only substantial differences are, *first*, the purely chemical one, that basic lithia forms with *uric acid* a salt much more soluble than the corresponding potassic compound; and, *secondly*, that clinically, in lithæmia and gout, speedier relief seems sometimes to follow from medication with salts of lithium than with those of potassium. But since the results reported have followed the employment of the remedy with the preconceived idea that such results must follow from theory, the clinical superiority claimed for lithium should be received with caution. There is no doubt, however, that the lithic salts are at least equally efficient as the potassic, but then they have the disadvantage of being more expensive.

II. The Medicinally used Compounds of Lithium.—These are the *carbonate, citrate, bromide, benzoate*, and *salicylate*. The first two will alone be considered in this place. For the others, see respectively Bromides, Benzoic Acid, and Salicylic Acid.

Normal Lithic Carbonate: Li_2CO_3. The salt is officinal in the United States Pharmacopœia as *Lithii Carbonas*, Carbonate of Lithium. It is a "light, white powder, permanent in the air, odorless, having an alkaline taste and an alkaline reaction. Soluble in 130 parts of water at 15° C. (59° F.), and in about the same proportion of boiling water; insoluble in alcohol. On heating a small quantity of the salt on a platinum loop in a non-luminous flame, it fuses to a clear, transparent bead, imparting a crimson color to the flame. The salt is soluble in acids, with copious effervescence" (U. S. Ph.). Lithic carbonate behaves in a general way like potassic carbonate, except that, because of its feeble solubility in water, it is not locally so irritant. As an alkali it is remarkably potent, because of its chemically low combining number, and hence great saturating power in the neutralization of acids. Its use has so far mainly been as a substitute for potassic alkaline preparations in internal medication in gout and lithiasis. It is given in doses of from 0.30 to 1.00 Gm. (five to fifteen grains), several times a day, best administered in some effervescing water, since in such it is freely soluble.

Normal Lithic Citrate: $Li_3C_6H_5O_7$. The salt is officinal in the United States Pharmacopœia as *Lithii Citras*, Citrate of Lithium. It is a "white powder, deliquescent on exposure to air, odorless, having a slightly cooling, faintly alkaline taste and a neutral reaction. Soluble in 5.5 parts of water at 15° C. (59° F.), and in 2.5 parts of boiling water; only slightly soluble in alcohol. When exposed to a red heat the salt chars, emits inflammable vapors, and finally leaves a black residue, having an alkaline reaction, which imparts a crimson color to a non-luminous flame" (U. S. Ph.). The Pharmacopœia, alleging deliquescence in the case of this salt, enjoins that the same must be kept in well-stopped bottles. Lithic citrate bears the same relation, in medicinal behavior, to the carbonate that potassic citrate does to potassic carbonate. It is pleasanter to the taste and more grateful to the stomach, while yet becoming transformed to a carbonate after absorption into the blood. Constitutionally, therefore, it is the equivalent of the carbonate, and it is used internally in conditions of gout and uric acid diathesis. The salt, it must be remembered, is not alkaline while under its own form, and hence would be useless as a local alkali for the direct neutralization of acid. Dose, from 0.65 to 2.00 Gm. (ten to thirty grains), several times a day, in aqueous solution.

Edward Curtis.

LITHOLAPAXY (Rapid Lithotrity with Evacuation), λίθος and λάπαξις (evacuation).

This operation, which has already superseded the old method of lithotrity, and which successfully disposes of stones that could formerly be dealt with only by lithotomy, has been before the world for but eight years.

In January, 1878, Professor Henry J. Bigelow [1] published his first paper introducing this procedure to the medical profession, and it was at once enthusiastically adopted by the surgeons of all countries.

The writer's association with Professor Bigelow in this branch of surgery lends authority to the description of the operation which follows:

Before the year 1878 lithotrity was performed by short sittings (a few minutes each), with intervals of several days between them. The débris, more or less finely pulverized, was passed with the urine.

If the expulsive power of the bladder was good, the voidance of the fragments was usually successfully accomplished. When, however, the bladder had lost its power, or when, owing to some obstruction, it could not thoroughly empty itself, the discharge of the fragments after crushing was an extremely uncertain matter.

Moreover, in a certain proportion of cases, especially when the stone was a hard one, or when the bladder was much inflamed, the crushing was followed by serious symptoms, with marked increase of the bladder-inflammation, which not only put a stop to further crushing, but frequently went on from bad to worse and ended fatally.

This aggravation of symptoms after lithotrity was ascribed largely to the irritation of the bladder-wall by the instruments; and operators tried to avoid trouble by making the sittings short, and by extreme gentleness in manipulation.

Sir Henry Thompson, then the English authority upon the subject of lithotrity, had recently stated it as his opinion that a sitting should not be prolonged beyond two or three minutes, and that stones requiring more than three or four sittings for their removal were not advantageously within the province of lithotrity.

Prior to this year (1878) there had been various attempts to remove by suction portions of the débris after crushing, and Clover's apparatus, consisting of a catheter and bulb, was sometimes used to aid a bladder in freeing itself. Such efforts at evacuation were, however, regarded as introducing special dangers into the operation of lithotrity, and writers upon the subject were practically unanimous in thinking that any serious attempt in this direction should be dispensed with, if possible.

In 1875, Professor Bigelow, having devised a more thorough evacuator than those previously in use, tried the plan of operating by a long sitting under ether, with the object of crushing the stone and completely removing the fragments at one operation.

The success of the first cases so treated showed that the previous dread of instrumentation had been to a great degree groundless, and that the presence of sharp angular fragments in the bladder after an operation was a source of more serious danger than that consequent upon the prolonged and skilful use of instruments which resulted in the complete removal of the stone.

These cases showed that, contrary to previous belief, the thorough evacuation of a large stone at one sitting could be accomplished without special danger, and in consequence of this success Professor Bigelow went on to perfect the apparatus which he described in his paper, published in January, 1878, and which he has since that time still further improved, until it has reached the forms which will be described farther on.

The operation of litholapaxy may be divided into two acts: 1, The comminution of the stone; 2, the evacuation of the fragments. We will first consider the instruments concerned in pulverizing the stone.

Lithotrites.—As has been said, lithotritists were formerly possessed with the idea that the bladder was an extremely sensitive organ, prompt to resent any irritation from the use of instruments, and that, therefore, only small stones, not requiring a great amount of manipulation for their comminution, should be crushed.

This belief, together with their failure to recognize the full size of the urethra, led the operators of those days to use instruments smaller and less powerful than the conditions allow, and than those which are now readily and safely employed, when the size and consistence of the stone make their use desirable.

Fig. 2094.—Handle and Lock of Closed Lithotrite.

The lithotrite now to be described was devised by Professor Bigelow. The modifications in its form are designed to enable it to meet the needs of the new operation.

It is made in various sizes,* of which the larger are very strong, and, though rarely necessary, enable the operator to deal with larger and harder stones than could be disposed of with the smaller instruments.

The *handle*, which is of hard rubber, is egg-shaped, and gives a better hold with more power than could be attained with the old wheel. By giving a full grasp to the hand it is far more comfortable and less fatiguing in a long operation.

The *lock*. Immediately below the handle is a revolving cylinder-cap, which is attached to the screw-guard and closes the lock by a mere rotation with the fingers of the right hand while it is grasping the handle.

So far as I know, this is the only lithotrite in which the lock is constantly under the control of the right hand. This arrangement gives the surgeon the great advantage of being able to lock and unlock the instrument indefinitely, and even to complete the operation without disengaging the hold of either hand. It thus saves time and strength, and lends greater accuracy to the manipulations.

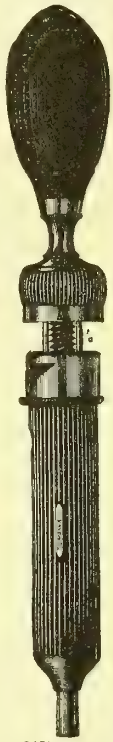


Fig. 2095.—Lithotrite Partly Open, showing the Cylinder-cap in connection with the Handle. The screw-guard is seen as two rods alongside of the screw, reaching from the revolving cap to the cap of the lock. These slide through notches in the cap of the lock, and so connect it with the revolving cap that a twist of the latter turns the lock and so wedges up the screws.

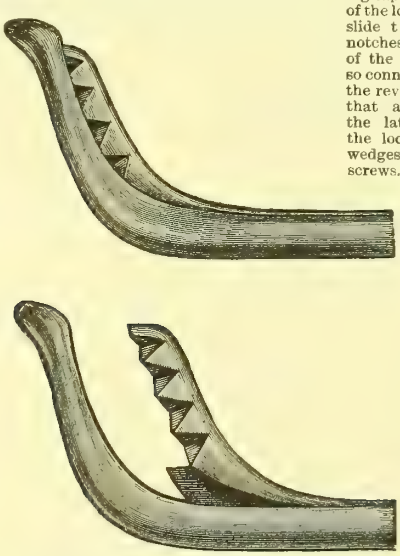


Fig. 2096.—Blades of Lithotrite, Open and Shut.

* These correspond to Nos. 25, 27, and 30 of the French catheter scale.

The *blades*. In the female blade the rim is low and sharp, while the floor, especially at the heel, is high. A fragment readily falling upon this blade is firmly held by the rim while it is crushed.

Fig. 2097.—Diagram showing the Blade of the Lithotrite in the Urethra, illustrating the Advantage of the Blunted Extremity.

The male blade is provided with a series of alternating notches, which expel the débris at the sides and prevent impaction.

In most lithotrites the dust is seriously impacted in the heel of the instrument. This difficulty is here met by raising the floor at the heel, so that no dust can lodge there. A large spur in the heel of the male blade also drives the débris through a corresponding slot in the female blade.

The instrument is thus self-clearing and does not clog, so that when once introduced it can be continuously operated as long as fragments can be found to crush. Also, when it is withdrawn the jaws are not held open with impacted fragments of stone to lacerate the urethra. A good-sized instrument, fairly shut, occupies no more room in the urethra than a smaller one which must be withdrawn while partly open to be cleared of its débris.

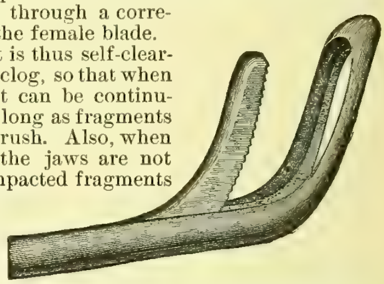


Fig. 2098.—Open-bladed Lithotrite, showing the Inner and Outer Edges of the Female Blade.

In a long operation this avoidance of the injury which would be caused to the urethra by the frequent withdrawal of a clogged instrument is a matter of the greatest importance.

The end of the female blade is bent over so as to offer a blunted extremity, which, as may be seen in Fig. 2097, slips along the roof of the urethra and is much less likely to injure it than was the sharp toe of the old lithotrites. This form does not interfere in the least with the catching of fragments in the jaws.

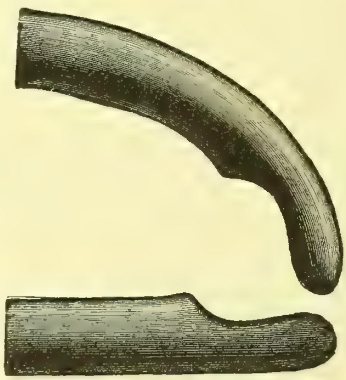


Fig. 2099.—Side View of the Extremities of a Curved and a Straight Tube.

In the lithotrite that has been described the sharp rim upon the female blade is very efficient in holding the fragment which is being crushed. Occasionally, however, in spite of this, the stone constantly slips from between the blades. When this occurs the open lithotrite should be used.

This instrument adds to the usual sharp rim another even sharper at the edge of the opening which the male blade traverses. This arrangement of the fenestrated blade makes the operation much more agreeable to the surgeon. The fragment rarely slips, and as the blades approach each other the force required is constantly diminishing instead of increasing, as it does when the solid blade is used.

Litholapaxy.

The inner edge can be quite sharp, as it is prevented from ever coming in contact with the mucous membrane by the width of the broad and flat female blade. It is essential, however, that the male blade should pass absolutely through the female blade and occupy the same level at the outlet; for quite a small portion of the walls of the opening will sometimes so support a fragment not wholly extruded that it will cling to the instrument and be dragged out, and so lacerate the urethra.

Evacuator.—This instrument may be, in general, described as consisting of a tube, an elastic bulb, and a receptacle for the fragments.

Fig. 2100.—Extremities of Tubes, showing the Opening.

Tube. For convenience of description the tube may be divided into two parts—the movable part, or catheter, and the fixed part, which enters the bulb and is attached to it by a bayonet-joint.

Catheter. A straight tube offers the least possible resistance to the passage of fragments, and is therefore the best. A slight curve at the extremity sometimes facilitates the introduction of the tube in a difficult case.

The receiving orifice should be on the front of the extremity, with a thickened rounded edge, to enable it to slide smoothly along the urethra. If the side-walls of this orifice be removed a little, it gives a snout-like extremity, which resembles the head of a shark, the orifice occupying the position of the shark's mouth.

This form is advantageous; and in introducing such a straight tube the tip should be insinuated through the triangular ligament by rotation. The orifice should not be larger than the calibre of the tube, as it would then admit fragments which would be wedged higher up.

At the upper end of the catheter-tube is a projecting wing, which facilitates the handling of the instrument. This wing is on the same side of the tube with the orifice, and is therefore a guide to its position.

The fixed portion of the tube connecting the catheter with the exhaust-bottle extends obliquely upward to the centre of the bulb.

This tube is for convenience provided with a stop-cock just outside of the bulb, and if a second cock is attached to the upper end of the catheter, the patient and bed-clothing can be kept dry when coupling and uncoupling these tubes.

It is, however, the portion of this tube which is within the bulb that is of especial importance. This part, which is simply a prolongation of the catheter up into the bulb, is perforated all around with small holes, the aggregate area of which is larger than the opening at the end of the tube.

When suction is applied the fluid from the bladder, mixed with fragments, rushes up through this tube into the bulb. When pressure is now made, and the water is forced back to the bladder, the greater part of it goes through the perforations in the tube, which afford not only the shortest road, but by virtue of their great area also the largest and freest outlet.

Thus the fragments enter the bulb easily, but are prevented by the strainer action of this tube from returning to the bladder. The simplicity of this contrivance speaks for itself. There are no valves to get out of order, and if any mucus clogs the lateral holes it can be easily removed.

The fragments which are thus caught and retained in the bulb naturally gravitate to the bottom of it, where they are received in the glass ball, or reservoir, which can be readily removed and emptied.

At the top of the bulb is an opening provided with a stop-cock, to which a hose can be attached. Through this any air which finds its way into the apparatus can be at once expelled, and the amount of water in the bulb and bladder can be easily and quickly altered during evacuation without disconnecting the instrument—a matter of great importance, as an over-tense and a too-empty bladder are both to be avoided. One of the most important additions to the evacuator was the brace uniting the metal collar of the catheter with that of the glass receiver. This so steadies the catheter that it does not feel the movement of the bulb when compressed.

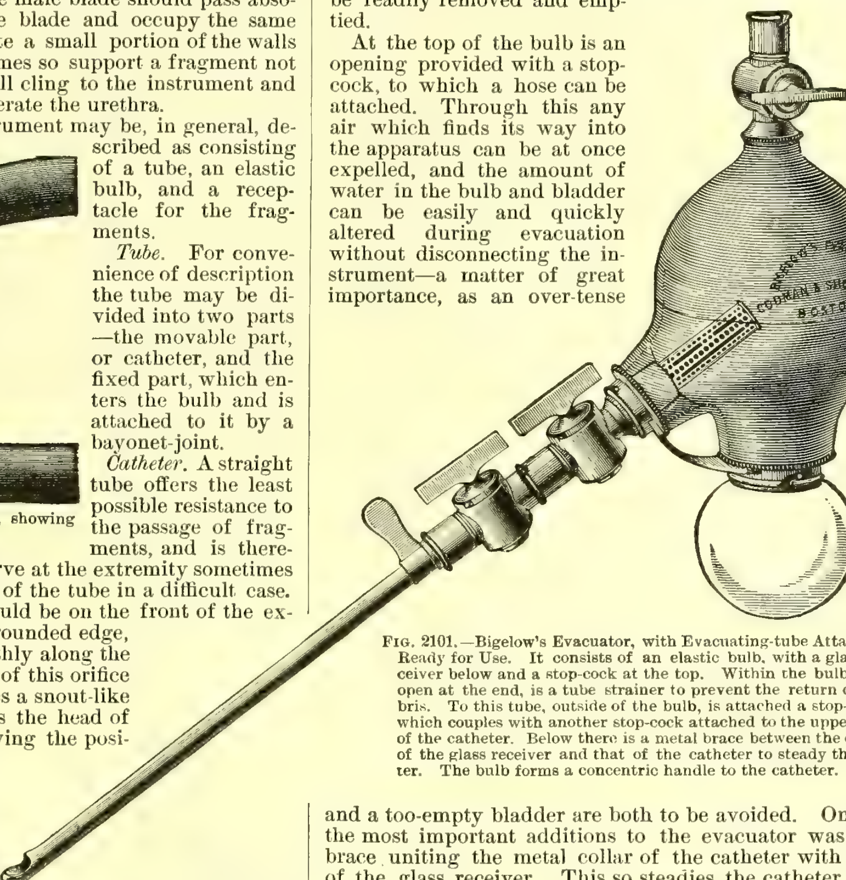


Fig. 2101.—Bigelow's Evacuator, with Evacuating-tube Attached, Ready for Use. It consists of an elastic bulb, with a glass receiver below and a stop-cock at the top. Within the bulb, and open at the end, is a tube strainer to prevent the return of débris. To this tube, outside of the bulb, is attached a stop-cock, which couples with another stop-cock attached to the upper end of the catheter. Below there is a metal brace between the collar of the glass receiver and that of the catheter to steady the latter. The bulb forms a concentric handle to the catheter.

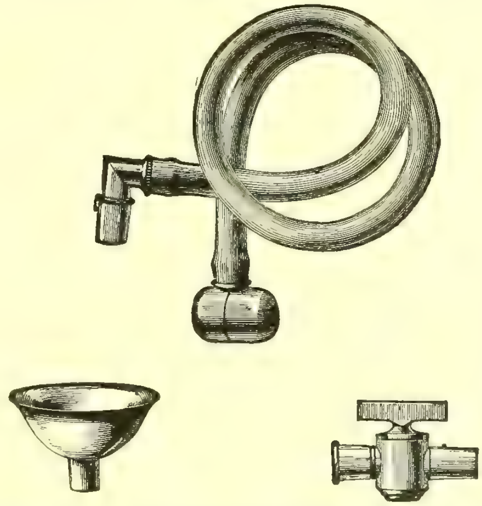


Fig. 2102.—Hose and Funnel to attach to Top of Bulb, and Stop-cock for Upper End of Catheter.

The Operation.—The presence of a stone having been established, a large steel sound may be passed down through the urethra to make sure that there is no stricture or other obstruction. If a stricture is found it may

be rapidly dilated with large sounds, or divulsed. A narrow meatus may be cut.

The urine should then be drawn with a catheter, and enough borax-water should be introduced to gently distend the bladder and so keep its walls out of harm's way during the crushing of the stone. From six to ten ounces is usually a proper quantity.

An elastic-rubber tube may then be tied lightly around the penis close to the corona glandis, to prevent the escape of water alongside of the instruments. This serves the double purpose of keeping a known quantity of water in the bladder and of preventing the wetting of the patient and bed.

Before each introduction of an instrument the urethra should be filled with liquid vaseline, from a syringe, in order to lessen injurious friction as far as possible.

To introduce the lithotrite properly the point should be carried with considerable gentleness through the constriction made by the rubber tube, and it then slips without difficulty through the movable urethra. After the beak passes below the pubes the handle should be brought to a vertical position, and the instrument will then drop, almost without assistance, by its own weight, until the point rests just in front of the triangular ligament. Traction upon the penis now effaces the depression made by the extremity of the instrument in the bulbous urethra, and if the handle is then brought down gently between the thighs of the patient, and at the same time the point is advanced in the axis of the body, the instrument enters the bladder.

The places where difficulty may be met in a normal urethra are at the triangular ligament and at the prostate.

The point of the instrument may catch on the upper or lower edge of the comparatively rigid opening in the triangular ligament. If the handle is depressed before the beak of the instrument has been carried vertically down as far as it will go toward the rectum, the point is likely to catch against the upper edge of this opening; while, on the other hand, if the instrument is pushed too forcibly toward the sacrum, the lax, bulbous urethra is depressed below the aperture and the point catches on the lower margin. Practically, if the instrument catches at the triangular ligament it should be passed down with the beak hugging first the roof and then the floor of the urethra, and in one or other of these ways it will usually find its way through. The finger pressing against the convexity of the curve of the instrument in the perineum will often lift the point over the lower margin of the opening when it is catching there.

A similar difficulty may be met at the opening into the prostate. This happens but rarely, and is to be overcome by the same tactics. In case of much difficulty the finger introduced into the rectum serves as a good guide, and with it the point of the instrument may be lifted into the prostate when it is catching on the lower edge. An enlarged prostate is, as a rule, easily passed by the lithotrite, whose short curved beak carries the point along the roof of the canal, where it rarely meets with an obstacle.

False passages may make the introduction of instruments extremely difficult and dangerous. Even if by long and patient trial they are finally passed, and the stone is comminuted and removed, the danger is not then over, for a serious swelling of the urethra, with retention of urine, is likely to follow, and under these circumstances the passage of a catheter is almost an impossibility.

To avoid this course of things, a catheter should, in such a case, be tied in at the end of the operation, and left in place until the urethra has, partly at least, recovered from the injury received.

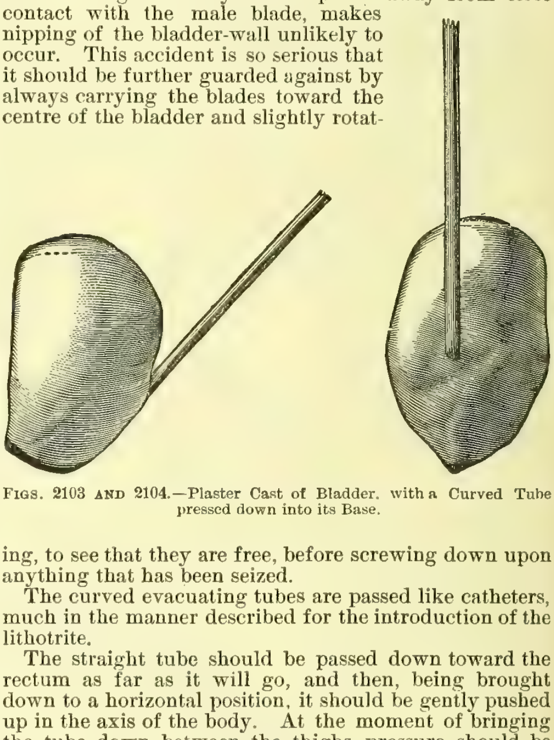
A single false passage, if its position is accurately made out, may usually be avoided by carrying the instruments along the opposite wall of the urethra at that point. If, however, several of these pockets exist, in which the instruments are constantly caught, it will, perhaps, be a wiser plan to resort to lithotomy, which, though a more severe operation, has the great advantage of providing certain drainage for the bladder.

The stone and, subsequently, the fragments are found and seized upon the floor of the bladder. Figs. 2103 and 2104 show how, when the lithotrite stands at an angle of forty-five degrees with the axis of the body, the floor of the bladder is indented, so that the extremity of the instrument lies at the bottom of a funnel-shaped depression and fragments naturally gravitate into or close alongside of its jaws. Usually when the blades are opened in this position the stone falls between them. When this does not occur the blades should be opened in the upright position, and then turned over on one side or the other and closed along the floor of the bladder.

A stone may be too large to fall into the depression made by the instrument, and it may then be necessary to depress the handle before it can be seized. This sensation of having the stone above the sound or lithotrite sometimes leads to the belief that it is attached to the upper bladder-wall when such is not the case.

The crushing of the stone should be done as thoroughly as possible at the first introduction of the lithotrite. This saves time and irritation to the urethra, and with the self-clearing instruments described above, much may be accomplished by a little patience and skill in searching for fragments.

The form of the female blade, with projecting end and width enough to carry its sharp rim away from close contact with the male blade, makes nipping of the bladder-wall unlikely to occur. This accident is so serious that it should be further guarded against by always carrying the blades toward the centre of the bladder and slightly rotating, to see that they are free, before screwing down upon anything that has been seized.



FIGS. 2103 AND 2104.—Plaster Cast of Bladder, with a Curved Tube pressed down into its Base.

The curved evacuating tubes are passed like catheters, much in the manner described for the introduction of the lithotrite.

The straight tube should be passed down toward the rectum as far as it will go, and then, being brought down to a horizontal position, it should be gently pushed up in the axis of the body. At the moment of bringing the tube down between the thighs, pressure should be made at the root of the penis to relax the suspensory ligament. Before advancing the instrument horizontally it is well to withdraw it very slightly, in order to disengage its point from the depression which it is likely to make in the bulbous urethra.

When there is a hitch at the triangular ligament, or at the prostate, the tube may usually be carried through by a rotation in the manner of a corkscrew.

When the tube has entered the bladder the bulb is connected with it, and on opening communication between them a gurgle will be heard, indicating the entrance into the bulb of the air contained in the tube. By means of the hose entering at the top of the bulb this air is expelled and its place supplied by water.

Some operators use evacuators which do not provide for the escape of this air, which is churned in and out of the bladder during the pumping, and is a source of some inconvenience.

In commencing evacuation the point of the tube should be held a little above the floor of the bladder. At every squeeze of the bulb the fragments are then thrown into commotion, and by the subsequent expansion are aspirated through the tube as they are flying about the bladder. If the opening were at first buried in the débris, it would be liable to be clogged by the fragments rushing in together and wedging. Later, when but little remains, the point of the tube should be carried to the bottom of the bladder to gather the remnants as they gravitate into the depression thus made.

The direction of the orifice of the tube should be occasionally changed, so that any side pockets may be thoroughly washed out. The pouch behind an enlarged prostate should be especially attended to in this way.

During the earlier part of the evacuation there should be no interval between the compression and expansion of the bulb. The object at this time is to set the fragments whirling and to catch them while suspended. Later, when the fragments are few and the tube is carried to the floor of the bladder, a few moments should elapse after compressing the bulb, to give the fragments time to settle into the depression about the end of the tube before the expansion which is to suck them into it.

When any particular aspiration brings fragments, the position of the tube should be kept unchanged until they cease to come.

The wedging of a fragment in the tube causes an obstruction which is very noticeable. The compression of the bulb is rendered difficult and its expansion is slow.

An angular fragment may lodge so that while it allows the passage of water, it prevents the entrance of other fragments. This condition may be suspected if there is a constant clicking against the tube and still nothing appears in the reservoir.

The usual point where fragments wedge is at the entrance to the tube. When one becomes thus fixed, it may be dislodged with a stylet; and this is the safest method of disposing of it, although with care the tube may generally be drawn out with the fragment in it. This procedure, however, is not devoid of danger, for sharp projecting angles may lacerate the urethra, or the bit of stone may even remain sticking in the passage.

The tube may also be obstructed by the bladder-wall, which is sometimes sucked into the orifice. The stoppage from this cause is usually not continuous, but the wall flapping against the opening gives a series of jerks to the instrument, which reminds one of the bite of a fish.

When this is felt the end of the tube should be moved to another part of the bladder, and if it then continues, it shows that the bladder is not sufficiently distended, and water should be added through the hose at the top of the bulb.

When for several minutes no fragments appear in the reservoir, the tube should be systematically moved about the bladder until every part has been explored. If no débris appears during this procedure, and there is no longer any clicking of fragments too large to pass, it may be concluded that the bladder is empty and the operation is completed.

Small particles of stone may be caught in folds and pockets of the bladder, and so may escape a thorough pumping. It is therefore wise before the patient passes from under observation to give another washing with the evacuator. This is of especial importance when an enlarged prostate or other obstruction to the flow of urine exists, as under these circumstances a fragment of stone if retained has little chance of being expelled by the natural efforts, and may serve as a nucleus for another calculus.

Strict antiseptic precautions should be observed throughout the operation. The instruments should be thoroughly cleansed with a five-per-cent. solution of carbolic acid. The vaseline used for lubrication should be perfectly fresh, and may even contain a small quantity of eucalyptus-oil as an additional precaution. The fluid used for the evacuator should have borax or boracic acid added to it, to sterilize it and to exert a soothing effect upon the bladder.

Size of Instruments.—A few words upon this subject may not be out of place, as much of the earliest and most persistent criticism of the operation was directed against the use of large instruments.

The advantage of using as large an evacuating tube as the urethra will readily admit is so evident as to need no argument.

Otis' measurements have shown that the average adult urethra has a calibre about thirty-two millimetres in circumference, which corresponds with No. 32 of the French catheter scale. A tube one or two sizes smaller than a given urethra will usually pass with ease, and will give rise to no undue irritation.

The size of the lithotrite selected will depend largely upon the size and hardness of the stone. As the largest Bigelow lithotrite is No. 30 in the French scale, the operator will rarely be limited in his choice of instruments by the calibre of the urethra, except when this is unusually small.

A soft, small stone can be readily comminuted with a small lithotrite, and if the urethra is narrow it is, of course, an object not to pass larger instruments than are necessary through it. But if a large oxalate-of-lime or uric-acid calculus be found, its thorough reduction is greatly facilitated by the use of instruments strong enough to easily overcome the increased resistance.

Under these circumstances a large instrument works faster, more thoroughly, does not have to be introduced so often, and saves the strength of the surgeon.

This last point is of great importance, as the delicacy of hand so necessary in manipulations through the urethra is with difficulty maintained through a long operation, and yet it is even more necessary toward the close than it was in the beginning. *Arthur T. Cabot.*

[1] Am. Jour. Med. Sciences, January, 1878.

LITHOTOMY (λιθοτομία, from λίθος, a stone, and τέμνειν, to cut), a cutting operation for the removal of a stone. This term is by usage applied merely to the removal of a stone from the bladder. When otherwise used, the different application is designated by a prefix (nephro-lithotomy).

Lithotomy is one of the oldest operations in surgery, and was formerly the only surgical procedure to be resorted to in cases of stone.

Early in the present century (1824) the crushing operation (lithotrity) was brought into recognized use by Civiale, and was widely adopted in the treatment of cases in which the stone was so small or so soft as to be easily pulverized

In 1878, Bigelow introduced the operation of *litholapaxy*, and showed its applicability to stones of considerable size and hardness.

So efficient has this operation proved itself, that it leaves but a comparatively small number of cases to be treated by lithotomy.

For a brief discussion of the principles which should guide one to a decision between the crushing and cutting operation in a given case, see under Bladder, pages 516 and 517 of Vol. I. of this Handbook.

In modification of what is there urged, it might be stated, that within the past few years litholapaxy has been used in children, by some operators, with a most promising degree of success. Dr. Keegan, of India, has reported 58 cases, with only one death. How far the crushing operation will show itself to be applicable to cases before puberty is doubtful; for in children the death-rate after lithotomy is very low, and may perhaps be still further reduced by a strict observance of antiseptic methods.

The male bladder may be opened either through the perineum, or above the pubes. Each of these roads to the bladder has its own especial advantages and dangers, which have to be considered in selecting the proper operation for a given case.

Perineal Lithotomy.—The incision through the perineum may be central or lateral. As the lateral method is most commonly used, and is more universally

applicable than the central operations, it will be described first.

Lateral Lithotomy.—In preparation for the operation, the patient's bowels should be thoroughly emptied. This may be best done by the administration of an aperient, on the preceding day, and of an enema on the morning of the operation. If the rectum were distended

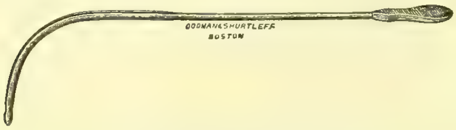


FIG. 2105.—Grooved Lithotomy Staff.

there would be considerable danger of its being wounded by the incision.

After etherization, the bladder may be emptied, and then moderately distended with a warm solution of boracic acid.

The grooved sound or staff is then introduced, and the stone should be touched and felt with it. If this precaution is neglected, the operator may be disappointed, either by finding no stone, or by failing to reach the bladder. This latter mischance has happened when the staff has found its way into a false passage.

When the stone is felt, the staff should be entrusted to a good assistant, whose duty it is to see that the point does not subsequently escape from the bladder, and that it is correctly held during the operation.

The patient should then be placed in the well-known lithotomy position: the buttocks projecting over the end

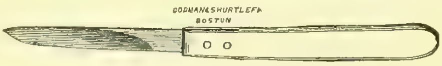


FIG. 2106.—Lithotomy Knife.

of the operating table, with the thighs strongly flexed on the trunk, and the knees separated so as to make the perineum prominent. This position should be accurately maintained by the assistants, as a very slight change in the posture of the legs or pelvis may considerably alter the relations of the landmarks relied upon for guidance in making the incision.

The surgeon now takes his seat, assures himself that the patient is straight and squarely in position, and that the staff in the hands of his assistant is on the median line, and so pressed down as to be readily felt in the perineum. The scrotum being held up out of the way, the operator enters his sharp-pointed knife upon or close beside

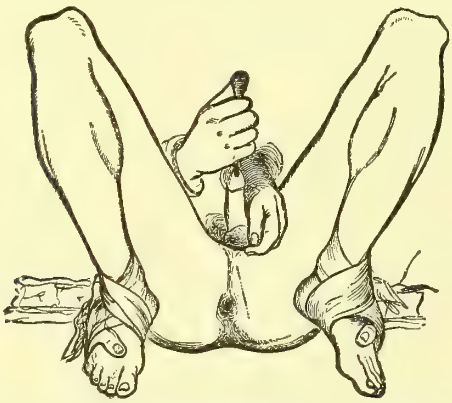


FIG. 2107.—Lithotomy Position. The dotted line indicates proper location of lateral incision.

the raphé, about an inch to an inch and a half in front of the anus, and makes his incision downward and outward for two and a half or three inches over the middle of the ischiatic fossa. The incision should be carried rapidly down through the loose fat and underlying tissues in the direction of the membranous urethra, the situation of which should be rigidly kept in mind.

As the deeper parts are reached, the left forefinger is introduced into the wound, and the staff is felt. The knife should follow the finger, and freeing the tissues, should make the outline of the staff easily discernible. A little care in this part of the operation may save the bulb and its artery from injury.

The finger-nail now feels and presses into the groove of the staff, where it lies in the membranous urethra, and,

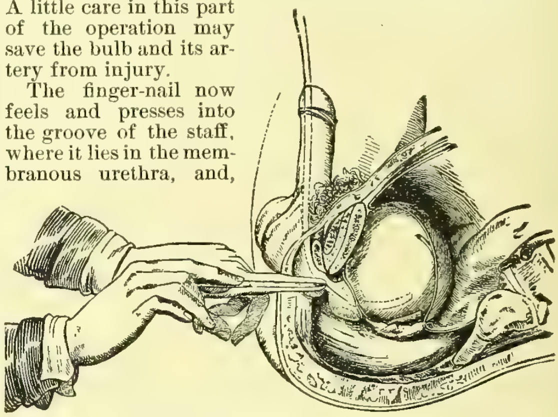


FIG. 2108.—Diagram Showing the Use of the Knife alongside of the Finger.

with this as a guide, the point of the knife is entered into the groove, and moved slightly to and fro in it with a scratching motion to make sure that it is rightly placed. The staff is now taken with the left hand from the assistant, and the knife being firmly held in the groove, the handle of the staff is depressed, and both staff and blade are pushed into the bladder together.

Some operators push the knife along the groove of the staff without altering the position of the latter. Whichever plan is adopted, the greatest care should be taken that the knife does not escape from the groove—an accident

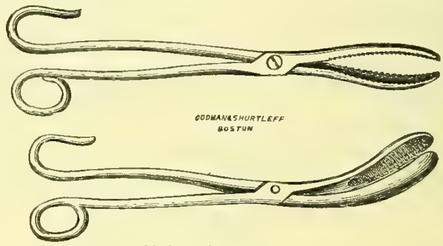


FIG. 2109.—Lithotomy Forceps.

which may easily happen, and which leads to considerable unnecessary laceration of the neck of the bladder.

The knife having reached the bladder, its handle is depressed and carried to the right (operator's right), and the point being still fixed in the staff, the heel of the blade makes an incision of the desired length in the left lateral lobe of the prostate.

The knife is now withdrawn and the right forefinger is passed through the wound along the staff into the bladder. The staff is next withdrawn, and the left forefinger

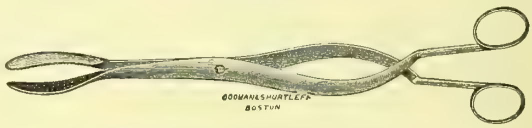


FIG. 2110.—Long Lithotomy Forceps for Use through a Deep Perineum.

is introduced alongside of the right. These fingers are then placed back to back, and by separation of their points a dilatation of the opening through the prostate may be made gradually and intelligently. The right hand is now withdrawn and the stone-forceps are introduced along the left forefinger, which has been kept in as a guide.

Usually the stone is found close to the neck of the bladder, where it is brought by the gush of urine escaping through the wound. Sometimes, however, it is held in a pouch, where it is reached with difficulty, and from which it is sometimes hard to dislodge. When it cannot be seized with the forceps, the lithotomy scoop may be used to lift it out of the pocket in which it lies.

If the stone is too large to come through the opening in the neck of the bladder, the deep incision should be

FIG. 2111.—Lithotomy Scoop.

enlarged with a probe-pointed bistoury. This is best done in the line of the original cut. If even this fails to give enough room, an incision may be made in the other lobe of the prostate as in the bilateral operation. Forcibly dragging a stone through an insufficient opening greatly enhances the danger of the operation, and should never be done. An incision of the deep parts, even beyond the limits of the prostate, is preferable.

If the stone is found to be decidedly too large for safe delivery through the perineal wound, it may be crushed *in situ* and then removed piecemeal, or it may be removed by a supra-pubic incision. Strong crushing instruments have been devised for use through the perineal wound and large stones are removed by their aid; but it is questionable whether, with its improved technique, the supra-pubic operation is not the safer method. Each case must be decided for itself.

With a soft stone great care should be taken during extraction not to break it. If this accident happens, or if a number of stones are found, or when a large stone has been intentionally crushed in the bladder, the operator should take great pains to remove the last bit, as the merest crumb, if left, may serve as the nucleus for a new calculus. Careful search with forceps and scoop, assisted by thorough syringing, will usually accomplish the removal of the last fragments.

After the stone is out, attention should be paid to stopping any hæmorrhage which persists. One or two little arteries may need to be tied or twisted. If these are deeply placed they may give some trouble. The artery of the bulb is the most considerable vessel which is likely to be injured, and this occurs usually when the deep incision is too far forward.

Sometimes, in a fat perineum, it is almost impossible to place a ligature on a deep vessel. In such cases Thompson recommends the use of a hook, upon which the vessel and surrounding tissue is caught up, and a ligature is tied around the whole; the tenaculum being left in the wound. A pair of artery-pressure forceps can be applied and left on for twenty-four hours in a similar way.

If, after the spirting arteries have been tied, there is still considerable oozing, it may be well to pack the wound.

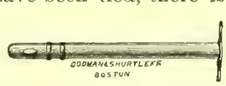


FIG. 2112.—Chemise Cannula with Cross-bar at Outer End for Securing it in Place. Near the eye are two circular ridges, between which the cloth is secured.

It is important, of course, not to occlude the opening and hinder the flow of urine; to this end a tube is usually inserted and the packing is put in around it. The chemise cannula is a convenient contrivance for this object. It consists in a metallic tube of proper length to reach from the interior of the bladder to the surface of the perineum. The edge of a piece of cloth is fastened firmly around the tube close to the end which enters the bladder.

When the tube is in place the bag, which the cloth forms around it, is firmly packed with iodoform gauze or other elastic material, the pressure of which stops any oozing. The tube is held in place by tapes carried to a waist-band.

Perineal lithotomy has its great advantage in the fact that the wound is well placed for drainage.

The lateral incision is superior to the median operations, now to be described, in that it affords more room for the extraction of the stone, and by limiting the incision to one side of the prostate it puts but one seminal duct in danger.

This method is suitable for the removal of any stone of moderate size (one to two ounces) which for any reason cannot be dealt with by litholapaxy.

The central operations are only useful for the extraction of small stones (less than one ounce in weight). As, however, it is just this class of cases to which litholapaxy is especially applicable, they rarely require a cutting operation, and median lithotomy has fallen into almost total disuse. A brief description of its principal modifications will, therefore, suffice here.

The most important of these are the median operation, the bilateral, the medio-bilateral, and Buchanan's operation with the angular staff.

In all of them the preparation of the patient should be the same as for lateral lithotomy.

The Median Operation.—The incision is made on the raphé, the urethra is opened, as in all perineal operations, in the membranous portion, and the incision in the prostate is made downward in the middle line.

The Bilateral Operation.—A curved incision, with the convexity upward, is made across the perineum just above the anus. The prostate is incised with a double lithotome (bistouri caché), which cuts the prostate outward and somewhat downward into both lateral lobes at once.

In the *medio-bilateral method* the superficial incision is on the median line, while the prostate is incised bilaterally as in the operation last described.

Buchanan's operation requires a special angular staff. This is bent at three inches from the end to a right angle, and the terminal portion has a deep lateral groove.

When introduced, the angle of the staff is carried to the apex of the prostate, and this position being verified by the finger in the rectum, the angle of the staff, with the membranous urethra upon it, is carried toward the surface until it can be easily felt in the perineum.

The staff is now held firmly by an assistant, and the surgeon, keeping his left forefinger in the rectum as a guide, enters the groove in the staff by a direct thrust with a lancet-pointed bistoury, which he carries directly on along the groove till it brings up at a stop near the end of the staff. In withdrawing the knife, he makes a curved incision around the left side of the rectum, equal to about one-half of the incision in the bilateral operation.

SUPRA-PUBIC LITHOTOMY.—This operation is now at least three centuries old, having been performed by Pierre Franco about 1560 A.D. Since that time it has been occasionally brought into more or less prominence by its adherents, but has never established itself as a safe and good operation until recently, when its dangers and difficulties have been greatly lessened by improvements in technique.

Its advantage has always been that it gave room for the removal of stones which were too large to pass through a perineal wound.

The dangers to be apprehended are from injury to the peritoneum, and from septic processes in the wound.

The peritoneal sac should always be avoided by a careful surgeon, and if, in case of an abnormally low pre-vesical fold, this is opened, it should be carefully closed with sutures before proceeding. It may sometimes be well even to postpone opening the bladder until a subsequent operation, when the peritoneal rent has had time to become sealed.

It may happen, on the other hand, that in the exercise of the care which is thought necessary for the avoidance of the peritoneum, the loose cellular attachments of the bladder are so separated as to open the way for septic absorption in a wound exposed often to fermenting urine and ill-placed for drainage.

The recent great improvement in the method of the operation, which was introduced by Petersen, consists in the simultaneous filling of the bladder with an aseptic solution and distention of the rectum by means of a rubber bag filled with water.

This combined distention of bladder and rectum has

done away with much of the dreaded danger to the peritoneum, which is lifted up well out of the way. It also, by bringing the bladder into easy reach, has made much manipulation unnecessary, and has thus greatly lessened the danger of infiltration and septic infection.

The present method of operating is as follows: The bladder is washed out and then filled with a weak solution of boro-glyceride or of boracic acid (two to four per cent.). From six to ten or more fluid ounces may usually be injected, and during this process the resistance to the entrance of the water should be carefully noticed, to preclude the possibility of overdistending and rupturing a weakened bladder, an accident which has happened in one or two instances.

A collapsed rubber bag is then introduced into the rectum, and water to the amount of from ten to sixteen fluid ounces is injected into it.

As the bladder is filled and its apex rises into the abdominal cavity the pre-vesical pouch of peritoneum is pushed up, and the space between it and the pubes is greatly increased.

Bouley has investigated this point and has deduced the following approximate rule: "When the apex of the bladder stands more than five, and less than nine, centimetres above the pubes, the peritoneal fold will be found three centimetres below this point. If the bladder reaches more than nine, and less than thirteen, centimetres above the symphysis, the peritoneum will extend four centimetres below its apex."

The rectal bag presses the bladder forward against the abdominal wall and fixes it there. It also lifts the vesical floor into easy reach and, by raising the bladder out of the pelvis, assists in lifting the pre-vesical fold of peritoneum. This last effect has been doubted by some operators, but is pretty clearly established by experiment.[1]

The incision is made vertically in the median line, between the recti and pyramidales muscles, and opens the pre-vesical space (cavum Retzii). The sides of the wound being separated, the peritoneum is held up and protected by the left forefinger, and the bladder is opened by a direct thrust close down to the pubes.

The upper angle of the opening is caught up and held with the forefinger, which is already in the wound, and this opening may then be stretched or enlarged by incision if the stone is a large one. Extraction should be done carefully to avoid damage to the soft parts.

The bladder should afterward be searched for other calculi, and the ease with which this can be done is a strong argument in favor of this method of operating. Its other advantages are the absence of hæmorrhage and the avoidance of injury to important parts, such as the prostate and urethra, which are necessarily interfered with by the perineal operations, and the seminal ducts and rectum, which may be injured by those incisions.

In the treatment of the wound the question of attempting to procure an immediate closure of the bladder-wall by first intention is an important one. This has been successfully done in some few reported cases, and when the tissues are fairly healthy it may be tried.

The stitches should be put through the muscular coats of the bladder, but should not penetrate the mucous membrane. If they are entered at some little distance from the edge of the wound they will, when knotted, bring considerable surfaces together, and will so promote firm union.

Either catgut or silk may be used for the bladder suture, and the skin should be united by a separate line of stitches.

When this plan does not succeed, it is attended by a certain degree of risk, for, if the bladder leaks after the skin is closed, infiltration of urine and peri-vesical abscesses may result. This danger may be partially met by the introduction of a drainage-tube through the skin down in close proximity to the bladder, so that if urine escapes it may be conducted off.

The other plan, which should always be adopted when there is inflammation of the vesical wall, is to leave the wound open and to drain the bladder by two tubes introduced to the bottom of the cavity. These tubes are put in place as the rectal bag is being withdrawn, and should be carried on the finger down with the floor of the bladder as it sinks into the pelvis. When in place they may be attached by stitches in the lower angle of the wound.

The upper part of the incision is then closed by one or two sutures, and an antiseptic dressing is applied. The tubes are conducted through this and discharge the urine into a vessel between the thighs or beside the bed. Their syphon action keeps the bladder empty, and through them it can be frequently irrigated.

When the bladder wound has contracted to a fistulous canal, a catheter may be tied in through the urethra and the fistula soon closes.

Very large stones may be removed by the supra-pubic method, and, until within a few years, it has been reserved almost entirely for such exceptional cases. Calculi weighing from twenty to twenty-five ounces have been successfully taken out in this way.

Of late years, since the operation has been improved, it has been applied to cases of all sorts, large and small stones, and in most cases with an encouraging degree of success.

It is as yet too early to say whether, as its advocates claim, it will supersede and displace the lateral operation, but at this time it is steadily growing in favor; and besides its other advantages, which have been discussed above, it has the merit of being easier of execution than any of the perineal operations.

Antiseptics.—In all of these operations upon the bladder antiseptic precautions should be observed as rigorously as in wounds in any other part of the body; and this should be the case even when the urine is foul and ammoniacal. Because the cystotomy wound is exposed to the organisms of putrefaction, it is not, therefore, proper to leave it open to the entry of the germs of erysipelas, pyæmia, and diphtheria.

The constant escape of the urine renders the problem of dressings in this class of wounds a difficult one. Most antiseptic substances are quickly dissolved and washed away, leaving the wound unprotected.

Fortunately, however, we possess, in iodoform, a material admirably adapted to our needs.

This drug is very sparingly soluble, so that it is not easily washed away, and yet enough is constantly dissolved to exert a decidedly antiseptic influence upon the fluids which come in contact with it.

A proper dressing of a wound through which urine is escaping would be somewhat as follows:

First, thorough drainage would be provided, which should guard against the possibility of any obstruction to the flow of urine.

The surface of the wound would then be lightly dusted over with powdered iodoform, and some charpie, filled with the same powder, or some iodoform gauze, would be lightly laid into the cavity. It should not be packed in for fear of hindering the escape of urine.

This inside dressing may be left in place for from twenty-four to forty-eight hours. Outside of it there should be a large pad of some absorbent material (oakum, peat, or wood-wool) which is to receive the urine and can be often changed. *Arthur T. Cabot.*

[1] Guyon: Ann. d. Maladies d. Organes Genito-Urinaires, vol. i., p. 109.

LITHOTRITY. Lithotrity, or, as it has been called, lithopriny, lithodyalisis, lithocenosis, lithotripsy, litholapaxy, lithodialysis, litholaby, lithomyly, lithophagy, etc., as at present understood, is a modern operation, although the idea of extracting calculi, whether whole or after reduction, without cutting, is not novel. While lithotomy goes back to long before the Christian era, when the Hindoos were the chief operators—and they have since continued to be—lithotrity, or the operation of crushing, goes back only to the memory of men not yet old; and the more modern improvements—those by which the operation has been deprived of much of its suffering and tedium—do not extend beyond the memory of men still young. Lithotomy (admittedly one of the most ancient of surgical procedures) has always been considered one of the most hazardous; lithotrity has been viewed with less aversion

by the patient, and with less anxiety by the surgeon. The former involves artificial openings, of greater or less magnitude, through important structures; the latter involves only the careful, delicate, and light-handed passage of suitable instruments along a natural channel, usually sufficiently capacious for the purpose, and their manipulation within a viscus usually not intolerant of their presence. The former was at one time considered as too hazardous for, or too unworthy of, the ordinary surgeon; the latter was performed, in its earlier history, by one who was not thought unworthy to be enrolled among the privileged few of the Académie Française. The former was, of necessity, bloody; the latter was usually unattended with that crimson evidence of violence. The former was classed among the bold and the brilliant; the latter among the quiet and effective. The former was performed only at certain seasons; the latter has not been so limited. The former was limited by age; the latter has already extended, in both directions, beyond its earlier assigned boundaries. It required centuries to unlearn the teachings of Celsus, that only youths under fifteen years of age should be subjected to the cutting operation; it was formerly taught that the crushing operation should be limited by a like age, but in an opposite direction. Time, however, has greatly modified those teachings, and the crushing operation has become practically unrestricted by old age on the one side, and almost so by childhood on the other. The state of the general health was at one time considered to be essential in either operation; it is not so now.

Certain general conclusions have been arrived at by surgeons unwedded to either method, and to these I shall now revert. But it may be here stated, in general terms, that the field of the lithotomist is being gradually circumscribed, while that of the lithotrotist is being, *pari passu*, extended, unless, indeed, the opinions I heard expressed by certain distinguished surgeons, at the recent meeting of the British Medical Association, in Brighton (August, 1886), be taken to represent the views of the surgical world, that supra-pubic lithotomy is allowable in cases of *very small* stones!

Lithotomy has long since reached its highest possible perfection. The details of methods of operating, which we read from time to time in medical journals, are but of little interest, and the old classical operation of two thousand years ago, with such aids as lighter and better instruments afford, is the operation usually performed at present.

Lithotrity is but as yesterday. Less than seventy years ago, France, ever foremost in all that pertains to science, and to the alleviation of human misery, made known the operation of crushing. Methods, 'tis true, bearing some analogy to lithotrity, are met with in medical literature. Space is here afforded to mention only the principal, and those the well authenticated.

Albucasis mentions an instrument which can be passed along the urethral canal and there seize a stone. It had, then, sometimes four branches. It was called an asta, but no record is given of its use. Sanctorius seems to have used, or at least to have invented, a similar instrument. But inventing an instrument and using it were not then—nor are they now—convertible terms. These instruments, and those devised by Paré, seem to have been used only in urethral and not in vesical cases. The *maschabarebilia* of Alsaravius is probably the same as that mentioned by Albucasis, which could be made "to seize the stone, crush it, if soft, and remove it." A Frenchman, Benoit, pretended to be able to seize a calculus in the bladder, and to crush it; and others, from time to time—markedly Sanctorius, Franco, and Hilden—made like claims; but these are admitted with reserve.

India has long been, and still is, a field for the operator; the native doctors are familiar with lithotomy, and still practise it with success. It is pretended that, toward the end of the last century, Major Martin, then at Calcutta, succeeded in introducing a file into the bladder through a curved cannula, and breaking up a stone from which he had been suffering. But the narrator, Velpeau, naïvely remarks: "It did not prevent his dying of stone in 1800." Something less apocryphal is the case of the monk of Citeaux, mentioned by Hoin, who, with the aid of a flexible tube and a steel *stilet*, succeeded in breaking up a stone much in the fashion of a chisel and hammer in the hands of a sculptor. At the beginning of this century (1813), Gruithuisen, a Bavarian surgeon, invented several instruments, and used them. The information obtained from Gruithuisen, is of a more precise character. He it was who recognized the larger calibre of the urethral canal, and the possibility of introducing straight instruments of from one-third to one-half of an inch in diameter. Gruithuisen published two memoirs on the subject of calculi, and described his instruments for boring them, and for crushing the fragments. Important as were his contributions to the subject, they were insufficient to obtain the general approval of the profession, and for many years after Gruithuisen wrote, lithotomy continued to be the operation to which the sufferer from stone required to have recourse.

Civiale in 1818—not 1817 as usually stated—devised an instrument for the purpose; and seven years later, with his instrument improved and fashioned, he performed an operation before a committee of the Academy of Medicine, and not unknown to the higher Academy, into which he was in due time to be admitted. He was quickly followed by Amussat and Leroy d'Étiolles, both of whom, but chiefly the latter, disputed with Civiale the credit of having brought the crushing operation into notice.* Elderton, Hodgson, Heurteloup, and Costello followed; and, at a later period, Coulson, Skey, and Sir Henry Thompson have extended the range of its application. Still more recently the operation of lithotrity, in the hands of Professor Bigelow, of Boston, has obtained a rapidity and completeness in execution to which Civiale never aspired, and the subject of a painful malady is not infrequently relieved, in a few minutes, by a painless and effective procedure.

I shall consider briefly the *historique* of the two important methods, having reference to instruments: one, the operation by means of straight instruments; the other by means of curved ones.

Of the first, or straight instrument, it may be observed that the difficulty of entering the bladder with it was long a hindrance to the performance of lithotrity. It is pretended, however, that straight instruments were used by the ancients, and that in the unburying of Herculaneum, straight instruments were found by Clarck. Many claims of a like character are put forth in favor of the ancients, to diminish the credit due to Liétaud. While some pretended that the urethra afforded every facility for the introduction of a straight instrument, others claimed that there is in reality no curve whatever in the urethra, even at its prostatic portion. Whether the statement that the ancients used straight instruments be apocryphal or not, it is certain that the French, after Liétaud, spoke of the use of rectilinear sounds as usual, easy, and as judicious as easy. This is merely of historical interest, for it is undeniable that a moderately curved instrument is more easily introduced into the bladder than a straight one.

The use of a curved lithotrite may be considered as the commencement of the operation of lithotrity.

At first the calculus was perforated in many directions, the several pieces were further reduced, and these were removed if they did not come away in the urine. The calculus was usually perforated at the centre. Sometimes the instrument was made to operate upon the circumference of the calculus, and sometimes crushing was resorted to without any preliminary perforation; sometimes the stone was fractured.

Until fifty years ago perforation was alone the method used. It was performed by means of instruments which are now not used. Their names have not, for the most part, been anglicized. They comprised instruments to catch the calculus; instruments to hold it, and instruments to break it; drills to bore it; instruments to protect

* On this subject I should suggest reference to that able and impartial observer of that period, L. M. Velpeau (Velpeau: Médecine Operative, vol. iv., p. 613 et seq.).

the walls of the bladder; hammers, and a complicated apparatus outside and around the patient's pelvis to secure immobility, to steady the instruments for striking, and to support the operator's arm. It would be profitless to attempt to describe them ; they may be seen in museums of surgical curiosities.

The rapid advance in the improvement of instruments was significant. A double steel rod was an essential part

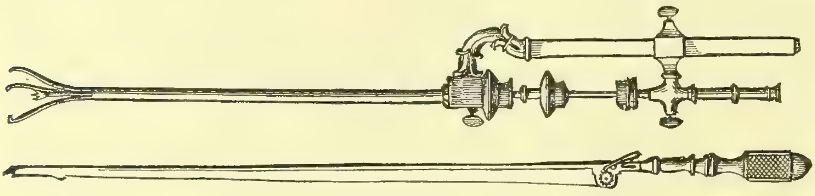


FIG. 2113.—Civiale's Litholabe as Modified by Leroy.

of every apparatus ; but the handle at one end, and the vesical extremity at the other, underwent frequent and important modifications. Instrument-makers vied with each other in devising. The instruments used for hollowing out the calculus—the excentric method it was called—gave place, in time, to those adapted to concentric crushing.

Rapid as was this method, compared with the preceding, and presenting the advantage of holding the stone till finally disposed of, the apparatus for the purpose was necessarily complicated, and the limbs of the instrument within the bladder were necessarily slender. This method, however, prepared the way for that which followed, and entitled Meirieu, Récamier, and Tanchon to grateful recognition. Meirieu and Récamier did not operate on the living subject, but Tanchon succeeded in rubbing away the outer surface of a calculus against the inner surfaces of the blades of the litholabe.

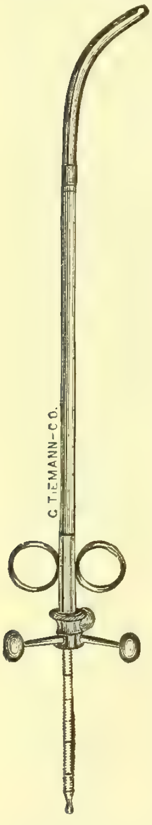


FIG. 2114.—Jacobson's Lithotrite. (Closed.)

Crushing the stone seemed from the first to offer greater inducements than any other method. It was a method not unknown to the ancients, though afterward forgotten till Amussat had recourse to it in 1822. At first it was limited to small and friable stones ; but Civiale, Heurteloup, Rigaud, and others extended its use to larger and harder ones. From 1820 to 1850 there was remarkable activity among surgeons and surgical instrument-makers ; but space is not afforded for chronicling the result of their diligence or ingenuity. And not alone in France, for Elderton, in Scotland ; Hodgson, in Birmingham ; and, later, Coulson, Skey, Fergusson, and Thompson, in England ; L'Estrange, in Dublin ; and Bigelow, in America, have made most important additions to our armamentaria, thereby greatly abridging suffering and protecting the soft parts against injury. Weiss, the surgical instrument-maker of London, was prolific in design. He made many modifications which even yet are not obsolete. The instruments for crushing stone have become extremely simple in comparison with those formerly in use for excentric or concentric reduction ; and it is unlikely that much more can be gained in the simplicity of design of the instruments now used, or in effectiveness in their manipulation. A few figures will illustrate this remarkable advance, although only those which had something more than an ephemeral use are introduced.

The sawing instruments of Leroy d'Etiolles and the lithontripteur of Civiale are extremely simple and ingenious ; but neither had a durable reputation, and the latter, it is believed, was never employed on a living subject. Civiale's litholabe, however, as it has been used with success, is here shown (Fig. 2113). The litholabe as delineated was modified by Leroy and others. Leroy constructed a three-bladed forceps, with a saw. He called it a lithoprione. It must have required a dexterity not possessed by surgeons nowadays to have used it with success. There were, in addition to the *litholabe* and the *lithoprione*, instruments for extracting simply, for crushing, powdering, breaking, perforating, triturating, etc., within the bladder ; and these various methods, more or less rude, were less satisfactory than were the sonorous Greek names invented to describe them. The litholabe has been greatly modified. Civiale's first instrument resembled the four-pronged invention of Franco. The principle was not novel, for A. Ferri and André de la Croix had separately furnished it in their *tire-balle*, and instruments for extracting bullets are still constructed on the same principle. It was, at first, so many watch-springs, which opened of themselves within the bladder when the cannula was drawn back, as in the representation ; and were closed, with or without the stone, as the case might be—usually without—by pressing the sheath home upon them. This ingenious device, and others constructed on a like principle, by Luckens, of Philadelphia, Colombe, and Leroy, were, it is asserted, neither adopted by others, nor used by the inventors. The branches of the litholabe were not always three : some suggested four ; some five (Amussat was among the number) ; Tanchon suggested ten ; Récamier would have ten in two cannulas ; Meirieu would not be satisfied with less than twelve branches in one cannula. The object of multiplying the branches was the better to retain the stone within them while the work of fragmentation was being attempted.

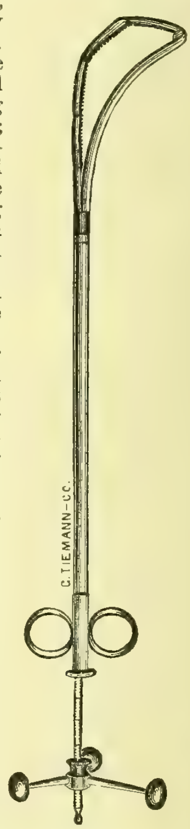


FIG. 2115.—Jacobson's Lithotrite. (Open.)

The lithomyleur of Meirieu, which soon underwent modifications at the hands of Récamier and Tanchon, had branches like the preceding, but their free extremities were pierced with eyelets, through which stiff silk was passed to draw them together, acting as the strings of a purse when tightening it. The two ends of the string passed outward through a groove between the two cannulæ. The rotation of the cannulæ tightened the string upon the stone, if the stone were caught within their folds. If not, the strings could not be easily loosened, nor the branches separated while within the bladder. Récamier, Meirieu, and Tanchon alike adopted means by which apertures were formed in one side of the apparatus, through which the calculus could drop within the lithomyleur. Ashmead, of the United States, greatly improved upon the foregoing. His instrument had four branches ; three of them were equidistant, while the fourth was separated from the rest. This arrangement permitted even a large stone to fall within the lithomyleur. But calculi are not always the same size; nor are they always in the same position in the bladder; nor can they be always seized at the centre ; and the multiplication of branches is obtained at the expense of their thickness and strength. If, adopting Meirieu's method, a silken cord

draws the branches together, it at the same time strengthens them; but the cords are apt to get between the branches. Deleau substituted an eel-skin for the silk. But to all these inventions there were such serious drawbacks, that it seems a matter for conjecture whether the calculus, or the apparatus for its removal, was the more hazardous when both were within the bladder.

In the meantime attempts to crush stone, without perforating it were, as already stated, made by Amussat. It is evident that the ancients were impressed with the notion of its possibility, for Acaravius advises it, and De Hilden and others are said to have practised it. This was the method which Jacobson adopted in 1831, and the simplicity of construction of the instrument used may be seen in Figs. 2114 and 2115. It will be at once apparent that, however safe to manipulate within the bladder, and however powerful to crush a calculus, it would be difficult to deal with the broken pieces, were the operator sufficiently fortunate as to seize the calculus in the first instance, and to hold it till broken. Jacobson's instrument is now obsolete, as well as the earlier instruments of Civiale, Amussat, and Rigal, fashioned on the same principle. Rigaud, in 1829 and 1831, suggested three blades (Fig. 2116). When the stone was seized, a mechanism was provided to close the three branches upon the stone, to hold it firmly, crush it, and reduce it to powder. Heurteloup's brisecoque, armed with strong teeth, was a much more powerful instrument, but a reference to the figure (Fig. 2117) will show how a somewhat heavy-handed person, armed with a brisecoque in one hand and a hammer in the other, was all-powerful to wound the bladder or break the instrument.

There seemed for a long time to be a disinclination to put aside the three-branched instrument, and an ingenious surgical instrument maker, Sirhenry, constructed a crushing instrument with three branches, but with their inner surfaces serrated. The calculus seized, the three blades were drawn within the cannula with such force that the hardest stone is said to have yielded. Emboldened by success, a large and hard calculus was seized, but one branch of the instrument broke.

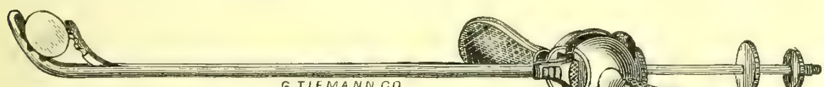
From that time forward instruments were always two-bladed, and the advance made in simplicity of design, in strength and lightness, was steady. In describing a lithotrite one blade of the instrument is called the male, and the other the female blade. The curved extremity is called the beak; the part held in the hand is the handle; the shaft is between the beak and handle. The jaws of the lithotrite are the open halves. The rack and pinion (Fig. 2118) took the place of the *brise-pierre*, and instead of blows of a hammer to break the imprisoned calculus, a few turns of the handle sufficed to crush it. But the handle was sometimes on one side, sometimes on the other—but always on one side—and in manipulating it the instrument was not evenly balanced. The rack-and-key instrument was that generally used by Sir Wm. Fergusson.

The *lever* (Fig. 2119) was preferred by many to the rack and pinion; but its movements I have found to be less steady. The lithotrite furnished with rack and pinion could not be worked without more or less movement of the point within the bladder. The same objection applies with equal if not with greater, force to the lever instrument, which requires frequent change of position of the right hand. I have discarded both, for the, to my mind, more satisfactory lithotrite which I have yet to describe.

Weiss's lithotrite has all the advantages of Civiale's, and also an additional merit. The screw-power is in connection with the male blade, and is more readily released, that being accomplished by placing the thumb of either hand upon a button on the handle, the movement being effected in a line with the shaft of the instrument. The cylindrical form of the handle added by Thompson, though admitting greater force in the hands of the operator, does not secure greater delicacy in manipulation than does Civiale's round-headed instrument. That instrument is the better, however, to which the operator is more accustomed. The screw, either on the male or female blade, is now an essential part of every lithotrite, and all modern instruments are so constructed that the screw can be put on or off at pleasure. This very great improvement is due to the ingenuity of Charrière, the Paris surgical instrument maker, who styled it the *écroubrisé*

The slightest modification in handle or in tooth or in screw now suffices to give a name to an instrument. All have certain essential features: a double shaft; a male and a female blade, jaws roughened or dentated, and at an approach to a right angle to the shaft; the jaw of the male blade always solid; that of the female blade closed or more or less fenestrated; a round, generally roughened handle, cylindrical or tire-shaped, with an arrangement by which the thread of the screw can be put on or off at will. All instruments, from Civiale's early ones to the present, have a graduated scale to indicate the extent to which the jaws are opened, and to serve as a measure of the size of the stone. I shall mention only those instruments with which I am more or less personally familiar: Civiale's last improved instrument (Fig. 2120) I have

FIG. 2116.—Rigaud's Trilabe. (Modified.)



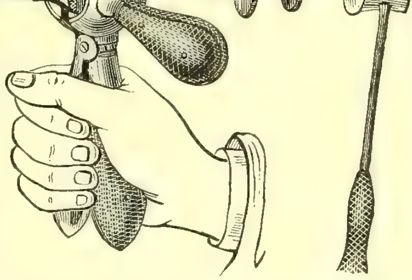


FIG. 2117.—Heurteloup's Lithotrite and Mallet.

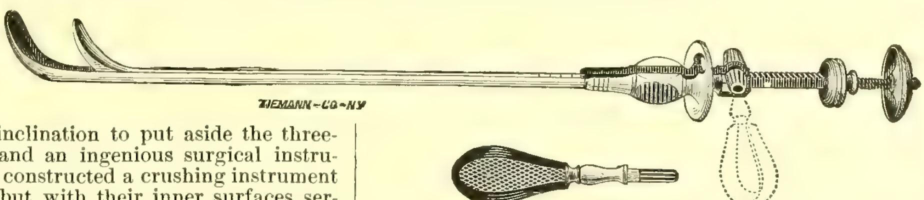


FIG. 2118.—Fergusson's Lithotrite. (Rack and Pinion.)

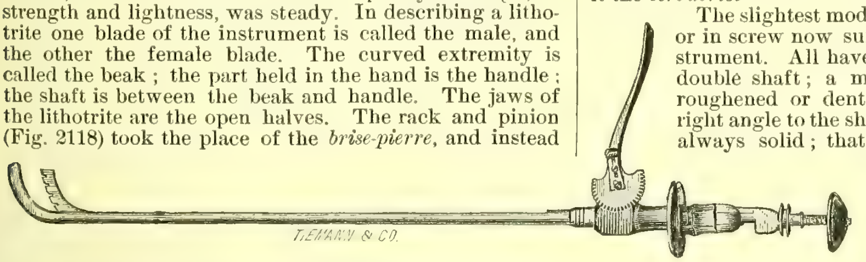
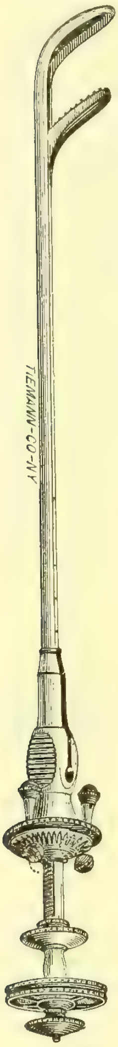
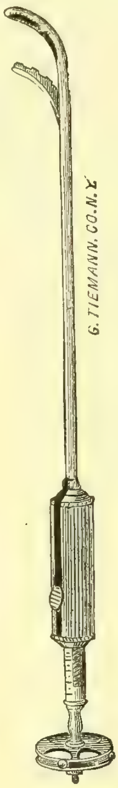
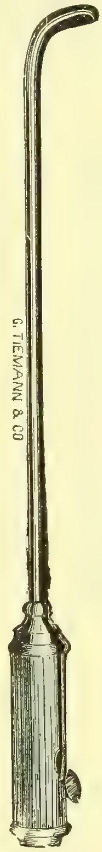


FIG. 2119.—Lever Instrument.

already alluded to. It may be easily worked, with or without the screw, this being attached or released at pleasure by turning what is called the revolving cap. The tire-shaped handle I have always found to be easily and delicately manipulated. Sir Henry Thompson's instruments (Figs. 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128) open and closed, fenestrated and almost solid, are here illustrated. I have generally used Civiale's instrument, modified, for large stones; and those of Thompson, with large or small fenestræ, as the case may be, for smaller and softer calculi. Sir Henry's large fenestrated, his latest improvement, permits the male blade to pass through the female. With this improved instrument there can be no filling up with fragments. With the small fenestrated Thompson instrument I have more than once found small and large fragments become impacted in the female portion; and these would continue to be pressed within the female blade so long







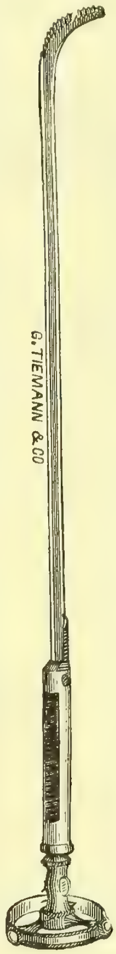


FIG. 2120. FIG. 2121. FIG. 2122. FIG. 2123.

FIG. 2120.—Civiale's Lithotriptor. FIG. 2121.—Thompson's Lithotrite.
FIG. 2122.—Female Blade of Thompson's Lithotrite.
FIG. 2123.—Male Blade of Thompson's Lithotrite.

as the male blade was pressed home upon the fragments. And it not infrequently happened that a more or less open lithotrite had to be removed with angular pieces projecting from one or both sides of the jaws. In some cases, I am certain, lacerations took place at the narrower portions of the urethral canal. The necessity for the use of a closed female blade does not now obtain, as the fragments can be readily got rid of by a better and safer method. Still, there are cases, to which reference will be made later, in which the unfenestrated instrument may be selected—cases in which friable and very small-sized calculi are met with, and in which the urethra is capacious and possessed of a moderate degree of sensibility. The screw-cap of Thompson's instrument is placed

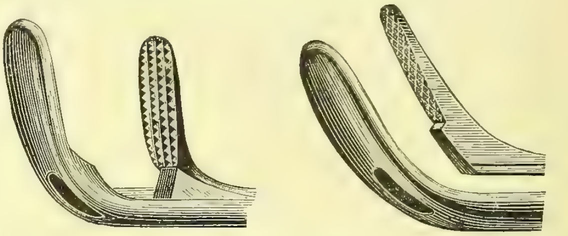


FIG. 2124.—Solid Jaws of Lithotrite.

on the side of the handle, and the screw can be easily attached or removed by a movement of the thumb. The attached or detached screw-power is indicated by the position of the head on the screw-cap.

Reliquet's instrument has certain important advantages over many other lithotrites in re-

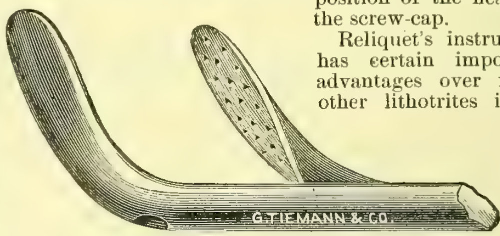


FIG. 2125.—Closed Jaws of Thompson's Lithotrite.

ducing calculi to fragments sufficiently small to permit them to pass through the urethra or evacuating-cannula. In a description which I have already made I observed that the oblique disposition of the teeth on the margin of the female blade prevents the calculus from slipping toward the point where

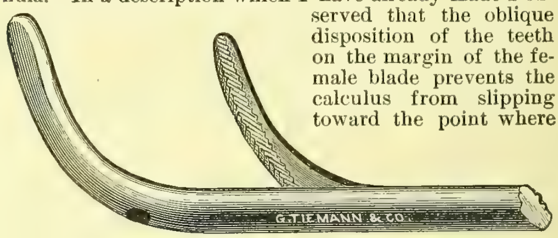


FIG. 2126.—Closed Jaws of Thompson's Lithotrite.

the teeth of the male blade cut and crush it. The teeth of the male blade act singly upon the imprisoned calculus, and drive it against the transverse teeth in the female blade, between which it is reduced to the desired size, the fragments falling behind, and out of the way of the male blade. Hence the disadvantages of overfilling the female blade,

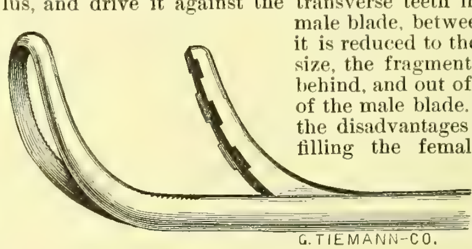


FIG. 2127.—Fenestrated Jaws of Thompson's Lithotrite.

and of necessitating the frequent withdrawal of the lithotrite to clean it, as in flat instruments, are avoided. But,

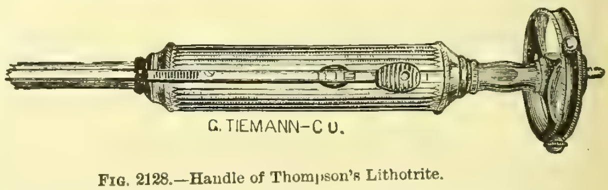


FIG. 2128.—Handle of Thompson's Lithotrite.

on the other hand, it may be mentioned, that when the instrument is closed, the teeth of the male blade project

through and beyond the female below, and the serrated margins of the female blade above are free. In its closed condition the instrument can be neither introduced nor withdrawn; the blades must be partially open for that purpose, and by a piece of mechanism that action is limited. Operators familiar with other lithotrites, which are always firmly closed prior to introduction or withdrawal, are likely to be unprepared for this novelty. In spite of

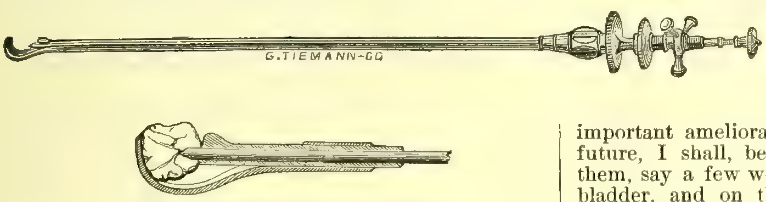


Fig. 2129.—Mathieu's Urethral Lithotrite.

this defect, however, much of what its enthusiastic inventor claims for it may be admitted, and especially the advantages of a flat instrument, without its inconveniences. Reliquet's instrument is much used in France, and is also a favorite in Germany.

Keyes's lithotrite, the jaws of which are given here (Figs. 2130 and 2131), is of three sizes, to accommodate itself to variations in the size and hardness of the stone. It is narrow, but exceedingly strong, grasps well, and cannot clog. It was at first "the back of the female blade cut out of Reliquet's instrument." The larger instrument has two buttons so placed "that any finger of either hand, in any position, may strike a button easily, and promptly connect the screw.

Gouley's lithotrite (Fig. 2132) has some advantages, but has disadvantages also. The edges

Fig. 2130.—Jaws of Keyes's Lithotrite.

are sharply cutting, but the bulk of the stone must be reduced by pressure, and pressure of a continuous kind. The comparatively sharp edges would seem to be more objectionable than they are in reality. It makes little difference whether the walls of the bladder are buttonholed by pressure or by cutting, when, unhappily, and it may be added inexcusably, within the jaws, or the spur and the heel of a lithotrite.

Teevan's lithotrite (Fig. 2133), made by Tiemann, like all Tiemann's lithotrites, is of best English steel, and is possessed of much power. It somewhat resembles Civiale's in handle. I have had no personal experience in the use of the three last-mentioned forms.

Bigelow's instruments (Figs. 2094, 2095, 2096) do not clog. The heel on the male blade projects through the

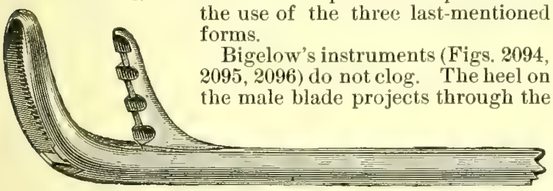


Fig. 2131.—Jaws of Keyes's Lithotrite. (Another pattern.)

female blade. There is a curve at the toe of the female blade, which, it is claimed, facilitates the introduction of the instrument. I doubt it. But I do not doubt the strength and general applicability of Bigelow's admirable instrument. Accustomed for many years to Civiale's and Weiss's improved, and afterward to Sir Henry Thompson's, I found the method of throwing the screw on and off, in Bigelow's instrument, a little confusing at first; but I have come to regard the arrangement as exceedingly ingenious and effective. "It is effected," as Keyes states, "by a collar upon the end of the cylindrical handle, and is thrown into action by rotation, conformably to the general wrist motion used in manipulating the screw." For the purpose of reducing the stone to fragments, preliminary to washing it out of the bladder, I am disposed to give the preference to Bigelow's and Reliquet's instrument, while frankly avowing, as I have already done, that three of the many instruments here described I have not yet used.

But with instruments so nearly approaching perfection as to make it extremely problematical that any important amelioration in design can take place in the future, I shall, before considering the mode of using them, say a few words on the symptoms of stone in the bladder, and on the methods of exploration. It may be premised, however, that stone may form either in the kidney or in the bladder, most commonly in the former. It sometimes remains in the pelvis of the kidney, or it may become "moulded in the calyces of the ureter, within the hilus of the kidney," giving rise to a variety of symptoms referable to that organ. It may there attain considerable size, and produce greater or less disturbance; or it may, while yet small, descend through the ureter into the bladder, where its presence may be recognized by certain symptoms; or these symptoms may be so hidden, or so ill-interpreted that the stone may escape notice till its presence is revealed at an autopsy. When the calculus is within the bladder it commonly causes irritation by its presence, and sometimes mechanical obstruction by its greater or less volume.

Symptoms of Stone in the Bladder. — Most persons, but not all, affected with stone in the bladder experience certain sensations, chief of which are the following: 1, A dull pain at the hypogastrium or at the extremity of the penis; 2, a feeling of weight at or near the rectum; and 3, the uncomfortable sensations are increased by exercise, whether walking, riding, or driving, while rest usually gives relief. The extremity of the penis is sometimes so irritated that the patient pulls and rubs it. In children considerable elongation of the member is often the result. There is a frequent desire to micturate, and it commonly happens that the irritation is increased thereby. "A slight pain, a mere passing sting," as Sir Henry Thompson says, "is mostly present at the close of the act of micturition in the end of

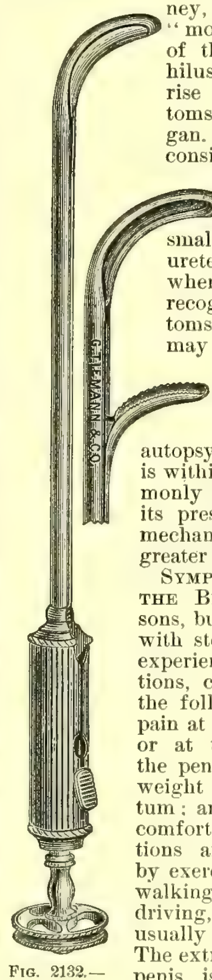


Fig. 2132.—Gouley's Lithotrite.

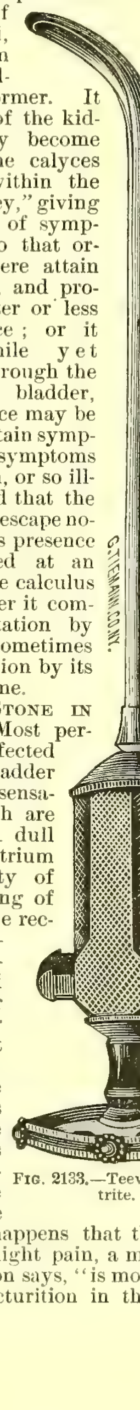


Fig. 2133.—Teevan's Lithotrite.

the penis." Frequently during micturition the stream suddenly stops, and, after a moment, or on change of position, the stream flows again. The urine is usually turbid, and a sediment, white and flocculent, or charged with mucus or soapy muco-pus, is not uncommonly present. Sometimes the deposit is stringy, tenacious, ropy, or charged with sandy sediment; sometimes the discharge is offensive, or charged with blood; sometimes gravel or small fragments of calculi pass away with the urine. Painful priapism is often a distressing symptom of stone, especially in children, who, as a general rule, suffer more than grown persons from all the symptoms of stone. Gant tersely summarizes the symptoms of stone under four heads: "Pain, chiefly in the glans penis; irritability of the bladder, with increased frequency of micturition; obstruction occasionally to the passage of urine; and morbid conditions of the urine, bloody urine in particular."

But a surgeon would be greatly misled if he expected all or many of these symptoms to be present in every case. Sometimes the symptoms are so insidious that they have escaped notice.* It sometimes happens that the distant reflex pains experienced by the subjects of stone are as numerous as are those complained of as arising from uterine disorders in nervous women. Pains have been felt in the sole of the foot, leg, thigh, groin, back, stomach, and even in the arm; and a burning sensation in the sole of the foot has been experienced, like the application of red-hot metal.

The stone may have formed in the most healthy individual, with a family history leaving nothing to be desired. A brick-dust or whitish deposit may have been noticed in his urine from time to time, but antecedent mental or physical exercise was made to account for it. That deposit may have been only occasionally present. The patient may have almost forgotten any pain in the region of the kidneys, or, if recollected, it was attributed to lumbago. Somewhat greater frequency in micturating may have been noticed, but that may have been attributed to cold; to illicit commerce, perhaps; † or to friction from the saddle or from ill-adjusted clothing. A small calculus may have passed, and a belief is begotten of it that as *discomfort* is relieved there can be no more. But a stone of nearly the same specific gravity as the urine; which tumbles about with every movement of the patient, and which gives, it may be, no uneasiness save, peradventure, when it falls against or near the neck of the bladder, may be steadily growing by accretion within the bladder.

As there is no symptom of stone which is pathognomonic, and as the usual symptoms are more or less subjective, and, therefore, more or less misleading, the only reliable means of diagnosis is touching the stone with a metallic instrument.

EXPLORATION OF THE BLADDER.—It is advisable, as I have said elsewhere, that this should be done, if convenient, when the bladder is more or less full. But this is a precaution of less moment than is often believed by those who erroneously think that the bladder is always in a state of contraction upon its contents. An exploration of all parts of the organ is not easily made when the bladder is empty; and in case of failure to find the stone, a more thorough examination should be deferred till the bladder is partly filled. But the bladder should not be quite full, as examination of a *full* bladder is more painful than is that of one partially filled. The injection of tepid water, or of any other fluid into the bladder, as a preliminary to sounding, is, in my opinion, objectionable, and for reasons which will be stated hereafter. The usual position of the patient is on the back, with the legs well flexed; but sometimes the patient prefers an erect posture, and it is one to which I do not object if he is not of a class liable to syncope. A reclining position is safer; but sometimes one position, sometimes another will be chosen, especially when a change of position is expected to facilitate the detection of stone. If the surgeon is right-handed, let him hold the sound in the right hand; if left-handed, he should use his left hand; if ambidextrous, one or the other hand; but let him not change hands during the introduction of the searcher, as that cannot be done without more or less disturbance of the instrument. The fingers of the hand *not* holding the explorer should merely steady the penis till the point of the instrument has entered the urethra, when there is usually no further use for them till the prostate is reached, and not even then in children or young adults. The practice of pushing the instrument with one hand, and drawing the penis with the other is objectionable. It is, no doubt, desirable that one should possess a thorough knowledge of the anatomy of the urethra, and of the curves which it makes in different parts of its course; but the best knowledge is that which is acquired by the constant practice of introducing catheters into urethræ of various dimensions and of different curves. By one possessing such experience any arbitrary rules, based upon observation made in the dissecting-room, are often found to be faulty. The *tour de maitre* is very brilliant; but whether the instrument is introduced with handle downward or upward is really of small moment. What is of great moment, however, is the *slow* introduction of the instrument, even when no difficulty would be experienced in introducing it rapidly; and, what is often neglected, its equally slow removal.

FIG. 2134.—Steel Sound.

When the sound is within the bladder, its convex portion, the handle being elevated, may at once be felt to strike against the stone at it lies behind the prostate, and near the neck of the bladder. If not, the point should be turned to right and left, then forward and upward; and if not in these situations, the stone will not uncommonly be felt as the instrument is being drawn back toward its first position. If still not found, the sound may be turned, with its point backward, in the median line, and then to right and left. As a stone is generally loose in the bladder, it moves about with every movement of the patient, and although it is usual to find the stone at a second examination where it was at the first examination, exceptions are not infrequent. Under ordinary circumstances, however, the position is much the same. A change in the position of the patient will often facilitate the detection of stone.

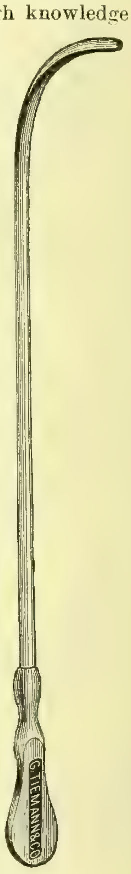


FIG. 2135.—Gouley's Searcher.

As the introduction of an instrument is often attended with some degree of irritation, and even danger, I fre-

* The largest stone I was ever called upon to remove, and which, from its history, must have commenced in infancy, twenty-three years before I examined the patient, was not suspected by any of the dozen of medical gentlemen who had examined the patient; the symptoms did not unmistakably point to stone, yet it weighed 5oz. 5 drachms.

† A remarkable case of this kind was brought to me by Dr. Lapthorn Smith. The patient had been entirely free from irritation, from frequent micturition, hæmaturia, pain, priapism, or straining of any kind; and free from any abnormal condition of the urine. He contracted gonorrhœa a few weeks before. The usual symptoms of gonorrhœa and the discharge were present for a time, but, as they seemed to Dr. Smith to be too persistent, an exploration of the bladder was made and a calculus was detected. It is evident that the condition of urine, induced by the gonorrhœa, had so "disturbed digestion and nerve-force," as Keyes puts it, "as to have furnished an excess of solids, chiefly uric acid." Or, perhaps, without giving to it a systemic origin, the injections used might have formed a nucleus around which the new-growth had rapidly accreted, from urine already too largely loaded with building material, either in the form of a separated constituent, or as the result of a catarrhal inflammation with its resultant colloid muco-pus.

quently sound with the lithotrite intended to be used to crush the stone, especially in cases where I am certain of the existence of stone, or where its existence had been previously determined. But for purely diagnostic purposes I use the sound somewhat like that here figured (Fig. 2134). The three following are not unlike each other in size, nor yet in curve. Gouley's searcher (Fig. 2135) has a more abrupt curve than the preceding, but the curve is not yet sufficiently abrupt. The nearer approach to a right angle the better. Little's searcher (Fig. 2136) has no advantage over Gouley's—the curve being the same and, except for children, the instrument is too slender. Otis's exploring sound (Fig. 2137), which is also used for exploring strictures, has a more abrupt curve than the preceding. Andrews's searcher (Fig. 2138), such as he exhibited to the Illinois State Medical Society, utilizes the sense of hearing as well as touch. The instrument which he used consists of a tube, hollow or solid, attached to an ordinary Thompson's searcher, and the free end, which is armed with an ear-piece, is placed in the surgeon's ear. The suggestion is an ingenious one, but I doubt if the normally delicate sense of touch possessed by the surgeon will ever receive much aid from the invention. What cannot be felt cannot be heard, and what can be felt need not be heard. Generally we succeed in both hearing and feeling, but I doubt if the well-heard click was ever so convincing to my mind as the sensation conveyed by the sense of touch. Billroth's sounding-board (Fig. 2139), attached to a steel sound, is an interesting contrivance, but its use will never become general. I can conceive of no sound registered by the sense of hearing that can aid the sound which is *felt* when a stone is struck. The angler who feels a nibble, though perchance of one of the tiniest of the finny tribe, would not be much aided were a sounding-board attached to the end of the rod he holds in his hand, and applied to the ear. The size of the fish, if there be a fish, and the family group to which it belongs, will not be elucidated by a sense which usurps, interferes with, and which, up to the present, has not aided the patient angler. The name of the distinguished inventor of the sounding-board however, will do much to secure its survival of any criticism which may be hazarded. The credit of having suggested auscultation as an aid to diagnosis, when the sense of touch was considered insufficient to detect the click of a small and soft stone, is due, unquestionably, to Laënnec. He suggested mediate or immediate auscultation of the hypogastrium, either with the stethoscope or the naked ear, while the sound, in its voyage of discovery, was within the bladder. Ashmead, recollecting that air is a better conductor of sound than water, thought of filling the bladder with it; and Moreau de Saint-Ludgère, fifty years ago (1837), anticipated both Andrews and Billroth in placing the ear-piece of a stethoscope upon the ordinary sound.

FIG. 2136.—Little's Searcher.

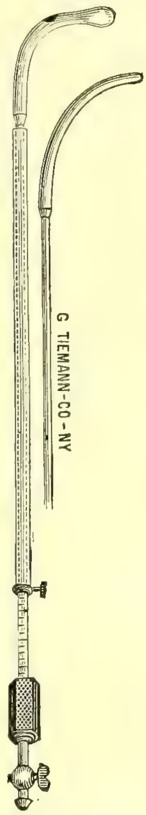


FIG. 2137.—Otis's Exploring Sound.

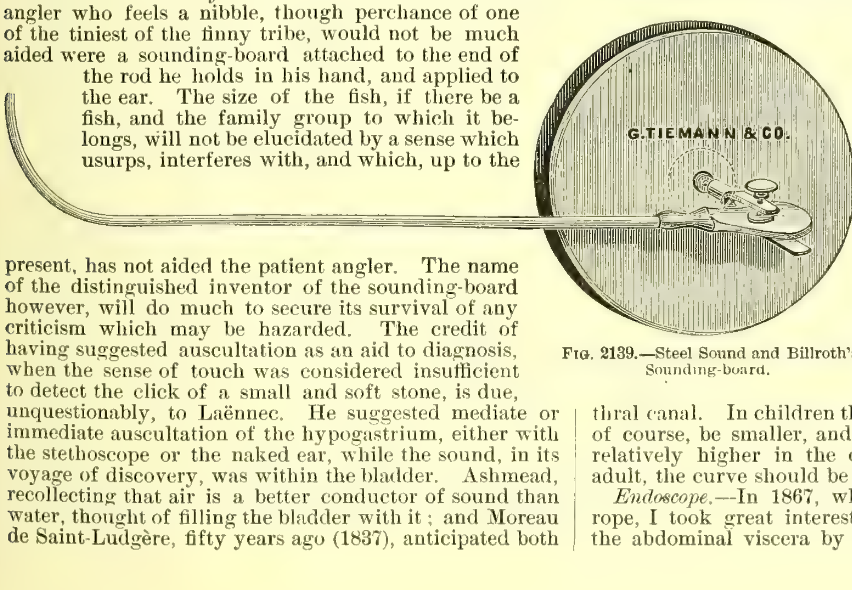


FIG. 2139.—Steel Sound and Billroth's Sounding-board.

Thompson's searcher (Fig. 2140) has the double advantage—if it be an advantage—of sounding and of securing at the same time a sufficient quantity of urine for purposes of examination. The shape of his instrument is unexceptionable, but I have always regarded a *solid* instrument as preferable to a tubular one, and the urine rushing through to the receptacle in the handle may be sometimes misleading. Its chief advantage, that of gathering the water, is, after all, but inconsiderable, as the patient can easily furnish otherwise what may be required.

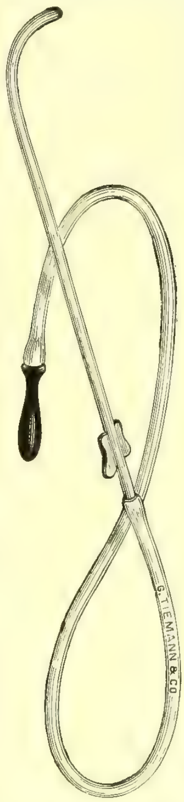


FIG. 2138.—Andrews's Searcher.

Although all these instruments *approach* perfection in shape there is still another which I consider preferable. It differs but little from some of those already figured, but that little is important. It is not always so easily introduced, but when within the bladder it can be turned more easily in all directions than a longer curved one. It is about the size of a No. 8 catheter, English measure. It differs from Van Buren's in being of uniform size throughout, and from Beniqué's in not being bellied backward at the curve, both these modifications appearing to me objectionable. It is well, however, to be provided with similar instruments of a longer curve—like that of the ordinary catheter—and corresponding to the usual curve of the urethra. Although this is different in different persons, the curve long since adopted by Paré, afterward by Heurteloup, and more recently by Thompson, is that which would seem to be the most generally approved in America, namely, a curve equal to one-fourth the circumference of a circle three and a third inches in diameter. Sometimes a long curved instrument will detect a stone which a short curved searcher had not touched. The size of the sound should be much under the calibre of the urethra to be examined, so as not to be impeded in any way by being grasped; yet not so small as to permit the urine to flow away too readily. But the surgeon should be provided with sounds of various sizes, to suit patients of different ages and with varying calibre of urethral canal. In children the instrument will, of course, be smaller, and as the bladder is relatively higher in the child than in the adult, the curve should be more abrupt.

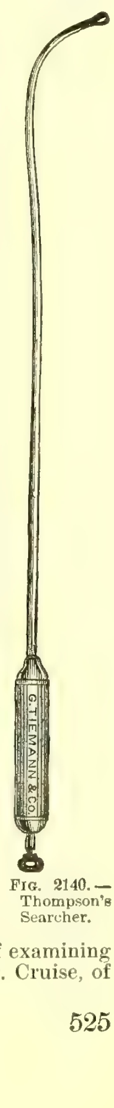


FIG. 2140.—Thompson's Searcher.

Endoscope.—In 1867, when visiting Europe, I took great interest in the method of examining the abdominal viscera by lighted tubes. Dr. Cruise, of

Dublin, perfected an instrument which bore his name, and from which much was expected. I was one of the sanguine, and provided myself with an endoscope wherewith to explore the mucous pouches and canals of loyal Canadians. But I received no assistance from its employment, and now that I have discontinued it, I may state, I can conceive no case in which more reliable information cannot be obtained with other means of diagnosis.

The *electric lamp* may some day perhaps do more to make diaphanous the interior of the body, and especially the bladder. But the apparatus which would be necessarily introduced within the latter viscus would be not less clumsy than the stone searcher, and would give results infinitely less satisfactory. It is now nearly twenty years since I first witnessed the experiment, in Paris, of lighting up the abdomen through the rectum; yet diagnosis of abdominal tumors has not been much aided by the contrivance. Still less, I believe, will be the information obtained regarding the contents of the bladder.

Anæsthetics.—It is a question whether anæsthetics should, or should not, be used in exploration of the bladder. Under ordinary circumstances, an anæsthetic is not necessary, except, to use Mr. Gant's words, "when the bladder is unusually sensitive, or irritable and spasmodic, or the patient is too restless for examination." But, it is rather the sensitiveness of the urethra with which we have chiefly to deal; and upon *its* tolerance or intolerance of the presence or passage of an instrument, depends the employment or non-employment of an anæsthetic. In the large majority of cases I do not use anæsthetics, either for exploring the bladder or while crushing the stone. Should, however, anæsthesia be decided upon, measures should be taken so that the preliminary sounding may be at once followed by crushing.

It is not alone the existence of stone which sounding elicits, but (*a*) its situation; (*b*) its freedom, or (*c*) its encysted condition; (*d*) its size; (*e*) its weight; (*f*) its hardness; (*g*) its shape; (*h*) the condition of its surface; and, when more than one, (*i*) the number. All these can generally be made out, if not with certainty, at least with a fair degree of probability. The *situation* is first ascertained—whether forward, near, or to one side or other of the neck of the bladder, or backward near the fundus, or behind the prostate—the latter a not uncommon situation in old men. Its *freedom* can be easily ascertained by dipping the point around and beneath the stone, movements which will be found to be impossible when the stone is encysted. The ease with which, having been once touched, it can be touched again, will establish its freedom. Its *size* can be approximately conjectured by passing the point or the convex part of the sound over the calculus, and estimating the distance it has travelled. If felt in whatever direction the sound is turned, it is reasonable to conclude the stone is a large one. Its size, however, can be established with precision by the lithotrite, upon the handle of which the scale will indicate the size of the calculus within its jaw. Its *weight* bears a direct ratio to its size, although calculi of different structures, and of different chemical constitution are of different weight. When the calculus is grasped with a lithotrite and carried from one part to another of the bladder, its weight may be estimated; but for this a sufficiently capacious bladder is necessary. Its *hardness* can be readily ascertained by the sound or click elicited when struck. A phosphate gives a dull, muffled sound; a mulberry gives a sharp click; while uric acid calculi give sounds which are intermediate. The *shape* of the stone is not always easily determined; but the condition of its surface, its smoothness or roughness, is not difficult to a practised hand. But when, as sometimes happens, the mucous coat of the bladder is covered with calculi attached to, and more or less buried in its surface, the diagnosis is not easily made, and I have known more than one distinguished surgeon mistake that condition of the bladder for calculi, with the disagreeable result of performing an unnecessary and useless operation. The question of *number* may be usually decided with the lithotrite. With a calculus firmly within the jaws of the instrument the lithotrite is made to grope for other calculi, when, if there is more than one calculus, sounds are elicited which could not be caused by the imprisoned stone. In this way the presence of a second or third calculus can be made out. But when calculi are numerous, as sometimes occurs, the number cannot be ascertained. Many years ago I examined an old man, and made out the existence of several calculi. But I could not even conjecture the number. By lateral lithotomy I removed twenty-five calculi of uniform size and shape, each about the size of a hazel-nut. The number, or anything like the number, could not have been conjectured in this case.

But calculi may exist, even large calculi, and escape detection, notwithstanding careful and repeated examinations. Almost every work on surgery contains some such admissions of failures, if failures they are, and to these reference is requested. I have already chronicled the case of Desiré Bayard, in whom stone in the bladder was suspected. On introducing a sound for the first time the calculus was at once felt. Next day the patient was placed upon the operating-table, and chloroform was administered preparatory to operating. The sound was again introduced, but after a long and careful examination I failed to detect the stone. The patient was frequently examined during the next three weeks by the then senior surgeon of the hospital, the late Dr. Munro—whose surgical experience was perhaps never exceeded on this continent—and myself, the patient sitting, standing, and lying, and when prone and supine, with instruments of every degree of curvature; but the desired click was neither heard nor felt. One day, when examining him in bed, I caused him to kneel, and bend forward upon his hands, when the characteristic click, which I had heard at the first examination, was again elicited. I turned the stone out of its position below the prostate, and with Civiale's lithotrite seized it and reduced it, as was then the practice, in a few séances. The stone was of uric acid, and the débris weighed upward of an ounce and a half. Who does not know the history of the monk who bequeathed his body for dissection purposes, so convinced was he of being the subject of calculus. He had been frequently sounded, but no stone was discovered. After death, however, a large stone was found in the bladder, and almost within the scrotum. Mistakes of like character have been numerous. Velpeau had personal knowledge of four such cases; S. Cooper, seven; and several others one, two, or three each, where stone was suspected but not found; while the number is still greater of large stones discovered after death which were not suspected during life. It is not easy to account for the difficulty experienced in again finding a stone once found—occurrences which have puzzled surgeons of every age, and especially such men as Chopart, Deschampes, Brodie, Dupuytren, Cluselda, and Pelleteau. Is it, as claimed, an interposed membrane, which effectually prevents the recognition of stone? or is it that pouches exist, and partially or almost wholly hide the calculus? Various opinions have been expressed as to this question. I shall not hazard an expression of my belief in the matter, but simply state the fact that a stone, even of large size, may long escape detection, and when found may not again be easily struck, although its position at the first examination had been carefully noted.

But if calculi sometimes exist, yet defy detection, it sometimes happens that calculi are believed to be detected which do not exist, except subjectively. Certain conditions of the urinary apparatus often give rise to a suspicion of the presence of stone. Who has not felt the instrument strike against what he erroneously considered to be a stone? and numerous have been the operations for stone where none existed. Brodie, Cloquet, Horstel, and Velpeau were among the number. The chief sources of error in these cases which I have summarized are, in the order of frequency: (*a*) an uneven, irregular condition of the lining membrane of the bladder; (*b*) the *folding* of that membrane; (*c*) its roughened condition, as if sanded; (*d*) the sudden jolting movement often experienced in turning the point of the sound quickly from the middle line to right or left; (*e*) fibroid, polypoid, or scir-

rhous masses, attached or free, in any part of the bladder; (*f*) bony or other tumors of the pubis, sacrum, or ischium; (*g*) the striking of the handle of the instrument against a button on the patient's or surgeon's clothing; (*h*) indurated fæces in the rectum; and (*i*) in females, a misplaced uterus or ovary. These possible sources of error make it advisable not to be satisfied with once touching the stone.

The existence of a calculus having been established, it is of some moment to decide which operation should be selected. The methods spoken of—electricity, galvanism, injections, or what is called litholysis, *i.e.*, the use of mineral waters by the skin, mouth, bladder, or rectum, are too unimportant to require notice. The operation of cutting, or that by crushing, will alone afford relief to the sufferer. The spontaneous cure, without operation, can only occur in persons in whom the stone has recently formed; and the possible chance of ulceration through the perineum is too remote to encourage the sufferer to defer an operation.

All operations in surgery are attended with certain risks connected with the operation itself, while others are connected with the individual operated upon. To lithotomy, there must ever remain the risk of "shock, hæmorrhage, wounding rectum, inflammation, usually pelvic cellulitis, or cystitis, urinary infiltration, deep-seated abscess, gangrene, peritonitis, phlebitis, pyæmia or purulent infiltration, erysipelas, sympathetic affections of distant organs, as of the brain or pleura, or those of the bladder, extending to the ureter, kidneys, rectum, or intestines;" added to which are the possible chance—especially in young children—of missing the bladder with the knife, and the great risk of the operation in persons suffering from pre-existing disease of the kidney. The discussion of these subjects belongs to another writer. I shall merely state that the operation of lithotomy must be considered in connection with these possible accidents and contingent dangers.

Lithotomy being so formidable-looking an operation, so soon as an almost bloodless operation was proposed in substitution the latter was pronounced to be comparatively free from danger. Some held that the knife should be laid aside, that the lithotrite would suffice for every form and variety of stone. But experience has taught that, while lithotrity is undoubtedly the better and safer operation when it can be performed, there are yet, and there always will be, cases which can be relieved *only* by the knife. These cases of compulsory lithotomy are becoming less frequent, for two reasons: First, the great improvement in modern lithotrites which enables them to crush stones which were formerly considered beyond the crushing process; second, the usually earlier recognition of stone, and consequently its earlier removal.

But lithotrity has its own dangers, some of them attending the operation, and others occurring afterward; and these I shall briefly enumerate: (*a*) Impaction of stone in the female blade of the lithotrite and consequent laceration of the neck of the bladder and of the urethra, on forcible withdrawal of the instrument;* (*b*) retention of urine; (*c*) irritation of the bladder; (*d*) cystitis; (*e*) anal irritation; (*f*) nephritis; (*g*) suppression of urine; (*h*) sympathetic irritation of the testicles; (*i*) abscess in the prostate; (*k*) congestion of veins around the neck of the bladder; (*l*) pus-poisoning; (*m*) exhaustion; (*n*) disturbance of the nervous system; (*o*) arthritis of a quasi-rheumatic character, leading sometimes to pus in the joints. These are all possible occurrences, though many are rare.

I have rarely noticed any untoward symptoms arise during or after the operation of lithotrity. Urinary fever I have seen occasionally. It is always an anxious matter, as the fever may denote a severe or a slight disturbance, the degree of severity bearing no direct ratio to the elevation of temperature.

Crushing and cutting have many dangers in common. The irritation sometimes caused by the passage of the sound or lithotrite for crushing is not greater than that caused by the passage of a grooved director intended to guide the lithotomist. More than fifty years ago, when lithotrity was yet in its infancy, the operation of crushing was considered much less dangerous than lithotomy; and still the field of the lithotomist is being steadily circumscribed, while the horizon of the lithotrotist is being more and more extended. To illustrate how much surgical opinion has changed in this respect I shall mention, first, age. Until quite recently every person under fifteen years of age, suffering from stone, was lithotomized; now it is not unusual to operate with the lithotrite on children of not over one-third that age. Formerly, old men with enlarged prostates were cut for stone; now, persons of the most advanced age submit to lithotrity, and the size of the prostate does not prevent crushing. Formerly, stricture forbade the use of the lithotrite; now it does not. I have more than once, but under exceptional circumstances, divided stricture, with Otis' instrument for dilating and dividing, and lithotritized at the same séance. And if, as is usual, time be allowed for the gradual dilatation of the canal for stricture, as a preliminary to lithotrity, the frequent introduction of instruments for one purpose familiarizes the capricious canal to the introduction of others for a different purpose. Formerly, inability to retain the water *four* hours contraindicated crushing; now, we sometimes lithotritize when the urine cannot be retained as many minutes. Formerly, only small and friable stones were crushed; now, larger and harder calculi are broken with ease and safety. The size of a stone is practically limited by the power of the jaws of the lithotrite to grasp it; and its hardness is limited by the power of the instrument to crush it. Formerly the intolerance of the urethra for instruments stood in the way of the less bloody operation, and I confess to some doubt as to this question. The intolerance exhibited by the urethra is so great in some persons as to make the repeated introduction of an instrument something to be avoided, if possible. The variations in temper of the urethra are very great. Some urethræ seem not to feel the introduction of an instrument or the injection of caustic lotions; others suffer severely from the gentlest manipulation of a well-shaped moderate-sized instrument, or the injection of tepid water. Nor are these disturbances purely subjective, for I have more than once seen formidable urethral fever, with all its accompaniments, set up by the passage of an instrument for the purpose of exploration or catheterization. But now, when one sitting is usually sufficient, even this ill-temper of the urethra, which, as Sir B. Brodie says, "varies as the temper of the mind," is not an obstacle to the performance of lithotrity in cases otherwise suitable for that operation.

The question of cutting or crushing for stone in cases of diseased kidneys is not, methinks, a puzzling one. Many will recollect the odium endeavored to be cast upon a distinguished English surgeon, who crushed, when it was contended he should have cut, a dethroned potentate suffering from stone. The howl was unreasonable, prompted partly by wounded national *amour propre* across the channel and partly by professional jealousy nearer home. As I can conceive no condition of the bladder to contraindicate the operation of crushing as compared with cutting, I can conceive no condition of the kidneys, not even with albuminous urine, which should influence a decision in favor of the latter. Not even a chronic nephritis or chronic pyelitis, which had resulted in more or less degeneration of the kidneys, should lead to the selection of the knife, but rather to its rejection in favor of the lithotrite; for these conditions of the kidney are admittedly "most prejudicial to recovery after lithotomy." It goes without saying that a healthy condition of the kidneys is most desirable; but, taking them as we sometimes find them, and admitting that we cannot improve them, lithotrity, properly performed, will, I think, disturb them less than lithotomy.

Space is not afforded for the discussion, at greater length, of the relative advantages of the two operations.

* This is more frequent than is generally supposed. I knew a distinguished surgeon to whom this accident occurred. A hard stone was partially forced into the female blade; the male blade could not be closed, nor could the calculus be detached. The surgeon, a powerful man, withdrew the open instrument *by force*, and the *coup d'athlète* was soon followed by death.

A few words, therefore, on the operation itself and on the manner of its performance:

PREPARATION.—It is well to have the skin acting properly. A laxative dose of castor-oil should be given the day before, and a copious enema of water on the morning of the operation. This enema should have all passed away before the operation. But beyond this, the less time wasted in the preparation of a patient for an operation intended to relieve him, the better. Liston was of this opinion with reference to lithotomy, and seemed to think emptying the rectum was the only needful preparation. In giving this advice, I well know that eminent surgeons counsel that "the bladder should be brought into as quiet a condition as possible"—that the patient should be kept at rest for several days. But the readiest, the best, the only way of diminishing the irritability of the bladder, is to remove from within it, with as little delay as possible, the cause of that irritability. Rest for a time in the recumbent position is often advisable and generally affords relief, as it permits the stone to drop away from the more sensitive part of the neck of the bladder and its vicinity. Medicated injections to diminish the irritability of the bladder are not to be recommended. It has been suggested that an irritable bladder should be deprived of its irritability by emollient injections; that the urethra should be habituated to the passage of metallic instruments; that the bladder should be partially filled with tepid water, with or without boracic acid, carbolic acid, gum-arabic, or the emollient linseed; and latterly, the injection of a solution of cocaine has been advised, and that the bladder should contain water of two or more hours. These recommendations are, in great measure, erroneous. The readiest way to diminish the irritability of the bladder is to remove the calculus which has given rise to the irritability.

If the urethra can become accustomed to and tolerant of the passage of a bougie, it can become tolerant of the presence of the lithotrite. It is not to be forgotten, however, that the urethra has its periods of tolerance and periods of intolerance; and that it is well to select, if possible, one of its good days—that is, when the patient is in a better than usual condition. I have often noticed with surprise how easily the introduction of an instrument is borne at one time and not at another, and have chronicled in my own practice, and in that of colleagues, cases where the introduction of a sound had been fatal in individuals who had already repeatedly borne the larger operation without inconvenience.

Filling the bladder with tepid water, under the impression that the movements of the lithotrite will be made easier, is a mistake. It is very desirable that the bladder should contain a few ounces of the fluid that is *natural* to it—but the injection of fluid, however bland, is the injection of fluid to which the bladder is not accustomed. The walls of the bladder are not contracted upon its contents, so that the lithotrite can move as readily in an empty bladder as in a full one. Between an empty bladder and a full one, however, there is a condition of partial fulness which is desirable, not for the additional facility it affords, but for the evidence it gives of the bladder's tolerance of its contained fluid. Formerly the quantity contained below which it was inadvisable to operate was between four and six ounces. Within the past few years the six or eight ounces have been reduced to four; and these again to two. For my part I have always taken the bladder as I found it, and proceeded to operate *without* any injection whatever. I was led, many years ago, to adopt this method from observing that an injection of warm water causes more pain, and arouses a patient from an apparently deeper sleep, than does the use of the lithotrite.

If it is unadvisable to operate when the bladder is empty, it is equally unadvisable to operate, as is sometimes done, when the bladder is full. There is a desirable medium: and that is the partially filled bladder—when the patient is not desiring to pass water—and when the bladder has not been recently emptied. When, however, the patient has inadvertantly voided his urine recently, or at the moment of my visit, the operation is never deferred a moment for a refilling.

METHOD OF OPERATING.—My remarks elsewhere on this subject are so recent that I transcribe them *in extenso:* The patient's body should be so elevated that the surgeon's right arm, while operating, may be nearly horizontal. If the patient is in bed the surgeon may be seated at his side; if the patient is on the operating-table the surgeon should stand.

The operator being upon the right side of the patient, who lies upon his back with his head and shoulders elevated and his thighs flexed, the closed lithotrite, well oiled and in the right hand, is slowly introduced within the meatus in the same manner as an ordinary catheter, the penis being supported merely—not seized—by the index and middle fingers of the left hand. It is of small moment on which side the operator chooses to place himself; but it is of importance that, having elected one side, he should keep to it.

At the beginning of my hospital career the right side of the patient seemed to me preferable, and I adopted it; and now, from habit perhaps, consider it the easier and more natural one, and I therefore recommend it. It was the position which I generally saw selected by Civiale and by Sir Philip Crampton. The introduction of the lithotrite is practised by some indifferently, either sitting or standing, and on the right or left side of the patient.

If, with an instrument of such inconsiderable weight as a catheter, it is not allowable to add much additional weight, still less is it allowable with an instrument already many times heavier. The increased weight of the lithotrite is alone more than sufficient, when once it has passed the meatus, to insure its passage along the urethra and into the bladder. The calibre of the canal is nowhere less than at the meatus, and there alone a slight amount of pressure, with a somewhat rotatory movement, may be allowable. The meatus is rarely as wide as the rest of the urethra, even in the healthiest persons, and in those who have never had balanitis. My experience in this respect corresponds with that of Mr. Berkeley Hill, who thinks that the meatus is "normally narrower than the rest of the canal, or that its morbid contraction is exceedingly common." The meatus once passed, no difficulty is generally experienced till the instrument is beneath the pubic symphysis, when its handle must be depressed. This carries it beyond the membranous portion, where delay sometimes occurs, and to the prostatic portion, where difficulty is sometimes experienced, especially in old men, in whom prostatic enlargement is usually accompanied by elongation of the corresponding portion of the urethra, to such a degree as sometimes to lead the inexperienced surgeon to believe that his lithotrite is already in the bladder when its point may be impinging against the superior wall of the urethral canal.

When within the bladder it is advisable to advance the instrument well along the floor of the organ, to make sure of its being completely within the cavity, before commencing the search for the calculus. Not infrequently the instrument, as it advances, strikes against the stone. If not, it is to be again slowly withdrawn to just within the neck when the instrument is made to dip gently from right to left and from left to right of the median line, then from front to back and from back to front. Sometimes the point of the instrument requires to be elevated, sometimes to be dipped backward, but always with the greatest gentleness; and sometimes, also, the difficulties experienced when searching with the sound are again renewed with the lithotrite, difficulties arising in great measure from partial concealment of the stone in a saccular depression behind an enlarged prostate; from the floating about of a small calculus in a capacious bladder; or from diminished space in an irritable one. Sometimes it is considered necessary to turn the patient on either side—and various contrivances have been suggested and used for the purpose, the most complete perhaps being that of Reliquet, which elevates the pelvis at will, or turns it in either direction. But without any special apparatus an air-pillow will be found convenient. I have never had occasion to turn patients upon the side and prefer having them always upon the back. One is less apt to forget the

Lithotrity.

relations of the lithotrite to the body when the patient is in that position.

When the calculus is touched with the still closed lithotrite, it is well to determine on which side it lies, so that the instrument, when opened, may the more readily grasp it. But, though desirable, this is not essential, and the investigation should not be pursued at the expense of any suffering from manipulation that can be avoided. When the stone is again felt, the male blade is gradually withdrawn and again pressed home, while the female blade rests against the back of the bladder, the penis in the meantime being gently held in position. In this way the stone will generally be at once seized within the blade. If not, the instrument is again and again opened and closed, while it is gently turned to the right and left, and backward and forward as before.

These gropings for the stone, its seizure, and its fragmentation, and all the necessary movements of the lithotrite occupy a greater or less time. That period was limited, till lately, to twelve minutes: "After five, eight, ten, or at most twelve minutes it is wise to terminate the séance" was the dictum of Velpeau! All this is changed, and séances of two or three hours' duration are not unusual. But I question the wisdom of too prolonged sittings; they should bear some degree of relationship, but in inverse ratio, to the irritability of the bladder and to the depressed condition of the general health.

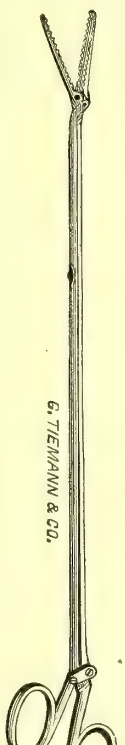


Fig. 2141.—Alligator Forceps, Straight.

After the operation of lithotrity the patient should be placed in bed, covered up warmly, and, if any suffering is experienced, a hot linseed-meal poultice should be applied to the hypogastrium. The two conditions of warmth and moisture are essential. The patient should be advised to put off making water as long as possible. When obliged to urinate he should be on his back, if the fragments are not expected to come away, but when the calculus has been reduced to powder I advise the patient to place himself on his hands and knees before urinating.

Care should be taken that the sediment and débris in the urine are carefully preserved by ordering the patient to make water in a sieve or a muslin cloth. The amount collected in this way should represent, nearly, the estimate made of the stone while yet unbroken within the bladder.

In persons with enlarged prostate, the stone will be situated in the *basfond* behind the gland, and when fragmentation takes place the broken pieces may fall back into the place occupied by their parent. It is not always easy to seize a fragment in this position. The instrument must then pick it up with the point of the beak, as a bird would any object, lift it lightly out of its resting-place, and not crush it till the point has been carried away from the mucous membrane on which the fragment had been lying. I should strongly advise gently rotating the instrument before firmly closing it.

The operation of crushing may be repeated in a few days, but the length of the interval will be regulated by the feelings of the patient. Some persons experience no inconvenience whatever, and are in condition to submit to a repetition of the operation the next day. Others are unfit for it until after the expiration of a week or ten days. Again, I must state that it is the condition of the urethra rather than of the bladder which gives rise to disturbance, and which causes delay. The bladder is much less frequently the seat of inflammatory action than is the urethra. Sometimes, however, and especially if the sitting has been prolonged, pain may be experienced in the hypogastrium. It is well, therefore, as already stated, to make warm, moist applications, and I know nothing more grateful than warm linseed poultices, sprinkled or not with tincture of opium.

But it is not now usual to allow any of the fragments of a calculus to find their way out of the bladder, or to allow any of the pieces to remain after fragmentation. The broken fragments are now usually washed out of the bladder through large-sized cannulæ, and an operation which formerly might have extended over many days, or even many weeks, is now terminated in one or two sittings. These sittings are now prolonged, and Bigelow in America, and Thompson, Cadge, and others in Europe, have extended the sitting much beyond the time formerly considered to be prudent. As one of the great inconveniences of lithotrity was the passage of the more or less angular fragments along the sensitive urethra, the lining of that sensitive tube by a smooth, metallic instrument, which presents no ply, no folding, no obstruction, but rather a help, to the outward passage of the fragments, is a boon impossible to overestimate. The credit of this great modification is due to Bigelow; and the fact that Mercier had previously moved in the same direction takes away nothing from this credit. Fuller details appear later, in the section on Rapid Lithotrity. I shall merely state here that, when the work of crushing is complete, a cannula of the full size of the urethra is introduced into the bladder and through it warm water is injected with a force barely sufficient to dimple the walls of the rubber bag attached to the cannula. The slightest force suffices to agitate the fragments, and when the force is removed, these fall into the large eye of the tube and pass along it to the glass, bulb-shaped bottle, resting on a level with the patient's body. I cannot help contrasting the present rapid method of operating—and which I have practised for many years at the Hôtel Dieu Hospital—with the very slow method followed by Civiale thirty-three years ago, when I had the advantage of his admirable instruction.

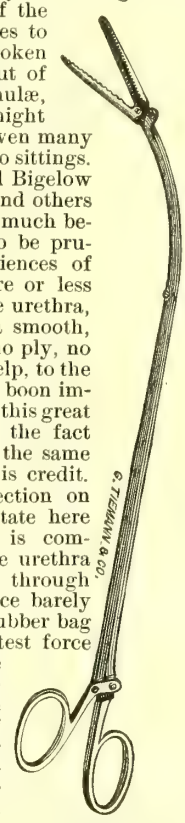


Fig. 2142.—Alligator Forceps, Curved.

The COMPLICATIONS of lithotrity have already been dealt with. But there is one which frequently gave trouble formerly, but which is now of rare occurrence—impaction of a fragment of the calculus in the urethra. Although, as I observed, this is infrequent, it is well to be prepared to deal with it should it occur. There are two ways: Introducing forceps, more or less ingeniously contrived, seizing the fragment in the canal, and, with more or less laceration, removing it. This is the plan advocated by many. The other consists in doing nothing but giving the patient demulcent drinks freely. When a calculus or fragment of calculus starts upon its journey, the urethra, which permits its admission, will permit its passage along the canal till the meatus is reached. *That* is the narrowest part, and it is there that difficulty is usually experienced. I have known calculi to give no trouble worth noticing at the membranous portion of the urethra, but much at the meatus. The alligator forceps (Figs. 2141 and 2142) and the variously shaped urethral forceps which instrument makers have devised, are difficult of introduction, still more difficult of application, and require greater space than the fragment, inasmuch as

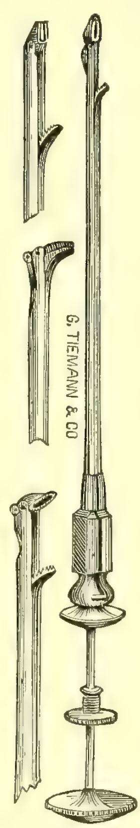


Fig. 2143.—Leroy d'Etiolles's Urethral Scoop.

they are intended to surround it. After one or two trials of the alligators I put them aside, trusting to the gradual advancement of the calculus unaided ; and on one or two occasions only was it necessary to divide the meatus. But that was when the operation of lithotrity was performed with large fenestrated instruments ; and not, as now, when the teeth in the male and female jaws are so arranged, that no fragments can pass through the fenestra of the latter which could give uneasiness from their size. Leroy d'Etiolles's scoop (Fig. 2143) is an articulated instrument which has been used to remove fragments from the canal when not situated too far back.

But should, as might happen, a fragment or an unbroken small stone find its way into the canal, and give rise to suffering and obstruction. Mathieu's urethral lithotrite (Fig. 2129) may be used. The instrument is ingenious. The

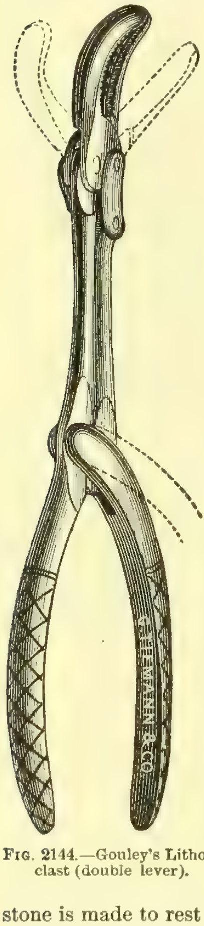


Fig. 2144.—Gouley's Lithoclast (double lever).

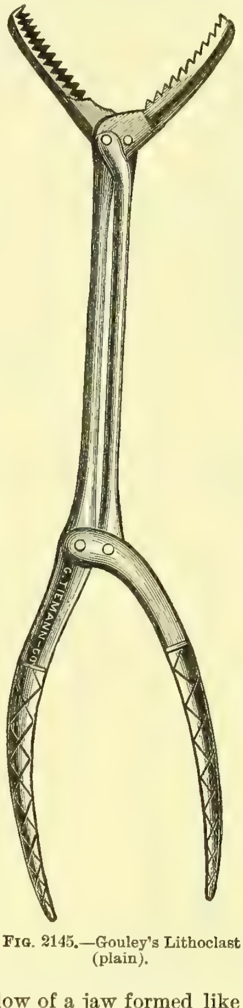


Fig. 2145.—Gouley's Lithoclast (plain).

stone is made to rest in the hollow of a jaw formed like a shepherd's crook ; this is double-bladed, and while one-half remains stationary, the other half passes around the calculus. Having it securely in the jaws of the instrument, a male blade advances and perforates the calculus. It is very evident that the passage of one blade of an instrument around a stone lodged in the urethra must be a work of great delicacy and even of difficulty. Happily it is not often necessary.

Search for Fragments.—It is not always easy to induce a patient, when his symptoms have disappeared and his sufferings are at an end, to submit to a search for fragments which may yet remain. Walking, running, rough riding, etc., have been recommended to develop some evidence of a fragment being still within the bladder. The patient's feelings, if honestly expressed, are a fair criterion ; and a recommendation of an early return in the event of trouble is considered advisable, but careful and repeated examinations are alone sufficient. But washing out the bladder, by means of a suitable apparatus, is the surest means of getting rid of the fragments, for if large stones sometimes escape detection with the searcher, small fragments are much more liable to remain hidden.

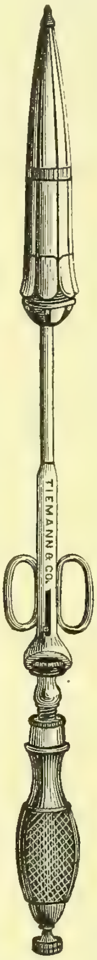


Fig. 2146.—Dolbeau's Dilator.

Perineal Lithotrity will receive but a word in passing. This operation was, at one time, recommended in conjunction with lithotomy, and various procedures were advocated, their chief feature being to enter the bladder upon a grooved staff, as for lithotomy, to seize the stone and to reduce it to smaller proportions, before extraction. As a stone can be as readily lithotritized through the natural channel as through a wound in the perineum, the operation by an artificial opening appears to be an unnecessary complication ; and as there is a renewed tendency to resort to suprapubic lithotomy for large calculi, perineal lithotrity would seem to be less called for, and small calculi can be got rid of more easily and more safely by the methods already described. But in exceptional circumstances, with an irritable urethra, or with the urethra diminished in calibre thoughout much of its extent, the perineal operation may be resorted to. Should the operation be decided upon, Gouley's lithoclasts (Figs. 2144 and 2145), although there is evident loss of power in their construction, will be found of service for crushing full-sized stones ; and the instruments already delineated will suffice for their further reduction.

Should the means of egress be insufficient, the timid and the inexperienced may use instruments for dilating, such as those here illustrated (Figs. 2146 and 2147). But I have again to state my belief that it is only under exceptional circumstances, that the use of these and the preceding instruments can be called for. It is well to have them, however, as adjuncts to the armamentarium.

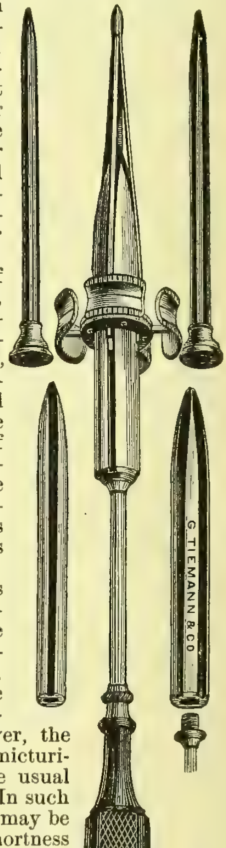


Fig. 2147.—Guyon Duplay's Dilator.

Lithotrity in the Female is not often called for, as the anatomy of the urinary organs in the female favors the escape of calculi through the short, straight, and capacious urethra, before they have time to grow to considerable size. Sometimes, however, the calculus fails to escape during micturition, and the patient has all the usual signs of stone in the bladder. In such cases a calculus, however large, may be disposed of by crushing. The shortness of the canal and its susceptibility of dilatation so favor the extraction of calculi, that extraction by cutting through the neck of the bladder, or through the vaginal septum, must be rare. The suprapubic method, now—and not for the first time—attracting considerable notice, will not often be called for in females.

Lithotrity in Children is as the operation in adults.

But the field is steadily extending, and it is not unlikely that soon even the youngest children may be subjected to the operation of the lithotrite with less risk than from the knife. I have operated in this way on children under five years of age without difficulty, and I cannot but compare the operation most favorably with suprapubic lithotomy, such as I saw it performed by a distinguished surgeon in England in August last. The exceptionally favorable results of lithotomy in children have led to an adherence to that operation, even in cases where the calibre of the urethral canal would have permitted the introduction and easy manipulation of a lithotrite. But in the operation upon children there are accidents peculiar to them, from which the adult is free—chief of which is pushing the left index-finger too deeply into the perineum, and pushing the prostate and neck of the bladder before it. That accident has happened to most surgeons. It occurred to me once, and again a second time, with all the disagreeable experience acquired in the first case.

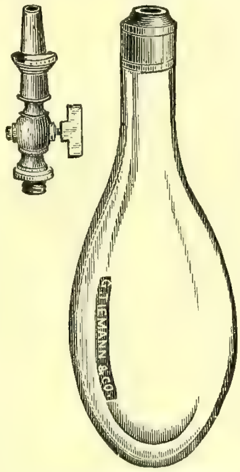


Fig. 2148.—Sir Philip Crampton's Evacuator.

To resume: Lithotrity in men, women, and children, as compared with its present capabilities, was formerly, as Sir Henry Thompson observes, an imperfect proceeding; yet now it is, by almost universal consent, the best operation for nine out of ten stone cases, at least in the adult.

Rapid Lithotrity.*—Few were the advances made in lithotrity from the time Civiale made it a regularly recognized operation for calculi under a certain size, and under a certain degree of hardness. The sittings were as short as it was possible to make them. Three or four minutes were considered by many to be the utmost limit of their duration—while some were so bold as to advocate sittings of ten and even twelve minutes; and I am not acquainted with the writings of any surgeon who advocated more prolonged séances. Velpeau's directions were probably expressive of surgical opinion at the time: "Après cinq, huit, dix, ou tout au plus douze minutes, il convient de terminer la séance." Such were the views entertained by the most expert lithotritists, and such were the views taught me by Civiale himself, thirty-four years ago. Since then there has been a complete revolution in the mode of operating, in the length of time occupied, and in the mode of removing the fragments. With the latter alone I have now to do. The credit of effecting this important change is due in part to Ireland, and in part to America. To Ireland, in the person of Sir Philip Crampton, of Dublin, who, in 1846, devised an instrument for washing out the fragments; and to America, in the person of Professor Bigelow, of Boston, who has brought the mode of removing them from the bladder, after crushing, to a perfection which may be said to be complete.

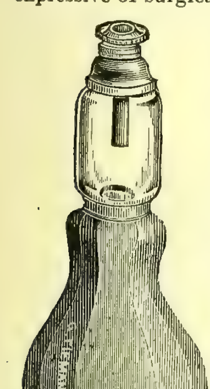


Fig. 2149.—Mr. Clover's First Evacuator.

Sir Philip Crampton's apparatus consisted simply of a glass receiver, in shape and size much like a soda-water bottle, from which the air was removed by means of an exhausting syringe, when a stop-cock prevented its readmission (Fig. 2148). A large silver evacuating catheter was introduced into the bladder. A quantity of warm water was injected—ten or twelve ounces if possible;—the receiver was applied to the end of the catheter and the stop-cock opened. Water and fragments of calculi escaped through the catheter. Cases are reported where the débris was brought away in this manner. One in particular — that of Mr. Roop, upon whom Heurteloup had already operated, but unsatisfactorily. Sir Henry Thompson disposes of the instrument thus: "It was found to be dangerously rough in its action, and required to be so repeatedly charged that I desisted from its use." In the winter of 1852–53, when I attended the Meath Hospital, Sir Philip gave many demonstrations of lithotrity; but I cannot recall an instance wherein the washing-out process was alluded to. I gather from his silence that he was not enamored of the operation.

At about the same time many European surgeons suggested modifications of the washing-out bottle—markedly Heurteloup and Leroy d'Etiolles in France, and Clover and Coxeter in Great Britain. Clover, by substituting a rubber bottle for a glass receiver, obtained a force equal, at least, to the expulsive force of the bladder. By compression of the sides of the rubber bottle its contained water was forced into the bladder, and on withdrawal of the pressure, water and débris found their way into the receiver. At first the instrument, which permitted a passage of the débris from the bladder, permitted a return to the bladder on the renewal of a compression of its sides. To meet this difficulty a chamber was added, and into this the fragments of a calculus would fall, out of the way of the returning current (Fig. 2150). A great improvement was made on this instrument by Mercier, of Paris. Mercier's instrument was oval-shaped, and a glass receiver at the end opposite to the stop-cock permitted the fragments to be seen as they dropped within it. This is always an interesting operation, and the transparent receiver ministers to pardonable curiosity; it also aids in directing the current entering the bladder. Mercier's instrument (Fig. 2151) was not unlike that afterward fashioned by Bigelow, and was worked in the same manner as Clover's, by alternate compression and relaxation of its sides. The French made another modification—I can hardly call it an improvement. They fastened the screw-pump portion of an enema-syringe to the catheter, and by a turn of the handle forced the water along it (Fig. 2152). This instrument bore Nélaton's name. But if the rack-and-pinion mechanism of a lithotrite was objectionable, a mechanism not unlike it, and worked in the same way, when attached to a catheter was still more objectionable. It contained less water, and was worked with less ease than Clover's, and required to

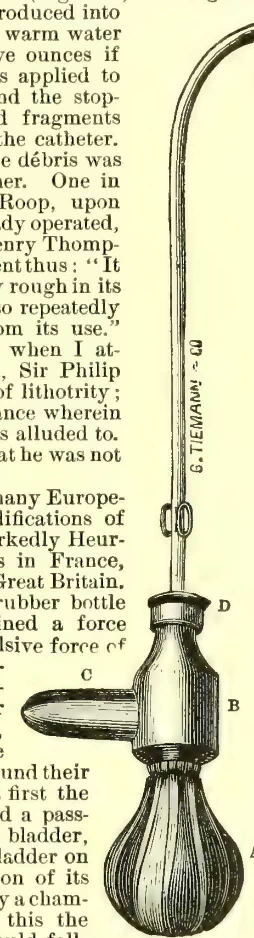


Fig. 2150.—Clover's Improved Evacuator. A, india-rubber air-chamber; B, glass receiver; C, tube projecting into receiver; D, junction between evacuating catheter and suction apparatus. Size of evacuating catheter 12—English—equal to 21 mm. in circumference.

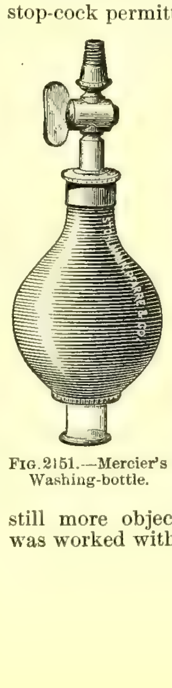


Fig. 2151.—Mercier's Washing-bottle.

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* Under the heading Litholapaxy (page 511 of this volume) the operation of "Rapid Lithotrity with Evacuation" has been also treated by Dr. Cabot, who has been associated with Professor Bigelow in genito-urinary surgery, and has, therefore, had unusual opportunities for obtaining an accurate understanding of this procedure.—Editor.

be removed and refilled more frequently. It never took the place of the instruments which it was intended to supersede, and was quickly put aside for the more perfect instruments which followed.

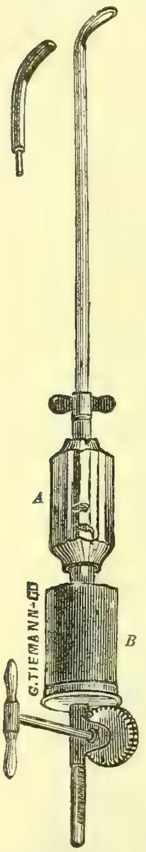

FIG. 2152. — The French Evacuator. *A*, the air-chamber; *B*, the piston worked by rack and pinion.

But there continued during all this time, in the mind of the profession, an erroneous notion as to the calibre of the male urethra, and its tolerance of metallic instruments. And here again, American surgery, in the persons of Otis and Bigelow, effected a revolution in the views till recently very generally entertained regarding the urethra. Only ten years have elapsed since the profession began to learn, from the repeated observations of these two authorities, that the normal healthy male urethra is much more capacious than was taught in books, and that the, till then, generally supposed maximum dimensions—number twelve catheter—is altogether below the normal standard. Otis, in 1876 (and I believe he was the first), dilated the female urethra up to 45, and a year later, continued his manipulations on the male bladder for an hour and a quarter without evil consequences. Bigelow, in writing on this subject, says: "Had Clover, whose catheter had a calibre of only 21 of the French standard (about 12 English), or Mercier, employed larger catheters (between 25 and 31 French = 15 to 20 English), they might have evacuated the bladder completely. They would have found how little affected it was by a long operation, if no fragments were left behind, and that polished instruments were not injurious, while sharp fragments were. They would have discovered a tolerance on the part of the bladder wholly at variance with the traditions of half a century. Upon this tolerance" (and I may add this knowledge of greater calibre of the urethra) "modern lithotrity is based."

The normal calibre of the urethra may or may not bear the definite and direct relation to the circumference of the flaccid penis which Otis claims. My own experience is that the exceptions to the rule are numerous, and being numerous they detract from the practical value of the rule, but there is no denying a frequent relation, such as Otis placed before the profession in 1875, and to which, with nearly a dozen years' additional observation, he still adheres. He states it thus:

Circumference midway of the Penis.	Calibre of the Urethra.
3 inches, or 75 mm	30 mm., or more.
3¼ " " 81 mm	32 mm., "
3½ " " 87 mm	34 mm., "
3¾ " " 93 mm	36 mm., "
4 " " 100 mm	38 mm., "
4¼ to 4½ " 105 to 112 mm	40 mm., "

Otis states in addition that, while he has seen "many cases where the urethra was larger than that claimed in the foregoing table," he has "never seen a case where it was less." He makes another statement equally specific and important, that he has "never yet met with a normal adult urethra of less than 28 mm. in circumference." He claims that when a less circumference is met with—say 26 or 27 mm.—"stricture is present, either at the meatus or at some deeper point," and recommends "restoration of the canal by removal of the contractions by dilatation or by division, before operating, rather than to use an evacuating tube of a smaller size." With the practical advice contained in the last two lines of the above I quite agree, but my experience is that contractions at the meatus—which are apparently congenital—are met with so frequently in persons who have in no way been exposed to the exciting cause of stricture, as to have induced me to place them among the normal.

I have found the necessity of division of the meatus to be not infrequent as a preliminary to lithotrity in the healthiest subjects, and in those who had always been healthy. I shall here state that any division of the meatus, or dilatation, or division of any part of the urethral canal preparatory to lithotrity, should not, as a general rule, be performed at the same séance as the operation for crushing.

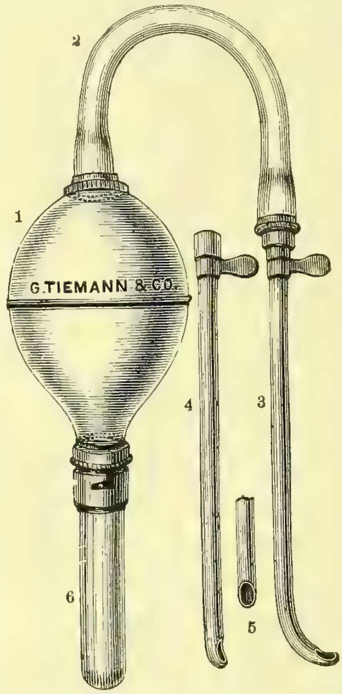

FIG. 2153.—Bigelow's Evacuator.

A longer consideration of this question would be foreign to the subject of this paper. It is sufficient to state that the operation of lithotrity, as now generally practised, depends on the knowledge that the calibre of the male urethra is much greater than it was believed to be by surgeons, when Clover, Crampton, and Mercier introduced their evacuating apparatuses; and for that knowledge we are indebted to the two distinguished American surgeons already named—to Otis, of New York, for having taught that the urethra admits "a much larger tube than that commonly attached to either Clover's or the French apparatus," and to Bigelow, of Boston, for having utilized that knowledge so promptly in the construction of apparatus of the most ingenious character.

Professor Bigelow's earlier apparatus differed from those already figured here only in the size of the evacuating tube. That here represented (Fig. 2153) is a large, strong india-rubber bulb like that of Mercier, with a glass receiver for the débris. From the other end projects a long tube with terminal screw to attach it to an evacuating tube, either straight or curved, a front view of which is shown. The adjoining figure (Fig. 2154) is the stand.

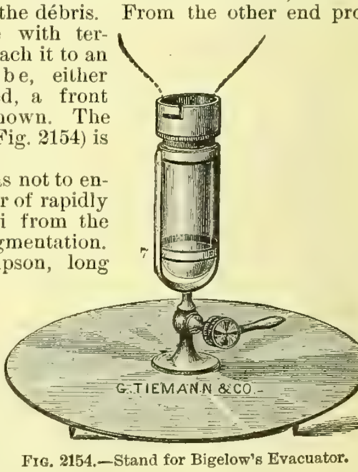

FIG. 2154.—Stand for Bigelow's Evacuator.

But America was not to enjoy alone the honor of rapidly evacuating calculi from the bladder after fragmentation. Sir Henry Thompson, long *facile princeps* in this department of surgery, "was quick to recognize the great improvement of Bigelow's method over those previously followed." His original instrument (Fig. 2155), here depicted, has, he claims, the advantage over Bigelow's original instrument that "the change in the position of the lower tap shortens the distance for the fragments to traverse, which thus reach the receiver by the shortest possible route. The current having less distance to travel, has thus more powerful action on the

fragments, and consequently the aspiration is more perfectly made than it has hitherto been. The fragments enter, fall downward through the tube, and *cannot mount again into the apparatus*, in consequence of the projection of the tube into the glass receiver." Of the advantages claimed by Sir Henry Thompson for his original instrument, that placed in italics in the text appears to me the most important, and from that time forth was an admitted principle in fashioning subsequent evacuators. Sir Henry allowed surgeons to choose, if they wished, a flexible tube between the aspirator and the evacuating tube, and later instruments are so provided, with, I think, great advantage. But for himself Sir Henry wrote: "I prefer the absolutely direct and shortest route, having no more fear of hurting the bladder with the inflexible evacuating catheter than I have with the inflexible lithotrite." I shall merely remind my distinguished friend that while an inflexible lithotrite is a necessity,

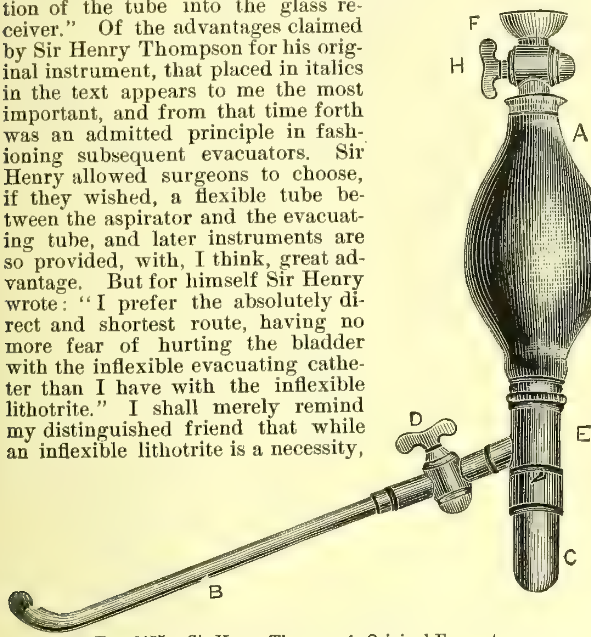

Fig. 2155.—Sir Henry Thompson's Original Evacuator.

an inflexible evacuating catheter may be dispensed with, and perhaps with advantage.

Great activity now prevailed in the workshop, and Professor Bigelow evolved an improved evacuator. The mechanism of this instrument will be readily understood from the annexed figure (Fig. 2156). This is the instrument I have now used for several years, to the exclusion of all others. Its stop-cocks at *DD*, one attached to the evacuator and the other to the evacuating catheter, *C*, permit an easy application of the former to the latter without loss of time or of fluid, and effectually prevent the admission of air to the evac-

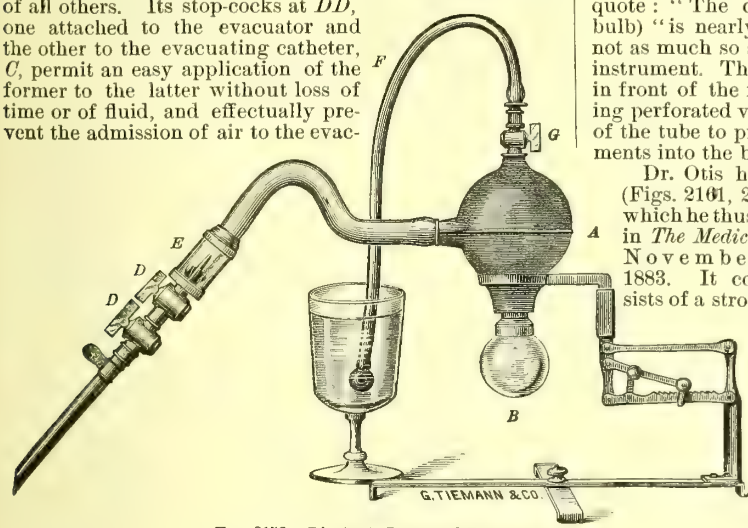

Fig. 2156.—Bigelow's Improved Evacuator.

uating tube. The tube *F*, with its stop-cock *G*, I have not thought of much value. Indeed, after the instrument is filled I usually shut off the current at *G*, and retain the stop-cock closed till the end of the sitting. Perfect as is this instrument, it has been still further modified (Fig. 2157), the strainer being transferred to the body of the bulb, and the ball-valve being dispensed with.

Again a swing of the pendulum—but now within a smaller arc—brings us a further modified Thompson—his latest evacuator (Fig. 2158), intended "to secure the shortest possible route for the passage of débris from the bladder to the receiver." Sir Henry claims that the cylindrical receiver, which, in his former instrument, was directly under the bottle, and might be influenced by currents, "is removed to the front of it, and is perhaps less disturbed by the current which passes over the mouth of the receiver." In neither "is any

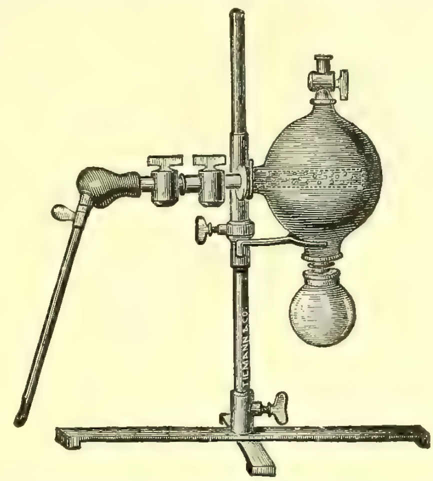

Fig. 2157.—Bigelow's further Improved Evacuator.

stand required, and the connection with the bladder is the shortest and simplest possible."

Professor Bigelow's recent improvement (Fig. 2159), the last so far as I can learn, is shown on page 534, somewhat modified in shape, and without the feeding tube. I have not used it, nor have I felt disposed to relinquish that shown in Fig. 2156, with which I am entirely satisfied.

Still another modification by Sir Henry Thompson—his fourth, and, so far, his last (Fig. 2160). One advantage in its design is, as stated by Keyes, from whom I quote: "The central axis of suction" (of the rubber bulb) "is nearly in the line of the evacuating tube, but not as much so as in the case of Bigelow's instrument. The glass reservoir is situated in front of the rubber bulb, and a swinging perforated valve hangs over the orifice of the tube to prevent the return of fragments into the bladder."

Dr. Otis has devised an instrument (Figs. 2161, 2162, 2163) which he thus describes in *The Medical Record*, November, 1883. It consists of a strong

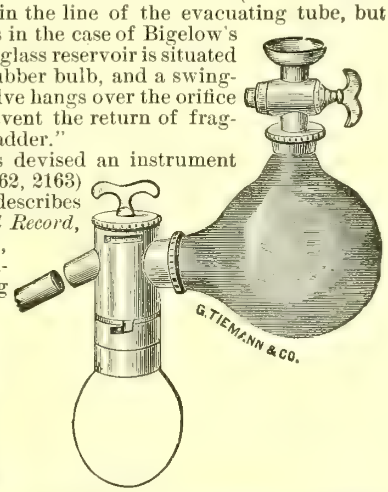

Fig. 2158.—Sir Henry Thompson's Modified Evacuator.

annealed glass bulb, *A*, two inches in diameter, the reservoir, into one side of which, a metal tube, *B*, forty millimetres in circumference, curving down to its lowest part, is inserted. This is connected to the evacuating catheter, *C*, by the india-rubber tube. Attached to the floor of the reservoir by a bayonet-joint, *E*, is a short, strong glass bottle, *F*, the receiver. On the side of the bulb, opposite the tube, connecting with the evacuating catheter, is another metal tube (at *G*) curving upward to near the top

of the bulb *A*. This is connected by another flexible tube, *H*, with a strong india-rubber bulb, *I*, constituting

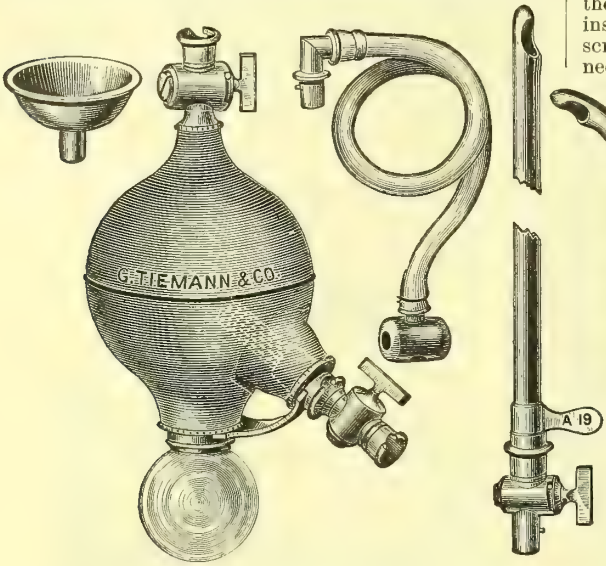

FIG. 2159.—Bigelow's latest Improved Evacuator.

an independent air-chamber. A stop-cock at the extremity of the flexible tube permits the removal of the catheter without leakage from the reservoir *A*. The capacity of the reservoir *A* is just three fluid-ounces; that of the receiver *F*, one and one-half ounce. To put the instrument in operation, it is necessary, first, to shut the stop-cock, then disconnecting the receiver *F* from the reservoir *A*, and reversing the latter, so that its opening looks directly upward, with a small pitcher or cup fill it with water to the brim.

Then, with the reservoir still in the same position, attach the receiver *F* (see Fig. 2162), return the instrument to its upright position, and it is ready to be attached to the evacuating catheter, previously introduced into the bladder. Or, the instrument in the position shown, may be emptied of the contained air by firm compression of the bulb *I*, the evacuating catheter attached and placed in a vessel containing sufficient water, when, by removing the pressure, the instrument fills instantly and is then ready for use. Should it become desirable, during the operation of removing

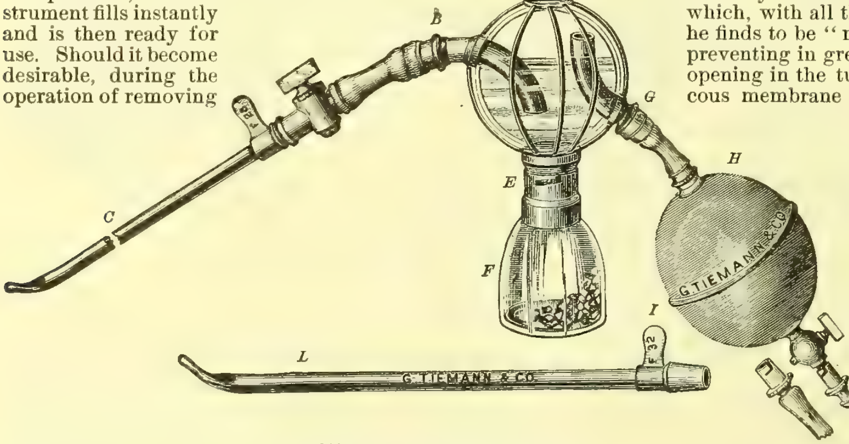

FIG. 2161.—Otis's Simplified Evacuator.

the débris, to introduce more water into the bladder, this may be readily done in the following manner:

Reversing the instrument, as shown in Fig. 2162, by unscrewing the tube connection at *B* half a turn, leaving the evacuating-tube undisturbed, any desired amount of water poured into the reservoir finds its way readily through the evacuating-tube into the bladder. In working the instrument the independent air-chamber, *I*, may be unscrewed at *G*, and filled completely with water, and the necessary vacuum produced by displacement of the water instead of air, as previously shown.

It is not necessary to devote more space to the description of instruments which have been more or less in favor with lithotritists in Great Britain, France, Germany, and Italy. Different operators have suggested different modifications, and enterprising surgical instrument-makers have moulded them into form. One, that of Guyon (Fig. 2164), is so simple in construction as to deserve notice. It is not unlike Sir Henry Thompson's, and is worked in the same way; the angle, however, of the evacuating-tube attached to the bulb is more acute—a less acute angle would, I think, be preferable.

EVACUATING TUBES.—A few words as to the tubes to be used. These are either straight or curved. The former, when they can be easily introduced, are preferred by many. For my own part I think a slight curve not in any way objectionable, and I am indifferent as to which I use. The calculus, it is said, finds its way through the straight tube more readily; but of this I am not convinced. Yet where it can be done easily, the straight, to which no one objects, may be

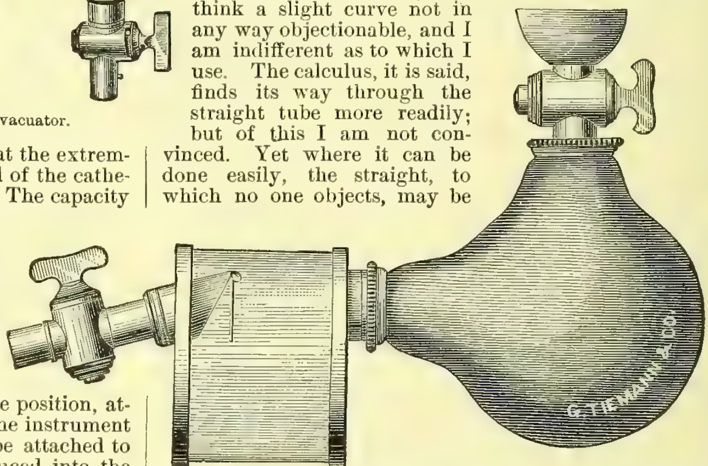

FIG. 2160.—Sir Henry Thompson's Latest Improved Evacuator.

used in preference to the curved, to which some do object. Dr. Otis has endeavored to overcome the difficulty of introducing Professor Bigelow's straight instrument by "adding a small curved projection which, with all the advantages of the former," he finds to be "more easy of introduction, and preventing in greater degree the closure of the opening in the tube from engagement of mucous membrane in it during the process of evacuation.

Professor Bigelow's tubes have been already illustrated with his evacuators. They are given in fuller size on pp. 512 and 513 (Figs. 2099 and 2100). These, with unimportant modifications, are the models upon which all other tubes are fashioned—the essential features of all evacuating-tubes being: full-size and capacious eyelet.

Dr. Keyes, of New York, has fashioned an almost straight tube of thin metal, open at both ends (Fig. 2165), which, he claims, is made easy of introduction by a wooden obturator, and "a washer on the obturator allows the latter to be withdrawn without leakage beyond the stop-cock, which, being turned, keeps the bed dry until the washing-bottle has

Lithotrity.

been fitted to the tube. To obviate any difficulty claimed to arise from the curved shape of the cannula, Dr. Keyes has constructed a curved evacuating-tube (Fig. 2166),

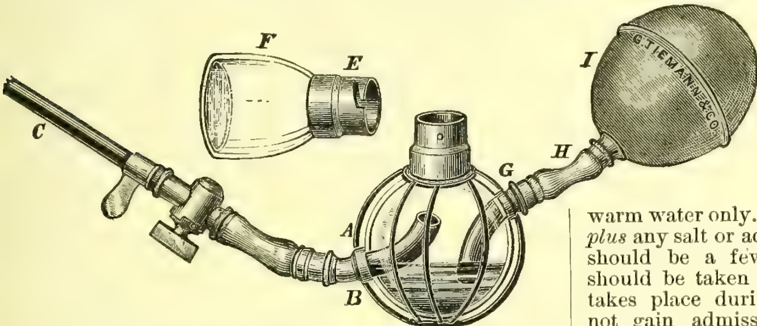

FIG. 2162.—Dr. Otis's Evacuator Receiver, detached.

"curved as far as the introduction goes, but straight for all purposes of delivery." Although I have not used Dr. Keyes's evacuating-tubes, it occurs to me that the eye on the straight part is a decided advantage, and brings the fragments at once nearer the receptacle.

The size of the evacuating-tube is now, with all instruments, much larger than was at one time considered advisable or even possible. And here, again, the knowledge acquired, chiefly through recent observations, of the greater calibre of the male urethra, has totally changed the views of lithrotritists. What should be, then, the size of the evacuating tube in any given case? If Otis's rule, already noticed, be approximately correct, little difficulty would be experienced in selecting the proper size in any given case. But as a difference of one or two millimetres would be of moment—a small size being inefficient, and a large one not easily worked—I am accustomed to try at first, in the adult, a thirty millimetre. If it enters easily I continue its introduction. If not, I withdraw it and use one of lesser size. *Cæteris paribus*, the larger the tube within certain limits, the better; the shorter is the séance, and the less is the danger of clogging. But the evacuating tube should never fit the urethral canal too tightly; and the desire to use a large tube should not lead one to forcibly dilate, or run the risk of tearing the urethra. The evacuating-tube should enter without any difficulty, save that which is connected with the curve of the canal, and should fit the urethra comfortably. I have not infrequently incised the meatus and passed the instrument to the bladder without difficulty, but anything like a feeling of grasping of the instrument, when passing through the urethra, should not be experienced by the operator. Bigelow and Thompson are not quite agreed on this question. The former uses the largest which will pass; the latter is usually content with twenty-seven millimetres as a maximum. There is no arbitrary rule in these cases, but a surgeon should not experience more than a moderate—a very moderate—degree of resistance in passing the tube along the urethral canal.

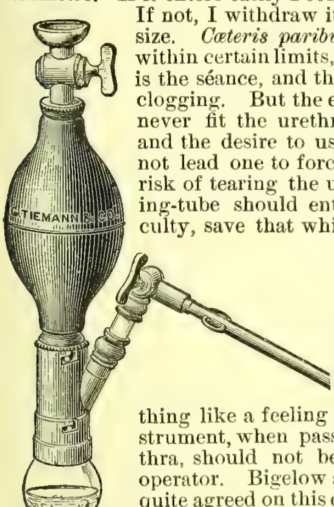

FIG. 2164.—Guyon's Evacuator.

MODE OF EMPLOYMENT.—A description of the instruments is almost sufficient to indicate the mode of their employment. Yet a few words may be said: When fragmentation is complete, oil the evacuating catheter and introduce it carefully within the bladder. The urine already in the bladder is allowed to remain—not drawn off as recommended by some. The evacuator is now attached, and warm water being in readiness, a few ounces are gently sent into the bladder. The warm water is variously medicated by various operators. I use warm water only. It is less stimulating than warm water *plus* any salt or acid which can be suggested. The water should be a few degrees above blood-heat, and care should be taken to raise its temperature when cooling takes place during a prolonged séance. Air should not gain admission, but when present is easily got rid of with a little care, yet have I known air churned up with the water in the bladder. When the apparatus is *in situ*, there commences the most important part of the operation. It is necessary that sufficient water should reach the bladder to bring back with it, in its return, the débris of the calculus. It is necessary there-

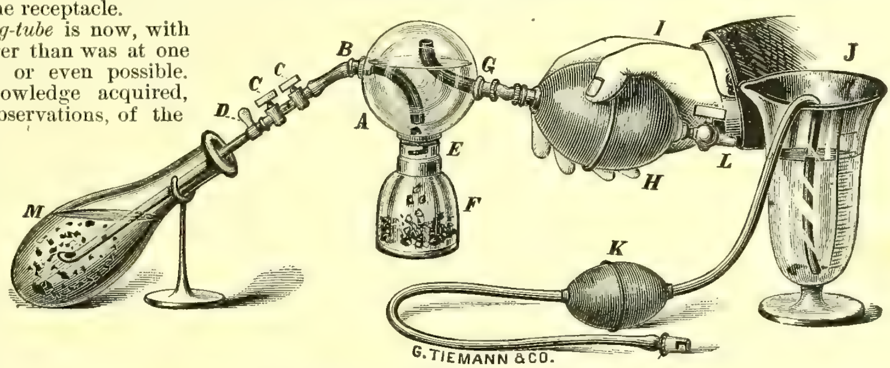

FIG. 2163.—Dr. Otis's Evacuator, in operation.

fore that the water should reach the bladder in sufficient quantity and with sufficient rapidity. But the facility with which the particles of water move upon each other must be borne in mind. Nor must it be forgotten, as I have said elsewhere, that at the end of the unyielding tube, attached to the evacuator, is the bladder, more or less diseased—and perhaps with ureters unhealthy, and kidneys more or less changed in structure. The bladder may not alone feel the backward pressure, and through the constricted orifices of the ureter, the pelvis of the kidney and even its tubuli uriniferi at the cortical walls, may be seriously injured by a strong man pressing forcibly upon the rubber bottle. There is nothing to overcome. The slightest dimpling of the bulb will put the fragments—which are near the urine in specific gravity—in agitation; and on withdrawal of that gentle pressure, *not* of the hand, but of the fingers, they fall within the evacuating tube. From the beginning to the end of the operation, the bulb should never be compressed with any degree of violence. Although a disciple of Bigelow's, from the time of the introduction of his method to the profession; and practising the same on a somewhat extended scale, I was not aware, till he kindly favored me with an exhibition in his laboratory a few years ago, what a slight degree of pressure sufficed to put the fragments and particles in motion.

The curved tube should be held more vertically, but the straight one should be more depressed, care being taken in both instances that the eye of the tube shall be completely within the bladder. Some keep the eye of the tube upward; others recommend it to be turned downward. It is of small moment which method is followed. I usually rotate the straight tube; but the curved one I prefer to leave with the convexity of the curve resting against the lower wall of the bladder.

Sometimes fragments will oscillate with each movement of the compressor, now toward the bladder, now toward the receiver. When this occurs, and it is not difficult to recognize, the tube should be uncoupled and withdrawn, when it will generally be found to contain some flattish fragments of stone.

Fig. 2165.—Keyes's Evacuating Tube (straight).

Sometimes impaction takes place in the eye of the catheter. This should not occur, and is an evidence of imperfect performance of work. The fragments should be so thoroughly reduced by the lithotrite *before* commencing the washing-out process, as to obviate all risk of impaction.

How long should the washing-out process be continued? In general terms it may be stated: So long as there are fragments in the bladder. The general condition of the patient, however, the irritability of the bladder, and the intolerance of the urethra may modify this. But as the condition of the patient is quickly improved by the removal of the fragments of a calculus, and as the irritability of the bladder commonly disappears, the occasional intolerance of the urethra should not be permitted to interfere too much with this desired result. The amount of débris reduced by the lithotrite does not always bear a direct ratio to the duration of the operation of reduction. Neither does the amount washed away in a given time always bear a direct relation to the amount of débris in the bladder. I have sometimes been pleased at getting away in a few moments, and sometimes with half a dozen dimplings of the walls of the receiver, several hundred grains, all that the bladder contained. On other occasions sittings have been prolonged, and I had not the certainty of having accomplished my wok. I am averse to a too prolonged sitting. Although Bigelow has continued his manipulations for more than three hours and his patient did well, so long a séance would, I am convinced, be injudicious in the majority of cases. An hour to an hour and a half is the utmost limit to which I have permitted myself to go; and if not successful in effecting, within that period, the removal of all the fragments, I prefer a second séance after a short interval.

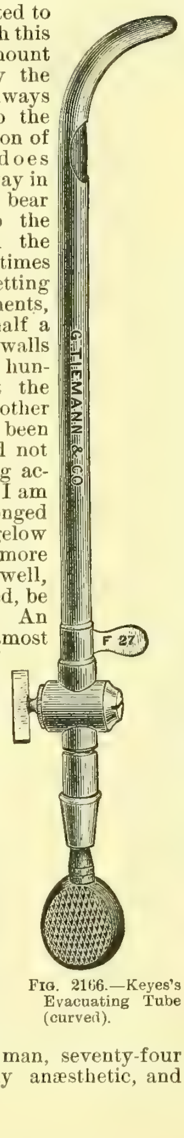

Fig. 2166.—Keyes's Evacuating Tube (curved).

How vastly different is the practice now and formerly. Civiale's efforts were directed to detain fragments within the bladder till their angles should be rounded off; and Heurteloup counselled the recumbent posture for the same reason. Acting on these views, one of my earliest lithotritics, many years ago, occupied fourteen séances of eight or ten minutes each, and at intervals of several days. My last—performed while this paper is being written—occupied less than twenty minutes, and was completed at one sitting. The patient—an old man, seventy-four years of age—declined to take any anæsthetic, and declared that he had suffered but little. After the fragments have been removed the patient should remain quiet in bed. This is a matter of moment. I have more than once seen the disadvantage of neglecting this precaution. Should pain follow the operation, a warm linseed-meal poultice will commonly give comfort. Drinks of a demulcent character should be taken; and if pain still continues an anodyne, either hypodermatically or by the mouth or rectum, may be administered.

The improvement which usually follows quickly on the removal of the fragments of a stone is very marked. But it is well not to give a too decided assurance of a complete removal of the fragments because of a subsidence of symptoms, or even of a failure to detect fragments. The disturbance of a calculus and its fragmentation may alone afford the patient such complete relief as to induce him to believe that all the fragments have been washed away. But after a few days, or perhaps weeks, the symptoms of stone may have again returned, and the work of fragmentation has to be resumed. Persons, under these circumstances, are apt to imagine that the stone has re-formed. This may be so, especially with phosphatic calculi, where the disposition to formation remains; but with uric-acid and oxalate calculi it is more probable that, should evidence of stone occur within a few weeks after fragmentation and washing out have been performed, fragments which escaped the returning stream and which had remained behind are now giving trouble. As this is not infrequently contingent upon an operation, it is well not to give a too strong assurance of freedom from fragments till after a short interval, and only then after a careful examination.

Hitherto the male bladder has alone received attention. A few words as to women and children.

Rapid Lithotrity in Women.—The anatomy of the female urinary apparatus favors the early escape of calculi when yet small. Lithotrity, therefore, as already said, is not so common in the female as in the male. But, when a calculus remains in the bladder and grows there, the procedure to be followed is much the same as in the male. The shortness of the female urethra permits the use of the straight tube, and its greater calibre permits the use of the largest evacuating tube, while the chances of fragments remaining, or re-forming, are less than in the male.

Rapid Lithotrity in Children is applicable to those cases in which the urethral canal, having permitted the easy introduction of the lithotrite in the first instance, allows the use of the evacuating-tube in the second. Those cases, however, are exceptional. Although I have occasionally lithotritized children under five years of age, I am prepared to hazard the statement that, whatever may be the difficulties sometimes, and only sometimes, attending the operation of lithotomy in children, the cutting operation must still continue to be, for them, the best surgical procedure in the greatest number of cases.

Wm. H. Hingston.

LITTLE ROCK. The city of Little Rock, Ark., stands upon a rocky cliff about fifty feet high, on the right bank of the Arkansas River, at a distance of about two hundred and fifty miles from its mouth or point of junction with the Mississippi. The population of the town in 1880 was 13,138. Fifty miles due southwest of Little Rock lie the famous Arkansas Hot Springs, a description of which will be found elsewhere. The sheltered position of the Hot Springs in a narrow valley, and the presence in such a valley of no less than seventy hot springs, combine to cause special modifications of climate at that point; but in the absence of full meteorological data from Hot Springs this chart of Little Rock, obtained from the Chief Signal Office in Washington, may be useful as indicating the normal climate of the region when not modified by such local influences as have just been indicated, and it is, therefore, here introduced for convenience of reference. The reader's attention is particularly called to the remarkable freedom from wind characterizing the climate of this region, as shown by the low figures standing in column 8.

H. R.

Climate of Little Rock, Ark.—Latitude 34° 45′, *Longitude* 92° 6′.—*Period of Observations, July* 1, 1879, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 275 *feet.*

	A			AA	B		C	D	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from Column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature.
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January ...	39.6	49.1	43.8	44.1	55.7	35.9	50.0	35.1	78.0	64.0	32.0	12.0	27	29
February ..	43.4	52.8	48.3	48.1	54.0	43.9	56.4	40.1	77.0	72.0	32.0	22.0	19	19
March	48.3	59.6	54.2	54.0	58.9	51.0	63.2	46.0	83.0	76.0	39.0	32.0	20	21
April.......	56.6	70.6	63.2	63.4	64.9	61.7	72.9	54.4	94.0	85.0	46.0	29.0	15	18
May........	64.3	77.5	69.1	70.3	74.8	66.1	79.7	62.1	91.0	87.0	61.0	44.0	22	26
June	72.4	85.4	77.3	78.3	80.4	76.4	88.1	69.6	98.0	92.0	65.0	55.0	17	22
July........	74.4	87.3	79.1	80.2	83.3	77.0	90.0	72.2	100.0	94.0	67.0	61.0	23	21
August.....	72.0	85.6	76.9	78.1	84.3	75.2	88.1	70.3	102.0	90.0	71.0	60.0	23	29
September .	64.6	79.5	70.2	71.4	76.4	68.8	81.5	63.0	97.0	88.0	54.0	47.0	25	16
October	59.8	72.2	64.3	65.4	67.8	60.9	74.4	58.2	90.0	82.0	46.0	39.0	24	19
November..	46.3	57.2	50.7	51.4	56.4	41.5	60.0	43.9	83.0	69.0	30.0	10.0	18	21
December..	41.1	51.4	45.8	46.1	49.2	40.6	54.4	38.8	74.0	67.0	34.0	6.0	19	22
Spring	......	......	......	62.5	64.5	61.3	......	......	......	......	......	......	......	......
Summer ...	......	......	......	78.8	82.4	77.4	......	......	......	......	......	......	......	......
Autumn ...	......	......	......	62.7	65.1	57.1	......	......	......	......	......	......	......	......
Winter.....	......	......	......	46.1	51.1	40.1	......	......	......	......	......	......	......	......
Year	......	......	......	62.5	63.0	61.9	......	......	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind in miles, per hour.
						Inches.	From	Miles.
January...	66.0	76.3	10.6	6.8	17.4	5.08	N.W.	5.5
February..	55.0	73.0	6.5	8.0	14.5	8.38	S.	6.4
March.....	51.0	65.5	9.2	11.0	20.2	5.12	N.&N.W.	6.9
April	65.0	67.8	10.5	12.3	22.8	5.28	S.	6.6
May.......	47.0	75.3	12.5	10.5	23.0	7.01	S.	5.1
June	43.0	75.0	13.7	13.5	27.2	3.56	S.	4.5
July.......	39.0	74.5	13.4	11.6	25.0	3.58	S.	4.5
August....	42.0	75.5	10.8	16.2	27.0	3.97	N.E.	3.9
September.	50.0	75.3	9.0	15.4	24.4	2.79	N.E.	4.1
October ...	51.0	77.5	11.9	12.7	24.6	3.87	S.E.	5.1
November.	73.0	73.4	7.8	12.0	19.8	5.31	S.	5.7
December.	68.0	71.7	8.2	11.5	19.7	2.82	N.W.	5.7
Spring	65.0	69.5	32.2	33.8	66.0	17.41	S.	6.2
Summer...	47.0	75.0	37.9	41.3	79.2	11.11	S.	4.3
Autumn...	87.0	75.4	28.7	40.1	68.8	11.97	N.E.	5.0
Winter	72.0	73.7	25.3	26.3	51.6	16.28	N.W.	5.9
Year.......	96.0	73.4	124.1	141.5	265.6	56.77	S.	5.3

LIVER, ABSCESS OF THE. There are three varieties of hepatic abscess: the so-called tropical or idiopathic, the traumatic, and the metastatic. They may occur at any age, and may be single or multiple. Though not confined to any one sex, males are far more subject to them than females, as will presently be shown.

Abscess of the liver—suppurative hepatitis, as it is most frequently called—may be primary and due to local causes, but it is more generally a secondary disease.

Although we are inclined to talk of it as a disease of tropical climates, the latest researches indicate that some error has been committed in this respect, the so-called tropical or idiopathic abscess being found not infrequently in temperate climates. Indeed, five or six of the patients under my own observation were known never to have lived in any other than a temperate zone. Nevertheless it is far more common in the tropics than in other parts of the world. It has been well shown by Hirsch [1] that in these latitudes foreigners are more frequently attacked than the native born, and he very logically attributes this fact to the habits of eating and drinking which the former, especially the British, bring with them from their native lands. Harley [2] has taken the same ground, and strengthened his statements by mentioning the fact that cases of "Indian liver" are now less frequent than they formerly were, comparing the actual proportion of cases now occurring to that of former times. He attributes this diminution in the frequency of the disease to the change made in the diet and habits of the Europeans, who now use light French wines in place of the strong and bitter ales; while they turn their attention more at present to out-door sports, which have become fashionable even in the hottest climates. Other contributive causes may be found in medicinal agents, which are often taken by patients for their constitutional effect, and especially those that superinduce constipation, of which opium and iron are examples; also in the use of such hydrocarbons as the fats and starches in excess.

In perfect agreement with the foregoing statements is the fact that females are rarely the subjects of hepatic abscess. Thus, out of 251 autopsies made at St. Luke's Hospital during the ten years ending with 1882, there were but nine cases of hepatic abscess, and of these only one was in a female, showing that there is in New York a comparative immunity from the disease in the female sex; and this is more marked than in Berlin, where, as shown in the autopsies, $1\frac{48}{100}$ per cent. were females.[3]

Hepatic abscess is chiefly a disease of middle life, and is found to attack the robust rather than delicate or weakly persons. The ages in my nine cases were from fourteen to seventy-three years, but most of them fell in the decade between thirty-five and forty-five.

Gall-stones occasionally lead to suppurative hepatitis; I have observed this in several cases, one of which I presented before the Pathological Society of New York in 1874. It occurred at the Presbyterian Hospital, in the service of the late Dr. J. L. Banks.[4] In this case the common duct was found occluded by a large gall-stone, the size of a filbert; this, together with several other calculi, had caused dilatation of the hepatic biliary passages, leading subsequently to ulceration and rupture of the common duct.

Ever since George Budd,[5] in 1842, insisted that dysentery was a primary cause of hepatic abscess, the attention of medical practitioners has been turned to this point, and for a certain period, his theory was very generally accepted. Subsequently, however, medical writers, from experience in climates where dysentery was very prevalent, contested this view on the following grounds:

1. That if dysentery produce abscess of the liver, the like result should follow from other intestinal irritants.

2. That in many cases of hepatic abscess there has never been any symptom of dysentery.
3. That abscess of the liver does not occur in all epidemics of dysentery.
4. That in deaths from abscess of the liver, in tropical climates, the intestines have often been found healthy.

To one conversant with medical pathology, there are satisfactory answers to all these objections.

In the first place, it does not follow that if dysentery produce abscess of the liver, other intestinal affections should have like sequelæ; for it is pretty well established that dysentery is a disease propagated by a poison peculiar to itself, and this may have a special affinity for the liver, just as in tubercular diseases the mesenteric glands are favorite seats for secondary deposits. In the second place, it is not necessary that a patient should give a well-defined history of dysentery. This he rarely does, being more apt to attribute his symptoms to "cholera morbus" or "chronic diarrhœa;" or he may even overlook the intestinal trouble entirely, attributing the passage of blood and pus to hæmorrhoids, fistula, or the like. Again, that abscess of the liver does not always occur in epidemics of dysentery, is a matter of general knowledge. This has been already noticed by Niemeyer in one epidemic, which I also had the fortune to witness, and during which this complication did not occur.

It may be well here to consider with Bartholow,[6] whether we may not have a special form of disease, confined to the large intestine, other than epidemic dysentery, as we know it from military experience. This disease is a marked affection of the mucous membrane of the rectum, which he calls proctitis. It is not improbable that, in a limited number of cases, any poison of a peculiar character, when the original focus lies along the line of the portal system, may be carried up to be deposited in the hepatic substance, and we have good reason to believe that a certain class of poisons will necessarily produce a secondary focus of a suppurative character; while a favorable issue for the individual will never ensue until the offending matter is, in some way, discharged from the body. Such processes usually and properly come under the term of septic.

That diseases of the intestine—and especially dysentery, as we understand it—are prime causes of hepatic abscess, is well sustained by excellent authorities,[7] although others who have high rank (Annesley and Waring) hold an opposite view, and base their belief upon a study of great numbers of cases. Other causes given are typhoid fever and variola.

There is another class, which fortunately appears at the present time more rarely, namely, the pyæmic. Of this nature were formerly most abscesses of the liver. In point of frequency, however, it is the lungs rather than the liver that take the real brunt of the fight in pyæmia. When the liver is reached the disease may have extended, as it sometimes does, through continuity, or by the less comprehensible medium of the pulmonary capillaries. The causes are usually made out at post-mortem examination, and hence it is proper for us to realize that the term idiopathic, as a word applied to hepatic abscess, may soon be expunged from our medical terminology.

In a comparatively small number of cases, traumatism is to blame for the inception of the disease.

Some years ago I collected the statistics of hepatic abscess from thirty-three cases occurring in St. Luke's, the Mount Sinai, and the Presbyterian Hospitals, New York City, from a study of which I derived the following conclusions:

The most commonly assigned cause of hepatic abscess was dysentery; next in order came the irritative action caused by the presence of calculi in the gall-bladder and biliary passages; while traumatisms and operations in and about the pelvic fossa held more subordinate places. These results differed materially from those published by Thierfelder[8] as collected by C. Baerensprung, who, in a total of 108 cases, found that 68 were associated with traumatisms (pyæmic). Traumatic cases should more properly belong to the class caused by such direct mechanical injuries as wounds, blows, etc.; but these instances are extremely rare, as the liver will usually sustain great violence without giving rise to suppuration. In other respects our statistics agree, affections along the line of the portal system holding the second place, and ulceration of the biliary passages the third place. Probably the statistics of to-day in Berlin hospitals would alter this ratio, as with the advances made in modern surgery the terrors of pyæmia have greatly abated. In most of my cases the abscesses were single, and then were usually confined to the right lobe.

There is some foundation for the theory of some (Saunders,[9] Annesley[10]), that dysentery has a malarial origin. It is true that dysenteric and malarial affections are apt to be associated in many regions of the globe. But where suppuration is not dependent, in any given case, on a special poison such as pyæmia or dysentery, or upon mechanical injury, malarial affections may be ranked as contributive factors, because they dispose to chronic congestion of the liver. Among predisposing causes should also be placed indolent habits, abuse of spirituous liquors, and exposure to cold, conditions which have been dwelt upon by military surgeons. In two out of nine cases, I found the attributed causes to be intermittent fever in one and "swamp fever" in the other. Gonorrhœa has been said to produce hepatic abscess, but the evidence is imperfect.

PATHOLOGICAL ANATOMY.—Abscess of the liver is known to the pathologist under two forms, the solitary and the multiple. In the former variety, where it is chiefly associated with intestinal affections, the abscess may develop to a great size, causing, when it reaches the surface, protrusion of the abdominal walls. Although, in many cases, a capsule is formed, in others we observe simply progressive ulceration without a defining membrane. When an abscess, however, reaches the external part of the liver, it causes inflammatory adhesions to some contiguous point, and then, if rupture ensue, the pus is discharged into the organ to which it has formed an attachment. Thus, it may burst into the pleura through implication of the diaphragm, or, after adhesion of the pleural surfaces has taken place, it may break through the lungs, and in this manner the matter may escape by way of the bronchi; in other cases it may rupture into the peritoneum, or may perforate into the colon or gall-bladder. It is rare, indeed, that the abscess dries up and its contents become caseous, or cretaceous.

Pyæmic abscesses are at the present time better understood than they formerly were. It is not now considered necessary to explain the occurrence of suppurative foci through the intervention of emboli or thrombi. The poisonous germs having been shown, by concurrence of pathological opinion, to be particulate, it is comparatively easy to explain how they enter the liver. For, as is usually the case in pyæmia from wounds, the secondary foci are first formed in the lungs; then the disease-germs, which are microscopic molecules, enter the pulmonary capillaries, pass to the left side of the heart, and then through the aorta to the several parts nourished by the systemic circulation; in this way they reach the hepatic artery, which conveys them to the liver, and as this organ has a depurating function in addition to many others, it is comprehensible that the poison may enter it to be passed out of the system; but in such cases the poison cannot be excreted and, favored by the extremely sluggish circulation in the intralobular capillaries, it sets up an area of inflammation about it, and several of these zones coalescing, we have suppuration of a multiple character. There is probably no difference between these abscesses and others, excepting, as it may be shown at some future day that the bacteria are peculiar and distinctive in the several varieties. Whatever be the nature of the poison, it is necessarily associated with a bacterial organism, which plays a primary or secondary part in the development of the abscess.

The inflammation affects, as elsewhere, the connective-tissue substance first, the hepatic cells taking no part in the process excepting in so far as they may be influenced by the presence and character of the disease-poison.

Rindfleisch[11] describes minutely the development of

abscesses according as they are embolic or thrombolic. From what has already been said, these matters have probably ceased to be of interest, excepting in a historical way.

The contents of these abscesses vary somewhat. They contain blood and pus, usually of a creamy consistency; sometimes the decomposing blood has given a greenish tinge to the matter, while at other times fresh hæmorrhages have colored it a light pink. Usually the matter is white and inoffensive to the smell, but occasionally it gives out a most horribly nauseous odor, containing, as it may often do, a large quantity of necrotic tissue. It is the presence of this more or less solid material that is apt to mislead the practitioner if he use the aspirator, for it may plug the tube and prevent the withdrawal of any pus. It is extraordinary what an amount of matter these abscesses may contain.

Clinical History.—It may be stated that in many cases there are no symptoms at all; at least none that are mentioned by the patient, so that it frequently happens that an abscess, which had never been suspected during life, is discovered at the autopsy; or the existence of the abscess may first become disclosed by the fact that the capsule breaks, and that there is secondary implication of other organs.

When clinical signs are present, one of the most common is a sense of weight and fulness in the hypochondrium; the patient may also have more or less pain in the right shoulder, and be unable to lie on the right side. The pain is then apt to be increased by a full inspiration. It will be found that in the early stages there has been more or less dyspepsia, and that nausea and vomiting have been present.

As soon as sufficient matter has collected to produce constitutional symptoms it is pretty certain that there will be rigors, followed by fever and sweating; the rigors, fever, and perspiration coming on in this way will sometimes be mistaken for intermittent fever, as in the case of biliary obstruction I have given, where the patient was admitted to the hospital with this history. The fever may reach 102° or 104° F. When the organ attains a considerable size there will be some cough, of a reflex character probably, due to implication of the terminal twigs of the pneumogastric. Possibly, by this time it will be found that the area of hepatic dulness is increased, although it does not necessarily follow that with abscess of the liver there is enlargement; yet, if the patient survive the initial stages of the disease the liver will pretty certainly be increased in size. Nature now seems to come to the assistance of the patient, and the abdominal muscles, especially the rectus, may show preternatural rigidity. It is difficult to say precisely in what way this condition of the muscles is brought about. Their unyielding character helps to protect the injured organ from outside influences, and assists in holding it fixed until the reparative processes of nature have attached it to such parts as may serve as avenues by which the pus may escape.

Jaundice is comparatively rare. The presence of a large collection of pus, indicated by the symptoms that have been described, naturally produces great prostration; and this is of itself an important symptom. The pulse is in harmony with the constitutional disturbance in a certain number of cases, the proportion being difficult to determine.

In a large number of cases—indeed, in my experience, in most of them—the patients recall symptoms of a dysenteric nature, or they may have peculiar symptoms of pyæmia that to the initiated are characteristic. Thus there will usually be the history of some surgical operation, though, in some cases, of a trivial character. In one instance it was merely the slitting of a small urethral stricture; but there followed on the same day a violent chill, fever, and sweat, and the patient was dead within forty-eight hours. He had been cut by the urethrotome (Otis's), after which a No. 26 steel sound had been passed. This was the third operation, the second having been performed six years previously. At the post-mortem examination the left lung was filled with infarcts from the size of a pea to that of a marble, and in the lower lobe a small abscess was found; in the right lung there were also several abscesses. In the liver were numerous infarcts, such as are seen in those cases of pyæmia that die early. In this case there was the further complication of chronic diffuse nephritis, which was the proximate cause of death. Sometimes, in advanced cases, bulging of the hypochondriac region will be seen on inspection. With some such previous history the patient may suddenly fall into collapse, the tumor disappearing to a great extent, while the pus passes off in one of the ways that have been described; or, if the abscess be situated behind the liver, the matter may pass back of the peritoneum and lose itself temporarily in that situation. Ascites and œdema of the lower extremities are rare, except as connected with cardiac or renal disease; but pressure upon the portal vessels may at any time cause an accumulation of serous fluid in the abdominal cavity.

In rare cases palpation will elicit pain and tenderness over the liver, and sometimes, if the abscess be very large, fluctuation, though it will be well not to rely too much upon the presence of this sign. In such cases, and whenever there is any doubt, the aspirator should be resorted to in order to establish a diagnosis, and a sufficiently large needle should be used to enable the operator to secure pus if any be present.

Dr. Hammond adopts a very simple method for determining fluctuation. He places the patient on the back, puts the points of the index and middle fingers of the left hand between the eighth and ninth ribs, a little in advance of a line falling from the middle of the axilla; then, by gentle tapping or percussion at a point about two inches above the umbilicus, and a little to the right of the median line, fluctuation is detected by the fingers of the left hand.

He has operated successfully in a large number of cases, ten of which have been put upon record.[12] The matter is removed by the aspirator, and he prefers to introduce his instrument in the eighth or ninth interspace, and in a line midway between the mammillary and axillary lines. In the event that matter is not reached, the operation is harmless, and in this latter statement he is sustained by Davis[13] and Jimenez.[14]

In my thirty-three cases already alluded to there were frequently no symptoms of the disease before death, but the following signs were found in the majority, and their order of comparative frequency was as follows: (1) Rigors and sweats; (2) pain in the epigastrium; (3) jaundice; (4) clay-, or occasionally bronze-colored stools. Central nervous disturbances were noted in one instance only.

In my set of cases taken from the St. Luke's Hospital records, a few of which entered into my first statistics, I noted that the most frequent of the early symptoms were digestive disturbances, such as loss of appetite and constipation, sometimes alternating with diarrhœa. In more than half of these cases there was hepatic enlargement, the liver usually reaching more than an inch and a half below the free border of the ribs.

Next in symptomatic prominence was pain, which occurred in six out of nine cases; this was usually confined to the region of the liver, though in two patients it shot up to the right shoulder.

Fever was noted in a great number of cases, and it reached in one individual 105° F. The following symptoms were noted, but without any uniformity in the order of their occurrence; (1) A dry tongue; (2) chills and sweats; (3) rigidity of the abdominal regions; (4) great prostration; (5) rapid and painful respiration; (6) œdema of the feet.

In a suspected case, when the matter is expectorated, the pus should be examined microscopically, and an expert may be able to determine, from the known character of the hepatic cells, whether the liver is involved. (For a further differential diagnosis see Liver, Enlargements of.)

From all that has been said, however, it will be manifest that abscess of the liver cannot always he diagnosticated during life.

Prognosis.—In cases of tropical abscess, it is said that about seventeen per cent. recover. It is doubtful if

there be any recovery in pyæmic abscess. A more favorable issue may be expected if the abscess be solitary and break through the bronchial tubes, integument, or by the alimentary canal.[15] A protracted convalescence of three to five months is thought to be desirable, but the best expectation of life is when the abscess discharges directly through the external walls of the body. Of course, the liver-substance will be destroyed to a certain extent, but enough may be left to carry on the processes of nature with a fair degree of success. The mortality, including tropical cases, is about seventy to ninety per cent.

TREATMENT.—We rarely are called upon to prevent a hepatic abscess, for the reason that its comparative infrequency precludes us from anticipating it; nor is it probable that we should succeed in our endeavors to do so, except by checking the original disease.

Nothing, of course, is more obstinate than dysentery when it has reached such a form that the bowel is filled with indurated tissue from the cicatrices of large sloughing ulcers. Possibly, in such cases, puncture of the liver may do good, and we have the further testimony of Bartholow and Condon [16] to the effect that it not only relieves congestion, but is quite harmless.

Among other remedial measures that have been suggested are local abstraction of blood, application of ice, the use of chloride of ammonia, ipecacuanha, and the opiates.

After suppuration has set in the treatment should be directed toward securing a free outlet for the pus. My experience, derived from a study of hospital cases, goes to show that the aspirator, though most desirable and indispensable, often, in diagnosis, is far less reliable in treatment; statistics tend to prove that it merely delays the evil day, while free incision holds out the best chance for life, if the matter is accessible to the knife. And yet upon this point writers of authority differ, as I have already shown. If free incision be attempted, the abscess cavity should be washed out with some suitable antiseptic liquid; if it be possible, however, the wound should not be sealed, but drainage should be established in order to prevent the fluid from accumulating. If the physician have in mind to operate, he may well adopt the plan of Graves—make a free incision about four inches long over the centre of the tumor, down to within one or two lines of the peritoneum; plug the wound with lint and keep it open for a few days, until adhesions have taken place; the abscess then will usually discharge by this passage; or a knife or trocar can be used, and a cannula or drainage-tube left *in situ*.

Thomas E. Satterthwaite.

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LIVER, ACUTE INFLAMMATION OF THE. Ger., *Acute Leberentzündung;* Fr., *Hépatite aiguë.*—The capsule of the liver may be the seat of inflammation—*perihepatitis.* The connective tissue that extends along the ducts and vessels, and separates the lobules, may be the seat of either an acute or a chronic inflammatory process. The acute form usually passes on to suppuration (suppurative hepatitis, abscess of the liver). In fact, some pathologists deny the existence of acute inflammation of the cellular tissue of the liver without suppuration. Others believe a threatened abscess may terminate in resolution. I have never seen any pathological appearances that would warrant such judgment. Macpherson, however, in "Quain's Dictionary," under the one title of Acute Hepatitis, treats of perihepatitis, and an inflammation of the connective tissue which may end in abscess, as practically one disease.

It is quite certain, however, we may have a diffused inflammation of the connective tissue. In fact, such a condition obtains in acute yellow atrophy of the liver, for a description of which see below. In the words of Fagge, "at the present day pathologists are pretty well agreed in believing acute yellow atrophy of the liver to be parenchymatous inflammation, in Virchow's sense of the term." The term *acute diffused hepatitis* is also given to cases of acute atrophy by many writers. Acute cirrhosis has also been thus applied, and in English nomenclature, if I understand it, "red atrophy" indicates an advanced degree of the same condition. It is now applied most generally to the advanced stage of acute yellow atrophy.

Chronic inflammation of the interstitial connective tissue, or cirrhosis of the liver, may be monolobular or multilobular. Monolobular cirrhosis is also termed hypertrophic or biliary cirrhosis, and multilobular cirrhosis is the alcoholic or common cirrhosis. That form of inflammation which results from long-continued congestion described by Rindfleisch as "red atrophy," is termed "*brown induration,*" "*cyanotic atrophy,*" or, in the less advanced stages, "*nutmeg congestion.*" Finally, an inflammation of the veins occurs, and is most important in hepatic pathology.

For an account of suppurative hepatitis, acute diffused hepatitis or acute atrophy, chronic interstitial hepatitis, nutmeg congestion, and pyelophlebitis, the reader is referred to the respective articles on these subjects.

John H. Musser.

LIVER, ACUTE YELLOW ATROPHY OF THE. SYNONYMS.—Ger., *Acute gelbe Atrophie der Leber, acute parenchymatöse Hepatitis;* Fr., *Atrophie Jaune Aiguë du Foie, Ictère Grave; Cholæmia, acholia, icterus gravis,* malignant jaundice.

DEFINITION.—Acute yellow atrophy of the liver is a general disease, characterized anatomically by a granular and fatty degeneration of the epithelial cells of the glands, the endothelial cells of the blood-vessels, and the muscles of the body, on account of which the evidence of the gross changes of atrophy of the liver, parenchymatous inflammation of the kidneys, catarrh of the gastro-intestinal tract, degeneration of the cardiac muscle, and endothelial degeneration and rupture of the minute blood-vessels, are observed during life. These phenomena are due, in all probability, to a poison in the blood. The poison may be organic (micro-organisms, as found in yellow fever, *icterus epidemicus, icterus gravis*) or inorganic (phosphorus, antimony, arsenic, alcohol); or the poison may be generated in the system (pregnancy, mental emotion, etc.). The nature of a poison, if thus generated, is not known. All interest has been previously centred upon the liver, however, on account of its being the largest gland in the body, and undergoing the most marked lesions. Now it is believed that all the glands are similarly involved. During life, acute jaundice, nervous symptoms (delirium, coma, and convulsions), alterations in the size of the liver and spleen, changes in the composition of the urine, and general hæmorrhages occur. The subsequent remarks apply to cases of acute yellow atrophy, in the general acceptance of the term, and therefore exclude that occurring after phosphorus and other poisoning, and yellow fever.

FREQUENCY.—Acute yellow atrophy of the liver is a rare disease. Thierfelder collected above one hundred and forty cases, and Legg one hundred for their monographs. I have examined the histories of fifty cases published since 1879, the date of issue of Legg's book. Quite a number of cases have occurred in Philadelphia in recent years. Pepper alone has observed five cases; I have seen two, and know of three others. Eight cases only have been recorded in Guy's Hospital in twenty years.

Etiology.—Certain predisposing influences are noted in the etiology of this disease, viz., the age, the sex, and habits of the individual, and the season of the year. It occurs most frequently between the ages of fifteen and thirty-five, although cases after sixty have been recorded. Ashby observed a case in a boy, aged four, and Legg refers to several about two years of age, and to one in a new-born child. The female sex is most liable to the disease. A larger number of the recorded cases have been observed among dissipated persons—prostitutes, drunkards, and those who drink largely of malt liquors. Syphilis is thought by many to predispose to this affection, and it is said that at the commencement of the secondary stage acute yellow atrophy may become developed and terminate fatally, due to the impress of the syphilitic poison on the constitution. Lebert thought the extremes of heat and cold favored the development of the disease, but the analysis of Legg disproves the predisposing influence of the seasons. Series of cases have been described, which appeared to show a marked family tendency to the disease, especially among those of the family that lived together under one roof. They possibly were cases of malignant jaundice, due to some micro-organism—epidemic or endemic in character. Pregnancy is one of the most marked predisposing causes. The disease usually occurs between the third and the sixth month of gestation. Cloudy swelling and parenchymatous degeneration of all the glands, more marked of the liver and kidneys, is a physiological accompaniment of pregnancy and suckling. Frerichs has insisted upon the importance of this, in connection with the frequency of acute yellow atrophy of the liver in this state. It is known that epidemic jaundice is more fatal in pregnant women than in any other class of people.

The mode of action of the exciting causes of acute yellow atrophy is involved in much obscurity. Nervous influences are considered the most marked exciting cause. Grief, fear, or anxiety may be so great as to excite such morbid changes in the blood as would cause general tissue degeneration. Malaria has also been looked upon as an exciting cause, and the continued fevers and scarlatina have been placed in the same category. The development of a special poison in the system by nervous influence, or from faulty digestion or assimilation, has been invoked for the causation of this disease. The growth of a specific micro-organism in the blood has been recently demonstrated, and may be the exciting factor in many cases.

Morbid Anatomy.—On section of the abdomen the liver cannot usually be seen. It is high up against the diaphragm, or placed backward toward the spinal column. It is small, weighing less than one-half or one-third as much as the healthy organ. Sometimes, however, the liver is enlarged, and Liebermeister, with others, believes that enlargement takes place in the early stage of the disease. Of course, acute yellow atrophy may occur in a liver previously cirrhotic or fatty. Its surface is smooth and yellow mottled. The capsule is usually wrinkled, but free from opacity. The organ is thin and limp. On section marked changes in color are seen. The entire cut surface may be uniformly yellow, or yellow alternating with a dark red or purple color. The lemon yellow, ochre, gamboge, or Turkey-rhubarb yellow color is distinctly outlined, or shades into the deep red. In the yellow portion the lobules are indistinct or increased in size. In the red portion the lobules are diminished in size, and with a lens the interlobular connective tissue is observed to be increased. The red portion is more shrunken and firmer than the yellow, which appears swollen and very soft. The red is considered by most pathologists to be a later stage of the yellow. The ducts are patulous; the mucous membrane biled-stained or covered with mucus. In many cases a catarrh of the finer ducts has been observed. The gall-badder is empty, or contains light-colored bile or only some mucus.

The histological appearances of the yellow and red portions vary. The hepatic cells of the yellow portion are swollen and cloudy, are granular, or are filled with oil-globules. In fact, all these changes are observed in each case. The nucleus is pushed aside or displaced entirely, and in many instances masses of fat represent the cell. The interlobular connective tissue is plainly observed, but not altered. It serves as a network to retain the granular and fatty débris. In a section vacuoles or vacant places are often observed, indicating the former seat of destroyed liver-cells.

On section of the red part, an increase of the interlobular connective tissue is observed, with an abundance of young connective-tissue cells. The liver-cells that remain—most of them being destroyed—are atrophied and shrunken, and become arranged in rows which simulate bile-ducts in appearance. The embryonic tissue invades the lobule between the cells. The central vein is thickened and often surrounded by a young growth of connective tissue. The capillary bile-ducts are usually dilated, and may contain proliferated epithelium. Pigment is observed among the cells in all instances, hæmatin crystals are abundant, and crystals of leucine and tyrosine are almost constantly observed.

In addition to the apparent increase of bile-ducts, some observers affirm the formation of new ducts, and others even believe that there is an increase of the vascular capillaries. Colonies of the lymphoid elements noted above are often seen in many parts of the section, independent of their association with ducts or vessels. The microscope shows distinctly the gradual transition of the yellow portion into the red.

Bacteria have been observed by many in the hepatic cells, the connective tissue, the ducts, and the vessels. Klebs, Eppinger, Hlava, Balzer, and recently Boinet and Boy-Teissier,[1] have observed the micro-organisms. The latter authors detected them in the blood during life, and cultivated them. Their conclusions were: 1. That the blood of the patient they examined contained a micro-organism of the class Coccus. 2. That this micro-organism is always the same and is not found with other microbes. 3. That in the different cultivations the organism is presented under the form of diplococci. 4. That these diplococci, though generally isolated, are sometimes disposed in rosary-like chains. Finally, that they are similar to the cocci found in the hepatic cells, the portal vessels, and the renal epithelium. The writers are cultivating the microbes they secured after death, and purpose, with similar ones from the blood, to make inoculation experiments.

The blood is dark and fluid, and contains the micrococci just mentioned.

The spleen is enlarged and pulpy. The kidneys are enlarged, swollen, and congested. On microscopical examination, cloudy swelling, and fatty and granular degeneration of the tubular epithelium are seen. The heart is soft and flabby; and marked fatty and granular degeneration of the muscular fibres is found. In some cases the degeneration extends to the blood-vessels, and in various parts of the body the endothelium is found to have undergone fatty and granular degeneration. No special lesions of the brain has been observed. The cerebral vessels are markedly the seat of fatty degeneration of the intima, consequently hæmorrhages into the membranes and the brain-tissue occur.

The mucous membrane of the stomach is congested and the seat of ecchymoses. The glands of the stomach and intestines are filled with granular and disintegrating epithelium. The stomach usually contains clotted or semi-coagulated blood. There is blood also in the intestines, in the lower part of which it assumes a tarry appearance.

In addition to the presence of ecchymoses in the gastro-intestinal tract, they are also seen in the skin and the mucous membranes, in the pleura, the peritoneum and omentum, and the brain and its meninges. The surface of the body and the mucous membranes are bile-tinged, and if a blister is applied, the serum is also bile-tinged.

The uterus, in cases occurring in pregnancy, either contains the fœtus or presents signs of a recent abortion.

The relation of the red to the yellow portion of the liver has been a subject of careful inquiry. It is now believed by most pathologists that the red is a later stage of the general process, because of its absence in the more

acute cases, because it shows greater destruction of hepatic cells, because the yellow portion gradually merges into the red, and because it (the red) is more abundant in old cases. If this theory of the relation of the red to the yellow portion is accepted, the question of the nature of the primary hepatic change becomes more easily soluble. Is the process in the liver a primary fatty degeneration, or a general diffused hepatitis, the fatty change being secondary? The arguments above hold in a measure against diffused hepatitis occurring primarily; moreover, the degenerations in various other organs would point to a general origin of the disease, and not to a local diffused hepatitis. Then, too, the liver is a distensible organ, and its cells would not degenerate from pressure of the small amount of diffused new-growth that is observed in acute yellow atrophy.

Symptoms.—The onset is gradual or sudden. In the former instance symptoms of gastro-duodenal catarrh may continue for two or three weeks, or more, before grave symptoms arise. In the latter, acute jaundice, accompanied by marked nervous phenomena, immediately ushers in an attack. The more protracted cases (the first class) present two varieties of symptoms, viz., prodromal and toxæmic. The symptoms of the prodromal stage are those of acute gastro-duodenal catarrh—headache, nausea, vomiting, loss of appetite, a bitter taste in the mouth, and general malaise. Diarrhœa may also occur. At the end of forty-eight hours slight icterus appears and gradually increases in intensity. Fever does not usually attend these symptoms. On the other hand, the pulse and temperature, as in jaundice, are often subnormal. The fæces are colorless, grayish, or parti-colored; often indeed quite natural. The normal appearance of the fæces in acute atrophy has led to the expression that such stools furnish an unfavorable prognostic element in jaundice, while the presence of clay-colored stools is a favorable sign. The urine contains bile-pigment, and does not indicate the serious changes that are to ensue. The liver may be found on percussion to be increased in size or of normal dimensions.

The toxæmic stage succeeds these prodromal symptoms more or less suddenly, and after varying intervals of time. The prodromal stage may be very short or quite protracted, even as long as three months. In some cases the toxæmic stage is announced by a convulsion or sudden profound coma. Legg insists on careful observation of the pupil in cases of jaundice, and declares that dilatation of it is the most significant indication of approaching cerebral symptoms. In others the typhoid state gradually supervenes, and is characterized by stupor, low muttering delirium, subsultus tendinum, incontinence of urine and fæces, restlessness, hiccough, motor and sensory paresis, with dilated, often insensible, pupils. A dry and brown, or fissured and glazed, tongue is present, sordes collect in the mouth, and the vomiting of the prodromal stage continues, though the character of the ejecta changes. "Black vomit" now occurs instead of the vomiting of a clear acid or greenish-yellow fluid. The black vomit is due to the presence of blood which has oozed into the stomach. Dark tarry stools indicate its presence in the intestinal tract also. Constipation, however, may be present.

The typhoid state terminates in deep coma, death being preceded by irregular or Cheyne-Stokes breathing, an irregular pulse, involuntary discharges, and sometimes by recurring convulsions. In some instances the typhoid type is not assumed, but active maniacal delirium attends this stage, with or without convulsions; coma or exhaustion closing the scene. Again, there is no delirium, but frequent and prolonged general convulsions—with local spasms in the interval and coma-vigil. It is believed that the cerebral symptoms are due largely to hæmorrhagic extravasation in the brain and its membranes. The blood dyscrasia, however, is probably an important factor. The brain symptoms have been attributed to uræmia, but the theory of such origin is not upheld by clinical facts. Flint, Jr., thought they were due to cholesteræmia, and others to the presence of bile-acids in the blood. Frerichs attributed them to the presence of leucine and tyrosine in the blood, but experiments do not confirm his notion.

It is in this period that hæmorrhages occur from mucous surfaces, as the nares, mouth, pharynx, stomach, and intestines. They also occur in the skin and into the serous membranes. They are due to changes in the walls of the capillaries and small blood-vessels, or, as some assert, to the altered blood. The hæmorrhages are passive, and in the skin are observed as petechiæ or vibices; in the external mucous membranes as sordes or small clots. They may be seen in the conjunctiva. The constant oozing from the nares may seriously threaten life, while in females an abortion is almost always attended by a most profuse hæmorrhage. When hæmorrhages into the stomach and intestines have taken place, the discharges appear as indicated above.

The urine undergoes marked change. It is passed involuntarily, and wetting of the person is prevented with difficulty. Albumen, hyaline, epithelial, and granular casts are present, from associate tubal nephritis. The urea is much diminished in quantity or entirely absent; phosphates and chlorides are also diminished. The urea is replaced by leucine and tyrosine, indicating less advanced tissue metamorphosis. The presence of leucine and tyrosine is not pathognomonic, and they may be absent (Murchison). The urine is usually acid, dark in color, and contains bile-pigment. Contrary to their course in the prodromal stage, the pulse and temperature are increased in the toxæmic period. This is especially true of the pulse. It is increased in frequency, often excessively rapid, and not uncommonly irregular. The temperature range varies. In some there is no rise; in others the ascent does not occur until the last day or two of life, and may attain the highest point after death. My friend, Dr. H. M. Wetherill, of the Pennsylvania Hospital for the Insane, of Philadelphia, kindly permitted me to study the histological appearance of the various organs removed from a patient of his, who died of acute yellow atrophy of the liver. The case presented many interesting features, none more so than the temperature range. The patient, fifty-one years of age, was admitted into the Insane Hospital, for acute mania with delirium, on March 12, 1885. She did not improve, and on April 9th had a "bilious attack," followed in three days by jaundice and urticaria. After the jaundice the maniacal delirium gave way to a low, muttering form. The icterus appeared on the trunk and arms first, and then extended to the entire surface. She lived nineteen days, and during the course of the disease had diarrhœa with pale, loose stools, and hæmorrhages from all the mucous surfaces, petechiæ and vibices. The liver dulness decreased in area, and the splenic increased from day to day. The urine became albuminous, contained hyaline and granular casts, blood and bile pigment, leucine, and tyrosine. The urea became diminished in amount. The temperature range is indicated below. The three days preceding the jaundice, when the patient was "bilious," a rise of temperature occurred. It then fell to normal and remained low until four days before death, when a continuous ascent began, reaching the acme, $105\frac{4}{5}°$, thirty-five minutes after death.

Day of illness.	Degrees, Fahrenheit.		Day of illness.	Degrees, Fahrenheit.	
	A.M.	P.M.		A.M.	P.M.
First	99.0	101.0	Eleventh	96.8	97.0
Second	99.4	100.2	Twelfth	97.2	97.0
Third	100.4	100.0	Thirteenth	96.6	96.8
Fourth	99.4	98.4	Fourteenth	97.0	97.2
Fifth	98.8	98.0	Fifteenth	96.8	96.8
Sixth	98.0	99.2	Sixteenth	97.6	98.4
Seventh	99.0	98.4	Seventeenth	99.0	99.4
Eighth	97.6	97.6	Eighteenth	99.4	100.2
Ninth	97.0	97.4	Nineteenth	101.6	101.8
Tenth	97.4	97.6	Twentieth	104.6	104.8*

*At 5.20 P.M. death.

The pulse did not increase beyond 90. The first, second, and third day of the illness it ranged from 82 to 90; from the fourth to the eighth day, inclusive, 76 to 82; and from the ninth to the sixteenth day the average daily range was 66. After the latter day it increased daily to the last day, when it was 86 (highest).

Along with the occurrence of cerebral symptoms and hæmorrhages, changes take place in the liver and spleen. On physical examination the liver dulness is observed to decrease from day to day, and even may disappear anteriorly. Care must be exercised that the flatulent distention of the intestines may not cause apparent lessening in the area of hepatic dulness. It must not be forgotten that the liver may be enlarged. The spleen, in a certain proportion of cases, is enlarged. Legg states that in one-third of the cases the enlargement is found at the autopsy. With the diminution in the size of the liver pain in the hepatic region is experienced. This may be extreme, entailing a great deal of suffering. It is most frequently seated in the epigastrium, and, as the changes are most marked in the left lobe of the liver, may be due to the atrophy. It is certainly a well-recognized fact that an agonizing pain attends acute yellow atrophy of the liver. Although attended by vomiting, the pain does not appear to have any relation to it. Marked tenderness in the epigastrium is associated with it in many instances.

The course of acute yellow atrophy of the liver varies. It is sometimes extremely rapid. Cases of death have been reported to occur twenty-four hours after the first seizure. The toxic stage is much shorter than the prodromal; the latter usually continues from one to eight weeks. The disease is more rapid in pregnant women.

The PROGNOSIS is unfavorable, but not necessarily fatal. Cases of recovery have been recorded. The celebrated case of Wilks recovered, and died two months afterward of a relapse.

DIAGNOSIS.—The presence of the cardinal features of a case of acute yellow atrophy of the liver renders the diagnosis easy. The prodromal symptoms, the jaundice, the character of the urine, the nervous phenomena, the changes in the liver and spleen, and the hæmorrhagic symptoms, are to be kept in mind.

Care must be taken to exclude those forms of acute yellow atrophy due to phosphorus poisoning or yellow fever, by attention to the antecedent circumstances and history of the case.

TREATMENT.—The treatment can be stated in a few words. Some cures have been reported, and hence it is well to seek some methods of treatment. The indications that we can thus far discern are to relieve or cure the catarrhal symptoms as quickly as possible, and to allay the malignant symptoms of the second stage. The former is the treatment of gastro-duodenal catarrh or catarrhal jaundice. General principles guide us in the treatment of the latter.

It is to be hoped that a more accurate therapeusis can soon be determined by positive proof of the supposition of the bacillary origin of the disease.

John H. Musser.

[1] Revue de Médecine, 1886, vi., No. 4, 334–342.

LIVER, CIRRHOSIS OF THE. SYNONYMS.—Sclerosis of the liver, chronic interstitial hepatitis, granular, hobnailed, or gin-drinker's liver; Ger., *Cirrhose der Leber;* Fr., *Cirrhose du foie.*

DEFINITION.—Cirrhosis of the liver is a chronic congestion with consequent hyperplasia of the interstitial tissue of the organ, resulting in greater or less destruction of the parenchyma.

HISTORY.—That the morbid state of the liver, which we call cirrhosis, was known to the ancients is sufficiently demonstrated by a reference to the writings of Aretæus,[1] Celsus,[2] Vesalius,[3] and Morgagni.[4] These authors refer not only to the small size of the organ and its firmness, but also describe its glistening, rough, and retracted surface, its comparative dryness upon section, and other distinctive features of the disease. They further narrate cases, in which the livers of individuals who had died suddenly from hæmorrhage, or with ascites or jaundice, or from some unknown cause, were thus affected.

The small nodules upon the surface and in the substance of the organ were generally described as tubercles, a word that was used then much as the word tumor is used now, and was applied to almost every neoplasm. Cirrhosis, in fact, was looked upon as a neoplastic growth, and was not distinguished from such formations until long after the time of Morgagni, who confounded it, for the most part, with carcinoma.

It was Laënnec[5] who first used the term cirrhosis (from *κιῤῥος*, tawny), it having been suggested to him by the color of the affected organ. The nodules he mistook, however, for new-formations capable of occurring in other organs, and liable to undergo softening. The name he proposed was universally adopted, but his explanation of the pathology of the disease never gained much credence, and various other theories soon arose. Boulland[6] first pointed out that the nodular appearance of the organ was due to a hypertrophy of the white (interstitial) tissue and atrophy of the red (parenchymatous). Andral[7] confirmed the view, considering it sufficient for the explanation of the disease. Cruveilhier[8] affirmed that, examined microscopically, a section of the cirrhotic liver presented the same appearance as a section of the organ in health, except that the tissue is penetrated by a large quantity of new tissue; yet this author failed to account for the atrophic condition of the organ, and it remained for Kiernan,[9] Hallmann,[10] and Carswell,[11] to recognize the increase of the interstitial fibrous tissue as the essential feature of the disease, and to explain its relation to the atrophy of the parenchyma. In more recent years the affection has been studied chiefly by French and German investigators—Frerichs, Virchow, Cornil, Charcot, Ziegler, etc.

ETIOLOGY.—In a large majority of cases, cirrhosis is the result of the abuse of alcoholic stimulants. The adult male, because most addicted to spirit drinking, is most frequently the victim of the disease. The ratio of its occurrence in women is variously estimated. Of Frerichs' 36 cases, 16 were females; but Bamberger saw only 12 females affected in 51 cases. It has occasionally been observed in children; Cayley[12] observed a case at six, Murchison[12] one at nine, Frerichs[13] and Griffith[12] at ten, and F. Webber[14] and Virchow[15] each report a congenital case.

The disease is most common in England, Scotland, North Germany, and the United States, owing to the free use of spirits in them, but it is by no means unknown in wine- and beer-drinking countries. The more constant the ingestion of alcohol and the more concentrated its form, as in brandy, whiskey, gin, or rum, the more potent it becomes in the production of the cirrhotic inflammation. The disease is, therefore, more frequent in those individuals who habitually take raw spirits into an empty stomach, even in moderation, than in those addicted to an occasional debauch.

In a certain small proportion of cases the disease is independent of alcoholic indulgence. The irritant action of various agents has been suggested for the explanation of these cases. Acquired syphilis may produce a hyperplasia of the interstitial tissue of the liver, which is usually very irregularly disseminated throughout the organ. Congenital syphilis is also capable of causing a cirrhosis of the organ, which may be more evenly disseminated than that occurring in the acquired form.[16] There can be little doubt that some of the cases referred to above, in which cirrhosis was congenital, or occurred in young children, were of this character.

The long-continued, or often repeated action of malarial poison is recognized as a potent cause of the disease, and such acute infections as cholera and typhus have been named in its etiology. The excessive use of spices or strong coffee is regarded as sufficient for its production.

Hanfield Jones,[17] in 1853, observed that, in a case of total obstruction of the gall-bladder, there was some thickening of the Glissonian sheaths, but considered it of so little significance as not to mention it in his conclusions. Legg[18] states that continued obstruction of the flow of bile into the intestine, as by the impaction of gall-stones, cancer, etc., as well as by ligature, causes an increase of the connective tissue of the liver, and that the organ is reduced in size and becomes granular. The same author[19] reports elsewhere a case of cirrhosis in an infant, due to congenital deficiency of the common bile-duct, the

cystic and hepatic ducts terminating in blind sacs. Cirrhosis thus produced has been observed also by Charcot,[20] and Foa, Salvioli, Litten,[21] and others have obtained the same results experimentally on dogs, rabbits, and guinea-pigs. Budd [22] affirmed that faulty digestion may produce the disease, and that residence in a hot climate renders the other causes more active.

A process of hyperplasia, identical with that which occurs in cirrhosis, may invade the interstitial tissue of the organ for a variable distance around tumors, abscesses, gummata, cysts, and foreign bodies; and the inflammatory action of a perihepatitis or a chronic peritonitis may thus extend well into the interior of the organ. This is not properly a form or part of the disease under consideration, yet it is termed "partial cirrhosis" by Cornil and Ranvier.[23]

Valvular disease of the heart leads to a hyperplasia of the fibrous tissue surrounding the central vein of the lobule. One-half of the cases of cirrhosis recorded by Becquerel were of this character. The lesion is a result of passive hyperæmia, caused by mechanical obstruction to the flow of blood from the liver through the hepatic vein (nutmeg liver), and is therefore sufficiently different, both in its etiology and its histology, to warrant its exclusion from present consideration.

Finally, it must be admitted that in rare cases the cause of the disease will remain unknown.

PATHOLOGY.—The attempts that have recently been made to formulate the lesions of hepatic cirrhosis into various species, based upon any given number of observed cases, have led to little more than confusion. One author, for example, names as many as eight varieties of the disease. That the lesions included under this title are exceedingly variable is a matter of repeated comment, and has always led to more or less misapprehension. Much of the diversity in the appearance of specimens is due, however, to variations in the cause or duration of the disease. The morbid process is the same in all cases—its extent, duration, and results are variable.

For convenience of description the disease may be divided into three stages, a stage of hyperæmia, a stage of hyperplasia, and a stage of contraction. The histology of these stages has been sufficiently described in another place (see Cirrhosis, vol. ii.). During the stage of hyperæmia, owing to the engorgement of blood-vessels, the organ is slightly increased in size and firmness. This enlargement can be recognized both by palpation and percussion, The color of the affected organ, as seen in autopsy, is dark; the capsule is tense. If the liver be incised, the edges of the capsule retract and blood flows freely from the cut surfaces.

The hyperplasia, constituting the second stage, affects first the fibrous tissue around the finer branches of the portal vein which ramify between the lobules of the liver, and may ultimately invade the lobule itself. The size and firmness of the liver now more rapidly increase, so that the area of dulness that is elicited by percussion extends an appreciable distance further in all directions, but especially downward, and the inferior margin may be distinctly felt, rather firmer and thicker than normal, below the margin of the ribs. The color of the organ peculiar to this stage is a chocolate-brown; the capsule becomes more distended, and is markedly thickened, and, as the growth of new tissue advances, becomes adherent to the organ by the formation of fibrous bands between it and the interlobular spaces directly beneath. Upon incision, blood flows freely from the surfaces; but when washed, the parenchyma appears as distinct red islands embedded in a grayish interstitial tissue, which is distinctly wider than normal.

Not infrequently the accumulations of embryonic tissue within the meshes of the interstitial tissue are sufficiently great to become visible to the unaided eye as minute, grayish-white striations in the interlobular spaces. The microscope resolves these striations into accumulations of embryonic cells closely crowded between the connective-tissue fibrillæ (see Fig. 2167).

As the growth of this embryonic tissue advances, new capillary blood-vessels develop in it, anastomosing both with the minute subdivisions of the portal vein and with those of the hepatic artery. It is affirmed that in some cases the minute bile-ducts undergo a hyperplasia, new branches being formed in the embryonic connective tissue, the epithelial walls of which are offshoots of the original lining cells of the normal ducts. In these cases, it is said that instead of a single vessel accompanying each branch of the portal vein, a network of vessels is formed about it.[24]

As the newly formed fibrous tissue attains maturity, a contraction of its fibres commences, partly as a result of the compression which is thus established, and its interference with the nutrition of the organ by obliterating blood-vessels, and in part as a result of the congestion which is present; the parenchymatous elements undergo a granular fatty degeneration most marked in the peripheral zone of the lobules, and many of the cells thus degenerated are absorbed. In advanced cases entire lobules are thus removed. Generally, however, sufficient normal parenchymatous tissue remains to maintain the functional activity of the organ until a late period of the disease. The peculiar tawny color of the lobules which resist destruction is due to the presence of blood- or bile-pigment that is absorbed by the cellular elements. As the contraction of the fibrous tissue progresses, the liver may become reduced to half or to less than half its normal size. As described, especially by Rokitansky, the right lobe of

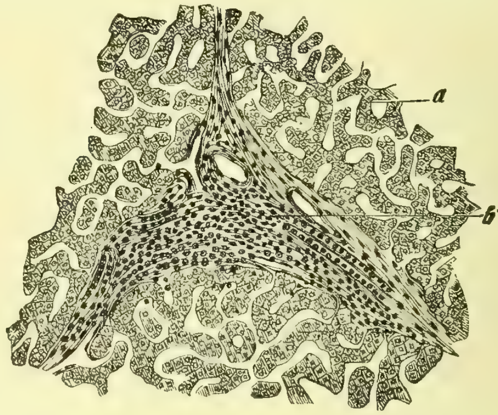

FIG. 2167.—The Second Stage of Hepatic Sclerosis. *a*, Normal liver tissue; *b*, interlobular connective tissue, infiltrated with embryonic cells. (Ziegler.)

the liver sometimes becomes small and rounded, being relatively thicker, but much smaller in circumference, than in health, the left lobe sometimes shrivelling to a mere fibrous appendage. As it diminishes in size the organ becomes firm and hard, so that in making an incision the knife encounters almost as much resistance as in dividing cartilage. The surface of the section is lighter in color, less moist and more granular than in the earlier stages of the disease. The capsule is thickened and firmly adherent to the organ; sometimes it is also united by firm adventitious bands to the diaphragm and other adjacent organs. Owing to the contraction of the fibrous bands which thus bind the capsule to the organ, the surface becomes nodular or granular. These nodules or granules usually vary in size from that of a millet-seed to that of a pea, and correspond to a single lobule or to several. In the form of the disease which is due to syphilis the nodules are frequently much larger than this measurement, but may vary greatly in the same specimen. The irregularity of the surface may sometimes be recognized by palpation through the abdominal wall; usually, however, the surface has not become granular until, owing to contraction, the inferior border of the liver has receded behind the margin of the ribs. When amyloid infiltration complicates the case, the roughness can usually be distinctly felt.

Between the enlargement of the second stage of sclerosis, and the stage of extreme contraction just described

and illustrated in Fig. 2168, every gradation of the disease is met with in autopsy. They represent, however, only the various steps in the gradual progress of the disease.

Beale[25] suggested that cirrhosis consists essentially in an atrophy of the parenchymatous cells of the liver, and that the increase of the connective tissue was a subsequent change. His theory received little consideration, however, and was again proposed by Ackermann at the meeting of the Society of German Naturalists and Physicians at Magdeburg, in 1884. Ackermann maintained that the primary change is a necrosis of the liver-cells, constantly associated with a deposit of fat in their interior. The liver is reduced in size, according to his view, because the necrosis of the parenchyma is, as a rule, more rapid than the growth of interstitial tissue. When, however, the interstitial increase is rapid, we have a hypertrophic cirrhosis. Ackermann's theory was favorably received by Küssner and Aufrecht, but opposed by Rindfleisch. An apparent defect in the theory is the fact that in the first stage of cirrhosis the liver is enlarged, whereas, if the necrosis of the parenchyma were the primary process, a diminution of the size of the organ would be more probable.

As a result of the contraction of the new fibrous tissue, important changes are produced in the various blood-

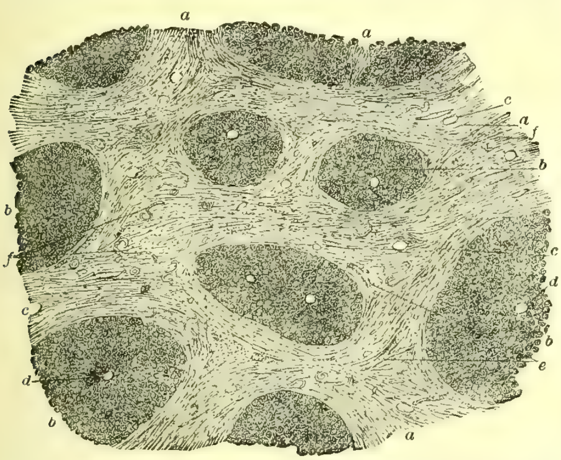

FIG. 2168.—Section of Liver in an Advanced Stage of Sclerosis. *a*, Interstitial fibrous tissue; *b*, parenchyma; *c*, branches of the portal vein; *d*, the central vein of the lobule; *e*, branches of the hepatic artery; *f*, bile-ducts. (From an original drawing.)

vessels and in the biliary passages of the liver. The smaller subdivisions of the portal vein are constricted, or even obliterated, the trunk and larger branches frequently becoming dilated; later their walls become thickened, and, in infrequent cases, permit of the formation of thrombi. Dieulafoy[26] has observed a periphlebitis of the walls of the portal radicles. Consequent upon this obstruction there is produced an increased tension of the blood and a retardation of its flow throughout the entire portal system of vessels, which, aided probably by a weakened condition of the vein-walls, finally leads, in some cases, to rupture and fatal hæmorrhage. The same contracting force acts also upon the subdivisions of the hepatic artery, causing a constriction or an obliteration of the smaller branches and capillaries, and a retardation of the circulation, and final dilatation of the larger trunks.

The hepatic vein is usually affected only as a result of an extension of the inflammatory process to its walls from the capsule or Glissonian sheaths.

The bile-ducts present various alterations. In some instances the only appreciable effect of the sclerosis is the destruction of the minute primary radicles of the ducts at the periphery of the hepatic lobules. In other cases, either from the constriction of the larger branches, or from a catarrhal condition of their mucous membranes, an obstruction is produced which leads to a dilatation of the smaller branches. The gall-bladder is sometimes thickened and adherent to the liver.

Hypertrophic Cirrhosis.—In certain, not very frequent, cases of cirrhosis the liver is of normal size or is even slightly enlarged. In many of these cases the enlargement is due to the presence of infiltrated fat, which may have preceded the sclerosis; to the presence of syphilitic deposits, especially in children; or to a complication with amyloid infiltration. It is affirmed, however, that in some cases there is an exceedingly prolific formation of new fibrous tissue,[27] containing numerous newly-formed capillary bile-ducts and a free anastomosis of young blood-vessels. Charcot and Gombault[28] and Hanot,[29] among others, have described a hypertrophic form of cirrhosis in which jaundice is an early and prominent symptom, and in which the enlargement was supposed to be largely due to the excessive production of bile-ducts and their subsequent distention. Mafucci[30] affirms that this form of the affection begins by a destruction of the hepatic parenchyma, occasioned by the irritation from distended bile-ducts.

The pathology of other lesions, which are the results rather than parts of the disease, will be referred to under the head of symptoms.

SYMPTOMS.—The symptoms of cirrhosis are due for the most part to the obstruction of the circulation in the portal vein, or to impairment of the functional activity of the liver, while others are secondary to the derangements thus produced.

The early stages of the sclerosis occasion so few clinical manifestations that the disease is seldom recognized until it has reached the stage of contraction. In occasional cases, however, owing to unusual activity of the process and an early involvement of the capsule, there is pain, with tenderness and slight tumefaction in the region of the liver. Fever may also then be present and moderate jaundice, with indigestion, nausea, and vomiting. These symptoms are of short duration, but may recur after variable intervals. For a considerable time after the acute manifestations have subsided, the disease advances so insidiously as not to attract attention. As a rule, the first symptoms that may lead to a suspicion of the disease are those on the part of the alimentary canal. Owing to the beginning obstruction of the portal circulation, the mucous membrane of the stomach and intestines, especially of the large intestine, is kept in a constant state of hyperæmia, necessarily causing a derangement of their function. The appetite becomes exceedingly capricious. At one time food is taken with a relish, at another with indifference, and again it is repulsed. Highly seasoned or acid articles of food and uncooked vegetables are frequently craved. Digestion is very uncertain. A diet which is ordinarily easy of digestion can no longer be tolerated. The tongue is furred. The ingestion of food causes gastric distress or burning, with pyrosis; meteorism is developed, and enormous quantities of gas are sometimes discharged from the stomach. Morning vomiting soon commences; only some viscid mucus, followed, perhaps, by a little bile, is ejected. These symptoms may, however, be in part a result of the direct irritation of alcohol on the gastric mucous membrane of the habitual drinker, and may thus occur before the hepatic affection has gone further than the hyperplastic stage.

Ascites is one of the most common symptoms of cirrhosis, sometimes appearing early, oftener only after years. It is due in part to the obstruction of the portal circulation, in part to the watery condition of the blood, which enables the serum more readily to transude from the capillaries of the peritoneum, and, according to Cohnheim, in part to an altered condition of the capillary walls. The extent of its formation is directly proportionate to the degree of contraction of the liver, except where a free anastomotic circulation has been established. The accumulation may be so slight as to escape detection, but as the fluid rises in the peritoneal cavity, it soon becomes easily recognizable by its fluctuation and by dulness on percussion. In some instances the accumulation is enormous; it usually amounts to from ten to twenty pounds, but in rare instances it has reached as high as fifty or sixty pounds. The most ur-

gent symptom of ascites is a gradually increasing dyspnœa, which may result fatally if it be not relieved by a removal of the fluid. The fluid, a slightly altered blood-serum, has a light yellow color, unless tinged with blood or bile, and contains, according to several analyses, from 1.33 to 3.59 per cent. of solids, chiefly (0.60 to 1.34 per cent.) albumen, with sodium chloride and other salts in small quantities.

After ascites has existed for a variable length of time, rarely before its occurrence, the lower limbs become œdematous, the swelling beginning at the feet and ankles, and gradually ascending until the thighs, genitals, and even the hips and back become, in the most advanced cases, enormously distended with fluid. This œdema is usually attributed to the pressure exerted on the inferior vena cava by the distention of the abdomen with fluid and flatus, or, at a late period, by the compression of this vessel as it passes through the hepatic fissure. More recently, Giovanni[31] has asserted that, wherever œdema is found, there is present a marked hydræmia and dilatation of the vena cava, with peri- and endo-phlebitis, and considerable thickening of the vessel walls. When, however, œdema is absent, these lesions are not found.

Another effect of the portal obstruction is an enlargement of existing anastomotic vessels, and the establishment of new circles where previously only capillary communication existed. We have, in the first place, an enlargement of the anastomotic branches of each of the vessels composing the portal system, from which a deflection of the current is favored by the absence of valves. The inferior mesenteric, through the superior and middle hæmorrhoidals communicates freely with the inferior hæmorrhoidal, and sometimes with the vesical plexus, which conveys the blood into the internal iliac, whence it reaches the vena cava inferior. The superior mesenteric vein, through the right gastro-epiploic, reaches the renal; the splenic, through the vasa brevia of the stomach, inosculates with the phrenic, and through the gastro-epiploic, with the renal. In nearly every case in which the cirrhosis is at all advanced, vessels of considerable size are found traversing each of the so-called ligaments of the liver, and sometimes, also, the adventitious bands which unite the organ to adjacent structures, especially to the diaphragm, the colon, and the duodenum; and in most cases the vasa vasorum are distended. In the round ligament, according to Rokitansky and Bamberger, in addition to the enlargement of the nutrient vessels normally there present, there is developed a pervious condition of the usually obliterated umbilical vein—an exceedingly improbable occurrence, and one that is strongly denied by Sappey. As a result of the dilatation of the vessels of this ligament, there is frequently observed, rather late in the disease, a dilatation of the subcutaneous veins of the anterior abdominal wall, especially of the right side, providing another communication with the vena cava. Around the umbilicus these often form a wreath or star, termed by the older writers the cirsomphalus or caput Medusæ. Sappey considered the appearance of this circle a favorable sign, denoting a removal or a diminution of the causes of ascites. It is not usually followed by any permanent improvement in the case, however, further than a slowing of the dropsical accumulations; but Monneret reported a case in which the ascites disappeared after the abdominal vessels had become largely distended. The occasional absence of dropsical effusions in very advanced cases of cirrhosis is explained as due to the development of these liberal anastomoses.

Not infrequently, owing to ulceration of the mucous membrane of the stomach or intestine, or to rupture of distended capillaries, blood is poured out in large or small quantities, and is vomited or is passed with the stools. Blood ejected from the stomach appears as normal coagula, as coffee-grounds, or as tarry matter; passed from the rectum, it is usually dark and tarry.

An enlargement of the spleen is generally associated with hepatic cirrhosis, and is then a further result of obstructed circulation. The increase of size is due as a rule to a simple hyperæmia, to a hyperplasia of the interstitial connective tissue, to syphilitic deposits, or to amyloid infiltration. The extent of the enlargement is exceedingly variable, being in one case hardly appreciable, and in another equal to several times the normal size of the organ. The frequence of its occurrence is variously estimated, owing probably in part to the difficulty with which the boundaries of this organ can be discerned in the presence of ascites.

Certain other symptoms are observed in the course of the disease, which require only brief consideration. With the early development of indigestion the individual commences to lose flesh and strength, his skin becomes dry and rough, and of a pale or ashen hue. Icterus, if it occur, is usually due to a catarrh of the bile-ducts, and may accompany a perihepatitis; it rarely occurs as a result of the cirrhotic contraction, except in the last stages of the disease.

The kidneys frequently undergo a cirrhotic or a fatty degeneration. The urine, owing to the faulty elimination of effete matters by the liver, is usually highly colored, sometimes turbid and depositing a brick-dust sediment; is at first increased in quantity, later becomes scanty, and frequently, in the last stages of the disease, contains albumen. The coloring matters of the bile are occasionally found in it.

Constipation is usually present in the early stages of the disease, but, at a late period, generally gives place to diarrhœa. The fæces vary in consistence and color. In the earlier stages of the disease they are usually firm, owing to constipation, but otherwise normal. With the progressive diminution of the biliary secretion, they become paler in color. Sometimes one portion is light and another dark, owing to the irregularity with which the bile is poured into the intestine. When diarrhœa supervenes, the dejections are usually of a grayish-yellow or a slate color, sometimes mingled with mucus, or tarry from admixture of blood from gastric or intestinal hæmorrhage. Severe intestinal hæmorrhages, if they occur, however, are usually observed only in the very last stage of the disease. Hæmorrhoids develop in some cases, but not in all. Anal fissures are also of occasional occurrence, and add much to the discomfort of the patient.

Late in the history of the disease, psychical disturbances, stupor, delirium, convulsions, and coma frequently supervene. These have been variously explained. They have been attributed for the most part to the toxic influence of absorbed bile-salts, and have therefore become known as cholæmia. Austin Flint, Jr., attributed their occurrence to the retention in the blood of cholesterine, from the discovery of this substance in the blood of an individual who had died of cirrhosis, and therefore termed the condition cholesteræmia. But this theory has been controverted by Von Krusenstern,[32] Pagès,[33] and Chomjakow.[32] Koloman Müller,[34] however, supports Flint's theory, since he has been able to produce cerebral symptoms (stertorous breathing, etc.), by the injection of cholesterine into the crural veins of animals.

As the case nears its termination, in the course of months or even years after the inception of the disease, the debility and emaciation rapidly increase, the appetite fails entirely, the dyspnœa becomes more and more urgent, and finally, in most cases, a serous diarrhœa supervenes, and the individual dies of exhaustion. In other cases he succumbs to hæmorrhage, pneumonia, acute pulmonary œdema, myocarditis, or with the symptoms of the retention of effete products to which reference has just been made (cholæmia). He then becomes jaundiced, purpuric spots or ecchymoses appear in the skin and mucous membranes, delirium, convulsions, and coma soon follow, and the individual dies of exhaustion.

The duration of the disease necessarily varies, depending upon the constitution of the individual, and still more upon his habits. In those rare instances in which the individual abandons at an early period his pernicious use of alcoholic stimulants, the disease is to a great extent, if not entirely, arrested, and the prognosis is favorable; if the disease is unrestrained, it may last for a period varying between six months and six years. Usually, however, death occurs within one or at most two years after the disease has been recognized—a time which

is usually marked by the appearance of dropsical effusions, with resulting dyspnœa.

Complications.—When such diseases as tuberculosis, pulmonary emphysema, diabetes, or such combinations in the liver itself as amyloid infiltration, cancer, or echinococcus, occur during the course of cirrhosis, they should doubtless be considered as entirely independent affections, rendering the disease more grave only by their injurious effects upon the constitution of the individual. Other diseases, however, of not infrequent occurrence, must be attributed in most cases to the same cause as gave origin to the cirrhosis of the liver; and diseases of yet another class are more or less directly induced by the hepatic affection. Among those owing their origin to the same etiological factor, mention may be made of fatty degeneration of the heart-muscle, lesions of the brain and its envelopes (alcoholic or syphilitic), chronic parenchymatous or interstitial nephritis, and fatty kidney (alcoholic, syphilitic, malarial). The third class of complications includes pulmonary œdema, bronchitis, pericardial effusion, general peritonitis, and gangrene of the œdematous skin.

Diagnosis.—Cirrhosis is to be differentiated, in its early stages, from all affections which cause enlargement of the liver; in the stage of contraction, from those which cause a diminution of its size, or are attended with ascites. In the first category we have amyloid disease, cancer, hydatids, and abscess. The history of alcoholic excess always favors the decision for cirrhosis. From amyloid infiltration it is differentiated chiefly by a history of long-continued suppuration, and the permanent character of the enlargement in the latter affection; from the enlargement of cancer by its persistent character and nodular surface, by its painfulness, and by the discovery of the disease in other organs. In a case of primary cancer attended with early occlusion of the portal vein and consequent atrophy of the liver, like that reported by Fagge,[35] the diagnosis would be impossible until, as in this case, microscopic examination of the specimen was made. From hydatids it is distinguished by the cystic character of the latter disease, with the fluctuation and sometimes purring thrill, and by the withdrawal of fluid containing hooklets, or having other characteristic features. In hydatids, abscess, and cancer the spleen is not usually affected; in cirrhosis it is not infrequently enlarged. Abscess may be further differentiated by its acute and often febrile course, its tenderness on pressure and, later, fluctuation, and by the withdrawal of pus by aspiration. In all these affections there is not usually so great disturbance of digestion and assimilation as in cirrhosis, until long after the diagnosis has been fully established. In doubtful cases, the character of the urine is often of the greatest value; a dark urine, of high specific gravity, and depositing a heavy sediment, rarely leaves any doubt of the existence of cirrhosis.

In the second category are acute yellow atrophy, occlusions of the bile-ducts, occlusion of the portal vein from thrombosis or inflammation, and local or general peritonitis. To these need hardly be added such remote affections as the cardiac lesions attended by dropsy and the last stage of pulmonary tuberculosis. Acute yellow atrophy, with its rapid course and profound constitutional disturbance, is generally easily excluded. In hepatic atrophy, which results from occlusion of the bile-ducts, there is usually a history of previous attacks of hepatic colic, and the presence of an intense icterus. In mechanical occlusion of the portal vein there is generally a history of advanced disease of the heart or lungs, the dyspnœa precedes the ascites, and œdema of the inferior extremities is, as a rule, the first symptom of dropsy; the liver diminishes more rapidly in size. Chronic peritonitis with ascites is sometimes difficult of differentiation, owing to the impossibility of accurately mapping out the liver. As a rule, however, there is local or general tenderness, indurated masses may be felt, and, as the disease usually depends upon the presence of tubercle or cancer, one of these affections may be recognized in other parts. The urine is nearly always light in color and of low specific gravity. The symptoms on the part of the digestive organs are usually less prominent, and finally, after paracentesis, the exact condition of the liver can generally be determined.

Treatment.—It is only in those rare instances when we are called upon to treat the disease in its early stages, that we may hope to arrest its progress, for when the parenchyma of the liver has once been destroyed, we are unable to effect its restoration. The only means we have of arresting the cirrhosis is by removing the irritation upon which it depends. The abstinence from alcoholic stimulants, even in moderation, is therefore imperative, and the use of highly-seasoned articles of food, spices, condiments, and even coffee, which, although among the least frequent causes of cirrhosis, are recognized as capable of producing a hyperæmia of the liver, should be discontinued. Articles which require bile for their assimilation, or are liable to undergo fermentation in its absence, should be eaten with caution; fats should be abstained from, sugar and starches eaten with moderation, and the diet should consist chiefly of skimmed milk, lean meats, acid fruits, and vegetables poor in starch.

If syphilis appears to be the cause of the disease, or if it exist in an active form, it should be treated by mercurial inunction, or with the iodide of potassium, alone or in combination with mercury. If malaria be traceable as the cause of the disease, or if the individual be subject to attacks of it, he should be removed as much as possible from its influence, and relieved from its attacks by the proper administration of quinine.

If acute symptoms of hyperæmia with pain, tenderness, and tumefaction supervene, relief is afforded by the application of hot fomentations, leeches, or cups to the right hypochondrium, and the daily administration of the milder saline cathartics, or the mineral waters of Carlsbad or Franzenbad. Blisters, or counter-irritation of the hepatic region by the tincture of iodine, or by frictions with a mercurial salve, are also beneficial. It is believed by some authorities that we can, by the administration of suitable remedies, arrest the overgrowth of connective tissue. The agents which have been recommended for this effect are the salts of gold, silver, copper, and mercury, arsenic and phosphorus. The compounds of iodine and the chloride of ammonium have also been employed with reported success for this purpose. Bartholow[36] believes that he has seen curative results in the commencement of the disease from the chloride of gold and sodium, and the phosphate of sodium. Dujardin-Beaumetz[37] has recently reported beneficial results from treatment with hippurate of lime, obtained by the action of hippuric acid on white lime.

After the fibrous tissue has formed and its contraction has begun, we can no more remove it or prevent its shrinkage than we can remove or control by medicinal means the cicatrices of a burn. The treatment of this stage must, therefore, be entirely symptomatic. Every effort should be made to improve digestion, and to increase the strength of the patient. Iron, arsenic, the bitter tonics, and a nutritious diet should be employed. The digestion may be improved by the administration of ten drops of phosphoric, hydrochloric, or nitro-hydrochloric acid, well diluted, after each meal. The decomposition of food in the small intestine may be prevented by ox-gall, carbolic acid, or creosote. Flatulence frequently proves a distressing symptom, and will call for the administration of a little spirit of peppermint, the aromatic spirit of ammonia, or turpentine. The accumulation of fluid in the peritoneal cavity may be checked, or when formed, may be removed, by the action of medicine upon the skin, upon the kidneys, or upon the bowels; or the fluid may be withdrawn by paracentesis. The milder methods should be chosen until the dyspnœa calls for prompt relief. We can best act upon the skin by warm water or vapor baths, or by pilocarpine administered subcutaneously; upon the kidneys by digitalis and the resin of copaiba; upon the bowels by the hydragogue cathartics, the compound jalap powder, colocynth, gamboge, or elaterium. These remedies may be employed separately and in succession, or their action may be combined; they must, however, be used with caution, especially in complicated cases, lest prostration result from them.

It is rarely, however, that medicinal treatment can do more than delay the development of urgent dyspnœa. When this occurs, tapping is generally resorted to, either by the trocar or by the aspirator. Shock should be averted by the administration of a little brandy just before the operation, and by suitable external compression with a bandage. In debilitated cases the fluid should be very gradually and cautiously withdrawn. It is never necessary to withdraw all the fluid, but only enough to permit easy respiration; for in some cases the complete removal of the serum appears to only hasten its reaccumulation.

Hæmorrhage must be met by the administration of opium, ergotine hypodermatically, ice, gallic acid, etc.

As the disease draws to a close the efforts of the physician are to be confined to the sustaining of the strength of the patient, even by free alcoholic stimulation. The occurrence of serous diarrhœa will require the administration of bismuth, opium, astringents, and mineral acids. The effect of the remedies is, however, but transitory, and does not long delay the fatal termination of the disease. *James M. French.*

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LIVER, ECHINOCOCCUS OF THE (Syn.: Hydatid Cyst).

Definition.—A cystic disease of the liver, due to the presence of a larval form of the tænia echinococcus, causing a gradual enlargement and alteration of the form of the organ, and various functional disturbances both in the liver and in adjacent organs.

History.—In the works of Hippocrates,[1] Galen,[2] Aretæus,[3] and other ancient writers, references are made to large cysts of the liver containing water and, in some instances, numerous vesicles, which were undoubtedly hydatid in character; and in the literature of the sixteenth and seventeenth centuries we find many unequivocal references to the disease. The first accurate descriptions of the cyst are to be found for the most part in the "Sepulchretum" of Bonetus.[4] The parasitic nature of the disease was not known, however, until Pallas,[5] in 1766, discovered the parasite and showed its close relationship to the tapeworm. Götze, in 1782, determined that the scolices were the heads of embryonic tænia, and Bremser,[6] in 1821, described the disease as it occurs in man. The term echinococcus was introduced by Rudolphi, in 1801. The exact relationship of the echinococcus to the parent tapeworm, and the manner in which it invades the human body, remained hypothetical until Küchenmeister,[7] Von Siebold,[8] and Leuckart,[9] showed by direct experimentation that the hydatid is the larval state of the tænia echinococcus, which infests the alimentary canal of certain lower animals. The literature of the subject has been greatly added to by Davaine, Budd, Andral, Frerichs, Murchison, Heller, and Madelung.

Etiology.—Echinococcus of the liver is met with more frequently in Iceland than in any other part of the globe. It has been estimated that every seventh person in that country harbors the parasite. Jonassen,[10] says, however, that this estimate is too high for the average occurrence of the disease in the entire island. No part of the world is exempt from the disease, but the statistics of its frequency in many parts are very meagre. In the United States, and in most parts of Europe, it is comparatively rare. Osler,[11] of Montreal, discovered the parasite three times in the examination of over eight hundred bodies. He was able to collect only forty-four cases of liver echinococcus in America, and some of these had been imported. In some localities, however, as in Iceland, the disease is always more or less prevalent, owing to the fact that the domestic animals have become pretty generally infected by the tænia.

The disease appears alike in both sexes, and at all ages, except during infancy.

It was formerly supposed that the dog was the only host of the tænia echinococcus, a supposition based on the frequency of the disease in Iceland, where it is known that the dogs are largely infested by the worm, and where these animals come into closer contact with the people than in other countries. The ova were supposed to enter the alimentary tract of man in drinking-water, or in food infected by the fæces of the dog, or by this animal licking the face of the individual. The discovery of the parasite in the wolf and fox did not materially affect this conclusion. But, more recently, it has come to be believed by many that the disease may be developed from the larval scolices ingested in eating infected meat. Scolex-bearing cysts have been discovered in the livers and other tissues of the ox, sheep, hog, goat, deer, horse, squirrel, and many other animals. Richardson[12] attributes the frequent occurrence of the disease among the shepherds of Victoria, South Australia, to the eating of mutton, in the belief that the sheep have become infected from the shepherd-dogs. Thomas[13] found at least forty per cent. of unregistered dogs, in various parts of Australia, infested by the tænia echinococcus. Heller[14] has suggested the possibility of auto-infection, on the supposition that the tænia may gain lodgement in the alimentary canal of man, although its presence there has not been demonstrated. Richardson's view is especially emphasized by Madelung in the Report of the Mecklenburg Physicians.[15] He shows that the dogs of Mecklenburg, where the disease is comparatively frequent, are not more numerous, do not come into closer contact with the people, and are not more generally infested by the tænia than in South Germany, where the disease is rarely encountered. Sheep, on the other hand, are more numerous than the people. Echinococcus cysts have repeatedly been discovered in these animals, especially in their livers, but further investigation is necessary to establish the extent of such infection. The possibility of the disease being communicated in this manner should therefore be remembered.

Pathology.—As previously stated, the echinococcus cyst is the larval state of the tænia echinococcus. This parasite is about four or five millimetres (¼ inch) in length, and consists of a head and three segments (see p. 53 of vol. ii.). The head supports a rostellum bearing from twenty-eight to fifty-two rather blunt hooklets, arranged in two rows, as first recognized by Livois. The last segment is larger than the others combined, is endowed with both male and female generative organs, and, according to Leuckart, has the power to accomplish its own fecundation. This view is not, however, accepted by all investigators.

After fecundation has occurred the segment becomes filled with ova, estimated at about five thousand in num-

ber, each containing an embryo. As soon as the embryos have become mature, the segment containing them becomes detached from the anterior portion of the worm, and is discharged from the intestinal canal of its host, either in its entirety or after it has been ruptured and has evacuated the contained ova. Birth per vaginam is rendered improbable by the relatively small size of this channel. The ova reach the stomach singly, or in numbers, in the manner that has been described. Here the dense, sometimes calcified, capsule is dissolved by the gastric juice, and the embryo is liberated. This is an oval, globular body, about three times as large as a human blood-corpuscle, and armed at one extremity with six minute hooklets. From its point of liberation in the stomach or small intestine the echinococcus reaches the liver, either by boring directly through the intervening tissue, or by penetrating a branch of the portal vein, and being carried to the organ by the blood-current, or by passing up the bile-duct. Its migration, unlike that of the cysticercus or the trichina, is unattended by symptoms. Fortunately, the greater number of the parasites are destroyed before leaving the alimentary canal, and the cyst is usually single, but several cysts have occasionally been found in proximity. The cyst is usually located near one of the surfaces of the right lobe, but may be found in any part of the organ. The growth of the cyst is slow, years sometimes elapsing before it has become large enough to create appreciable disturbances. When discovered, as in autopsy, it varies in size from that of a millet-seed to that of the human head. The latter limit is rarely exceeded, but Leuckart records a case in which the cyst and its contents weighed thirty pounds.

FIG. 2169.—Tænia Echinococcus. × 12. (Leuckart.)

The cyst of the echinococcus is sometimes very delicate and of a gray color, sometimes thick and translucent, but is little more dense than coagulated egg-albumen. It is lamellated, consisting of a variable number of concentric layers, composed of a substance resembling chitine.[16] The inner layer, known as the parenchymatous or germinal membrane, is granular, and, according to Naunyn,[17] is provided on its inner surface with rapidly vibrating cilia. After the echinococcus has existed in the liver for a variable time, usually for from two to five months, little mounds appear on the surface of the germinal layer, each of which has a small depression at its apex, which later becomes a vacuole-like cavity. These cavities then enlarge, and are known as daughter-cysts. The process of budding may occur in the daughter-cysts, giving rise to granddaughter-cysts. Either generation of cysts may develop either endogenously, projecting into the interior of the cyst, or exogenously, projecting from its outer surface. The former method of growth is much the more common in man. The number of cysts formed varies from a few to several thousand. From the surface of the daughter or granddaughter cysts, scolices, the heads of embryonic tænia, develop, either singly or in as great number as nine or more (Heller). These appear as conical projections, each having on its free extremity a rostellum, armed with a double row of hooklets and four suckers. The opposite extremity becomes constricted into a narrow pedicle, which later divides, liberating the scolex, thenceforth to float freely about in the interior of the capsule. The scolices and the brood-capsule are endowed with the power of contraction, so that the heads may be protruded from the surface of the capsule or withdrawn; and after the head has become detached, it has also the ability to withdraw its anterior portion, with the rostellum and suckers, into the larger posterior part. It thus acquires a spherical form. Throughout the parenchyma of the scolex more or less numerous oval or spherical calcareous bodies are generally observed. Very rarely in man, although more frequently in the lower animals, scolices develop directly from the germinal layer of the mother-cyst, without the intervention of daughter-vesicles. Küchenmeister[18] attributes this phenomenon to the invasion of what he designates the echinococcus scolicipariens, having from twenty-eight to thirty-six hooklets; while he designates the parasite which produces daughter-vesicles the echinococcus altricipariens. This he describes as having from forty-six to fifty-two hooklets, and as sometimes present in the small intestine of man. His view has not, however, been generally accepted. Daughter-cysts may develop also within the scolex, which then gradually becomes converted into a capsule.

In another variety of the disease, the cysts remain sterile, no scolices being formed. These were first described by Laënnec, and were by him designated acephalocysts.

The multilocular echinococcus is another form of cyst, which is encountered once in about one hundred and eighty cases of the disease. The sac, sometimes of very large size, is surrounded by an exceedingly dense fibrous capsule, firmly united to the surrounding tissue; is subdivided into numerous small cavities, and is filled with a thick, gelatinous, or colloid material, rarely containing scolices. Owing to the peculiar colloid matter and its liability to undergo caseous or purulent transformation, this form of echinococcus was formerly confounded with the colloid cancer, until its real structure was demonstrated by Virchow.[19]

The echinococcus vesicles float in a limpid, usually clear, fluid, of neutral reaction, with a specific gravity of from 1.006 to 1.015. Sometimes, however, the fluid has a yellow or a pale green tint, and is slightly alkaline from admixture of bile, or is opalescent from the presence of fatty matter and other débris; or it may be a pale red from admixture of blood. Chemical analysis shows the presence of from 0.50 to 0.76 per cent. of sodium chloride, and small quantities of the earthy compounds of succinic acid, inosite, and grape-sugar. Albumen is rarely present, except from the admixture of blood. Urea, creatine, and hæmatoidine,[20] have occasionally been found, the last being considered peculiar to hepatic echinococci. Cholesterine is found in cysts whose contents have undergone fatty degeneration.

As a result of the irritation produced by the echinococcus vesicle in the liver-tissue, a firm fibrous wall is formed around it by a hyperplasia of the fibrous tissue of the organ, which extends also to the interlobular tissue for a variable distance around the cyst. This capsule is supplied with blood by vessels arising from the branches of the portal vein and hepatic artery. Old capsules frequently become more or less calcified (see Fig. 2171). As the cyst enlarges the parenchyma of the liver is, to a variable extent, destroyed. In some instances, the cyst is of very large size, but little of the gland remaining.

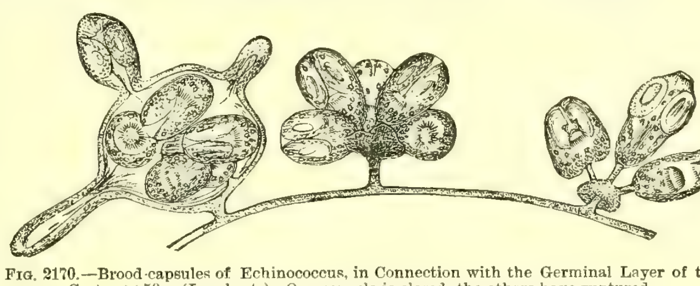

FIG. 2170.—Brood-capsules of Echinococcus, in Connection with the Germinal Layer of the Cyst. × 50. (Leuckart.) One capsule is closed, the others have ruptured.

The echinococcus sometimes dies, either spontaneously or as a result of accidents from without. Its growth is then arrested, and the cyst remains as a foreign body in the substance of the liver, its contents frequently undergoing retrograde changes and absorption, or calcification; or suppuration occurs, and the pus finds exit externally or through a neighboring viscus.

SYMPTOMS, COURSE, AND TERMINATION.—Echinococci frequently exist in the liver for years without occasion-

ing symptoms by which their presence is indicated; this is especially the case when the cyst is of moderate or small size, and is located deep in the substance of the organ. The greater number of echinococci have been discovered post-mortem. Only 7 out of 13 cysts, discovered in autopsy at Rostock, had been diagnosticated during life (Thierfelder); of 22 discovered at the Berlin Charité, 13 had been diagnosticated; and Madelung estimates that, outside of hospitals, only one-third of the cases are recognized during life.

In the majority of cases the first symptom to attract attention is the formation of a tumor in the region of the liver—an apparent enlargement of the organ. The direction of greatest protrusion depends chiefly on the location of the tumor. If situated in the anterior portion of the right lobe, the hypogastrium is rendered prominent; if in the upper portion of the lobe, it may push upward into the thorax, elevating the diaphragm, impeding respiration, often displacing the heart upward and to the left, and compressing the right lung so that the entire right side of the thorax yields a dull tone on percussion. It may also obliterate the intercostal furrows and even cause undue prominence of the chest-wall. If situated in the lower portion of the lobe, the cyst may extend down to the pelvis; when in the left lobe, the epigastrium becomes prominent and the spleen may be displaced. In a few cases the hydatid cyst has been found attached to the surface of the liver by a slender pedicle.

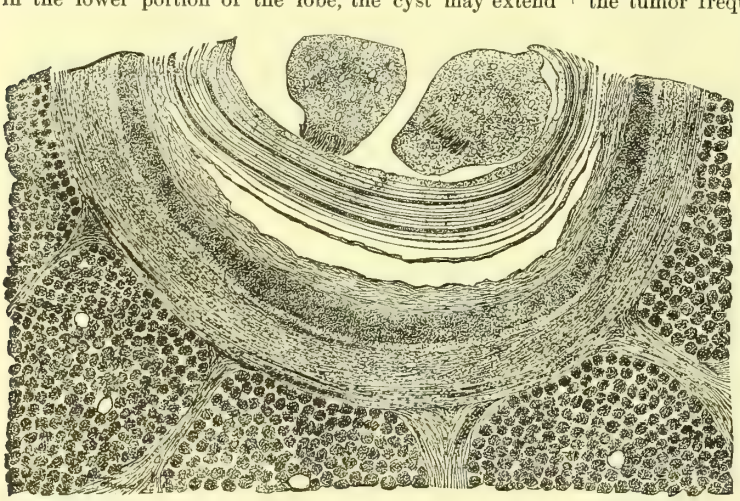

FIG. 2171.—Section of Echinococcus Cyst containing Two Scolices, in One of which the Rostellum is Protruded, in the Other Withdrawn. The firm capsule surrounding the vesicle shows a moderate degree of calcification. × 400. (From an original drawing.)

If accessible to palpation, the cyst gives the impression of a smooth globular tumor, fluctuating as a rule, although not always, and frequently somewhat irregular in outline. If the tumor be of large size and contain many daughter-vesicles, and if the abdominal wall be not too thick, we may, by grasping the tumor and exerting moderate compression with one hand, and striking a quick and pretty forcible blow upon it with the other, elicit a peculiar vibratory sensation—the hydatid purring of Briançon—which has been compared to the trembling of a bowl of jelly. By many this sign is considered pathognomonic of echinococcus, but unfortunately it is absent in about half the cases, and has also been elicited in ovarian cysts and ascites.

Pain is, according to most authors, an infrequent symptom; yet Finsen, of large experience (245 cases), gives it as an early and prominent symptom. Bamberger is probably correct when he states that some cases, until late, present no symptoms referable to the liver, while others are attended with more or less intense, undefined, pressing or lancinating pains.

The pressure of a large echinococcus cyst upon adjacent organs produces symptoms which belong alike to all abdominal tumors of large size. Prominent among these are dyspnœa with cough, cardiac palpitations, indigestion, vomiting, constipation, and later ascites, œdema, and occasionally varicose veins. Unless the tumor be located in the immediate proximity of the portal vein or bile-ducts, these vessels are not generally interfered with until late, when the growth has become large; jaundice is not, therefore, often present. There is usually no fever unless suppuration have occurred, and the nutrition of the individual, as a rule, is maintained. Suppuration of the cyst is announced by the development of pain and tenderness, and an elevation of temperature.

Rupture of the cyst occasions a new train of clinical manifestations, varied according to the direction in which the perforation occurs. The most favorable course which the fluid can take is directly through the abdominal wall; next to that, is into the stomach or intestine, into the gall-duct, the ureter, or the vagina. Spontaneous recovery has followed evacuation by each of these routes. Rupture through the integument is generally preceded by "pointing;" rupture into the hollow viscera is followed by sudden intense local pain, and the subsequent evacuation of a large quantity of fluid containing numerous vesicles. After rupture into the intestine or stomach the tumor frequently becomes tympanitic from the admission of air. An interesting case of perforation into the bile-duct, followed by evacuation of the cyst-contents and recovery, is reported by Cayley.[21] Twelve attacks of pain, resembling that of the passage of gall-stones, with intense icterus, were experienced by the individual, in the last of which the cysts were evacuated. The entrance of bile into the sac causes death of the echinococcus and favors recovery. Rupture through the diaphragm into the pleural cavity causes severe pain and urgent dyspnœa. If death do not result promptly from shock or from violent pleuritic inflammation, the fluid may ultimately perforate a bronchial tube and thus find exit. The latter accident may prove fatal, either suddenly from strangulation, or in the course of weeks or months from prolonged suppuration, gangrene of the lung, and final exhaustion; or it may lead to recovery. It is signalized by a sudden expectoration of fluid, generally purulent or bloody in character, and containing echinococcus vesicles, entire or in fragments, and is commonly followed by a pneumothorax.

Perforation of the pericardium proves fatal immediately, or from acute pericarditis. After rupture into the peritoneal cavity death results from acute, generally violent, peritonitis.

In a few cases the inferior vena cava has been perforated, giving entrance to the vesicles and leading to instant death from embolism of the pulmonary artery. Perforation of the arterial system leads to embolism and its consequences.

Spontaneous recovery may occur from the death of the echinococcus, the sac remaining throughout the life of the individual as an inoffensive foreign body in the substance of the liver, its contents undergoing absorption or calcification. It is believed also that recovery has occurred by an evacuation of the cyst through the bile-ducts without the production of symptoms by which the event was recognized. Little is known of the influences which are capable of causing the death of the parasite.

The multilocular echinococcus is usually firm, rarely fluctuates, and is generally sensitive on pressure. It is frequently accompanied by enlargement of the spleen and ascites. Gastric disturbances are also more frequent than in the unilocular cyst, and jaundice is usually present. Gastric and intestinal hæmorrhages and an effusion of blood into the subcutaneous tissues have occurred.

DIAGNOSIS.—Echinococcus of the liver is to be differentiated from cancer, amyloid infiltration, syphilis, cirrhosis, and abscess of the liver, and occasionally from hydro- or pyo-thorax, from cystic disease of the retroperitoneal lymph-glands, from enlargement of the gall-bladder, and from aneurism of the abdominal aorta. In the early history of the disease its differentiation from other tumors of the liver or its neighborhood is often very difficult. A tumor with the history of slow, painless growth, with elasticity, fluctuation, and the peculiar hydatid fremitus, is in all probability an echinococcus. In every case, however, sufficient fluid should be withdrawn, through a small needle, to permit microscopical and chemical investigation. If the fluid be clear, limpid, free from albumen, of low specific gravity, and contain inosit and succinic acid, there can be little doubt of the hydatid character of the tumor. By the discovery of hooklets (Fig. 2172), and fragments of lamellated membrane, the diagnosis is established. But, unfortunately, many of these features are generally absent.

FIG. 2172.—Hooklets as found in Echinococcus Fluid. × about 750.

From cancer, the echinococcus may generally be distinguished by the absence of the lancinating pains, the tenderness, and the hard nodular surface of the latter, which is also frequently associated with a cachexia and cancer of other organs ; from the medullary carcinoma, which has undergone softening, the distinction is often very difficult. The multilocular echinococcus can rarely be differentiated during life. From amyloid infiltration it is distinguished by the absence of the hardness, as well as of the history of prolonged suppuration and the wax-like hue of the skin that is characteristic of this affection. Syphilis must be excluded by the absence of evidences of present or past specific disease of the skin, mucous membranes, bones, and genitalia. In cirrhosis the enlargement of the liver is not permanent, and there are usually ascites and enlargement of the spleen, with the history of alcoholic excess and consequent gastric disturbances, which do not belong to echinococcus. Abscess of the liver usually follows an acute inflammation of the abdominal or pelvic organs, and is associated with acute symptoms, chills, fever, pain, and tenderness. An echinococcus which has elevated the diaphragm is distinguished from hydro- or pneumo-thorax, by the course of the upper boundary of percussion dulness, which, in the echinococcus, is highest in the axillary line. Further, a pleuritic exudation is generally preceded by an acute attack of pain and dyspnœa, with fever and cough, and is frequently traceable to cardiac or renal disease, or to pulmonary tuberculosis ; whereas, echinococcus requires months, or even years, for its development, and by it the heart is pushed upward as well as to the left.

Cystic enlargement of the retro-peritoneal lymph-glands has rarely to be excluded ; but in a case reported by Ransohoff [22] the liver was so compressed, and its boundaries so enlarged by a smooth, globular, fluctuating tumor, that appeared to be a part of the liver, that the echinococcus could not be excluded until an exploratory incision had been made.

Enlargement of the gall-bladder can be confounded only with a pendulous echinococcus cyst. Chemical and miscroscopic examination of the fluid is sufficient to establish the diagnosis.

Aortic aneurism can generally be excluded by its position and outline, which are usually different from those of echinococcus cyst, as well as by its pulsation. Pean observed a case, however, in which an echinococcus cyst, as large as a child's head, projected forward and rested directly upon the aorta in such a manner as to transmit a strong impulse.

An important point which arises in the differentiation of the echinococcus cyst, especially with reference to the adoption of operative procedures, is to determine whether the cyst is simple or compound, *i.e.*, whether the daughter vesicles have developed endogenously or exogenously. Occasionally the presence of two or more large and distinctly defined prominences will denote the presence of the latter variety, and the diagnosis will be established if, after withdrawal of the fluid from one cyst, the others remain distended. It may also be suspected in case the quantity of fluid which can be withdrawn from a large tumor by aspiration is relatively small. The case reported by Whittaker [23] is of interest in this connection. Here a large cyst protruded and was incised, the writer being present at the operation, the numerous smaller cysts found at the autopsy a few weeks later not being recognizable.

PROGNOSIS.—The prognosis of echinococcus depends largely upon the size of the cyst and its location in the liver. If death of the parasite occur, whether spontaneously or as a result of accident or of medicinal treatment, recovery is almost certain. If the cyst rupture into a serous cavity, the prognosis is exceedingly grave ; if into the vena cava, it is fatal ; if into other vessels it is usually so. Rupture into the intestinal canal, directly or through the bile-duct, is, next to perforation of the abdominal wall, the most favorable route of exit. The prognosis of a living echinococcus in the parenchyma of the liver should always be considered sufficiently grave to warrant the adoption of measures for its destruction as soon as practicable after its discovery.

PROPHYLAXIS.—This consists in the prevention of the contamination of food and drink by the ova of the tænia echinococcus. In Europe and America, where the domestic animals do not necessarily come into so close contact with their masters as in Iceland, and where greater attention is paid to the laws of cleanliness, the disease may be largely controlled. To this end, and in view of Richardson's theory of infection from the flesh of domestic animals, the public, as well as the profession, should be educated to the necessity of excluding dogs from those localities in which their fæces may contaminate the food and drink not only of man, but even of sheep and cattle ; for it is probable that these animals are infected chiefly by the deposit in their pastures of the fæces of infected dogs, or by drinking water thus contaminated. Neither should dogs be allowed to eat the refuse or viscera of slaughtered animals, or, in fact, any uncooked flesh. All meats should be thoroughly inspected for the cysts, and should be thoroughly cooked before being eaten by man ; and vegetables desired for raw consumption, as lettuce, celery, cabbage, and cresses, should be thoroughly cleansed and inspected before being placed on the table. Boiling is sufficient to destroy the vitality of the ova in either animal or vegetable food.

MEDICINAL TREATMENT.—The use of medicines in the treatment of this disease has been pretty generally abandoned, for it is not believed that any drug can penetrate the dense capsule which surrounds the parasite, in sufficient strength to exert a destructive influence upon it. But that the interior of the sac is not wholly excluded from communication with the general circulation is proved by the occasional occurrence of toxic effects from fluids injected into it. Curative results have been attributed to the use of various drugs. Hjaltelin,[24] for example, administered from thirty to forty drops of the tincture of kamala, three times a day, with curative effects, as he believed, in twenty-two cases ; and Heckford [25] caused a

cyst in the left lobe to disappear by the daily administration for five weeks of twenty-seven grains of the iodide of potassium. The preparations of mercury, turpentine, and other anthelmintics, have been lauded. Laënnec attributed curative effects to frequent bathing in salt water, and fomentations of strong brine over the region of the liver have been recommended on the supposition that salt thus applied reaches the interior of the cyst. The application of cold to the surface of the tumor in sufficient degree, and long enough, to penetrate the mass, has been suggested, due caution being exercised not to damage the adjacent structures. When, however, we reflect that death of the echinococcus has sometimes occurred spontaneously, or as a result of the most trivial accident, we can readily comprehend how cures may be attributed to the most improbable agencies.

Surgical Treatment.—Surgical measures are indicated, as a rule, as soon as the character of the growth has been recognized, for the chances of recovery are directly proportionate to the early destruction of the echinococcus. The methods employed are: (*a*) simple acupuncture; (*b*) puncture and aspiration; (*c*) the injection of irritant fluids after aspiration; (*d*) electrolysis; and (*e*) free incision with subsequent drainage and irrigation. The simpler methods should first be attempted.

Acupuncture has proved successful in a few cases, and is strongly advocated by some, especially by Bartholow; but the hope for anything like universal success from it can hardly be entertained. Aspiration has proved successful when only a small quantity of the fluid has been withdrawn, as well as after complete evacuation of the cyst. Its chief element of danger is the certainty with which suppuration follows its repetition beyond a certain limit; it should not, therefore, as a rule, be repeated more than once or twice. After the withdrawal of fluid by aspiration various substances have been injected for the purpose of destroying the parasite. Alcohol, bile, and the compound solution, or the tincture, of iodine have been most used for this purpose. The results have not been uniformly satisfactory, and the procedure is not devoid of danger.

Electrolysis was originally proposed by Michon[26] and Althaus,[27] but was first extensively employed by Fagge and Durham,[28] who report eight successive recoveries from its use. The method consists in introducing into the most prominent part of the tumor two fine, gilded, steel needles, two inches apart, and both connected with the negative pole of a ten-cell battery capable of decomposing a saline solution. The positive pole—a moistened sponge electrode—is then placed on the surface, and moved about over the hepatic region. The current is permitted to pass for about ten minutes. In the cases to which reference has been made, the immediate effect on the tumor was often a slight increase of size, owing to the disengagement of hydrogen gas. Constitutional disturbances were also produced in all but one case, the temperature ranging between 100° and 103° F. for from two to nineteen days. Later, however, the tumor diminished in size, and finally disappeared, its absorption requiring from a few weeks to several months.

Incision of the echinococcus cyst may be performed by a continuous operation or at two sittings, inflammatory adhesion of the peritoneal surfaces being waited for in the interim. The old Récamier method of securing adhesion by means of caustic applications has been abandoned, owing to its frequent failure to secure adhesion and its great liability to cause peritonitis. The method now generally adopted is that of first sewing the wall of the cyst to the abdominal wall and cutting between the sutures. The steps of the operation are the same as those adopted in opening an hepatic abscess and need not be detailed here. Since the introduction of antiseptic methods, during and after the incision, the operation has become a much less dangerous one. Formerly its mortality was so great as to prevent its general adoption; but more recently Lihotzky[29] has reported twenty-five operations, four of which were under his own observation, with only four deaths, and three of these not attributable to the operation. Lihotzky's operations were all made by the two-sittings method, and were all successful. Neisser[30] estimates the mortality at about one-third. Even if the latter estimate be correct, the operation is certainly indicated, at least after milder measures have failed.

Cases are sometimes encountered which require special methods of treatment, as where the echinococcus is pendent and attached to the liver by a pedicle, and has to be removed *en masse*.

The treatment of the multilocular echinococcus is wholly symptomatic. *James M. French.*

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2 Galen: Comment. in Aphorismos, vii., 54.
3 Aretæus: De Causis et Sign. Diuturn. Morb., lib. ii.
4 Bonetus: Sepulchretum, lib. iii., Sect. 21.
5 Pallas: De Infestivis vivent. intra vivent., Diss. Inaug.
6 Bremser: Journ. Complém., Paris, tom. xi., p. 282 (Davaine, p. 360).
7 Küchenmeister: Prager Vierteljahrsschrift, 1852.
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9 Leuckart: Die Blasenbandwürmer u. ihre Entwickelung, 1856.
10 Jonassen: Quoted by Madelung, op. cit., p. 18.
11 Osler: Amer. Journ. of the Med. Sciences. October, 1882.
12 Richardson: Edinburgh Med. Journal, 1867, p. 525.
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15 Madelung: Beiträge Mecklenburg. Aerzte zur Lehre von der Echinococ.-Krankh. Stuttgart, 1885.
16 Lücke: Virchow's Archiv, vol. ix., p. 189, 1860.
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18 Küchenmeister: Die in u. an d. Körper d. lebend. Mensch. vorkommenden Parasiten, vol. i.
19 Virchow: Archiv für Anat., vol. xi., p. 80.
20 Davaine: Traité des Entozoaires et d. Malad. Vermin., 2me edit., p. 280. Paris, 1877.
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22 Ransohoff: Cincinnati Lancet and Clinic, vol. xi., p. 451, 1883.
23 Whittaker: Medical News, Philad., vol. xlix., p. 579, 1886.
24 Hjaltelin: Edinburgh Medical Journal, vol. xiii., p. 137.
25 Heckford: British Medical Journ., 1868.
26 Michon: Cited by Davaine, op. cit., p. 596.
27 Althaus: On the Electrolitic Treat. of Tumors, etc. London, 1867.
28 Medico-Chirurg. Transact., 1871, p. 1.
29 Lihotzky: Deutsche Zeitschr. für Chirurg., Bd. xxiii., 1885, p. 114.
30 Neisser: Die Echinokokkenkrankheit. Berlin, 1877. (Quoted by Lihotzky.)

LIVER, ENLARGEMENTS OF THE. In order to make a satisfactory diagnosis in cases of suspected hepatic enlargement, it is necessary to remember the following facts: The liver of a well-developed, healthy adult male of medium height measures 11 to 12 inches in its greatest transverse diameter; 6 to 7 inches in its greatest antero-posterior diameter, and 3½ inches in its greatest thickness, which is in the posterior part of the right lobe. A normal liver in such an individual will weigh from fifty to sixty ounces avoirdupois. On the other hand, in an equally well-developed adult female, the liver will be found a trifle smaller, and the three diameters above given will be 10 to 12 inches, 6 to 6½ inches, and 2½ to 3 inches respectively. These are standard measurements, about which such Anglo-Saxon writers as Quain,[1] Harley,[2] and Gray[3] differ very little. It is well to remark, however, not only that a considerable variation in weight is noticeable within the limits of health, but also that the relative weight of the liver diminishes in a direct ratio from infancy to old age, as is shown by the subjoined statement.

At birth the liver weight is as 1 to 28 of the whole body; in infancy, 1 to 20; at puberty, 1 to 30; at adult life, 1 to 35; in middle life, 1 to 40; in old age, 1 to 45.*

Indeed, it is a matter of clinical experience that the liver in childhood is disproportionately large, while in very old people it is relatively small. Still it will be seen from the above that from puberty to middle life the weight should represent on an average one-thirty-fifth of the entire bodily weight. Accordingly, in a healthy adult male of one hundred and seventy-five pounds the liver may properly weigh five pounds, while in an equally healthy but slight woman of one hundred and five pounds the organ would not be abnormally small at three pounds.

But in reality these weights and measurements are

* These ratios agree in the main with those of Frerichs (Diseases of the Liver, vol. i., p. 13).

more interesting to the anatomist than to the practising physician, who cannot measure and weigh, as is done in the post-mortem room; for he has to depend upon the scanty data derived from palpation, as applied to a limited part of the lower edge or extremity of the organ, or to percussion (ordinary or auscultatory), the purpose of which is to delimit those portions of the organ that his fingers cannot feel. Indeed it is readily understood that the liver is in a large measure inaccessible, from causes that are attributable to its anatomical situation. For, although it is a solid organ which yields a decidedly dull note on percussion, either the lungs or the stomach or the large intestine may so overlap it that at times the physician will fail to elicit any characteristic note indicating its presence. This sometimes happens in cases of extreme and rapid atrophy; when, however, the disappearance of the percussion note may prove to be a most valuable diagnostic sign. Usually a considerable portion of hepatic tissue is found immediately beneath the anterior wall of the abdomen, and percussion will determine the size of the organ with a sufficient degree of accuracy for

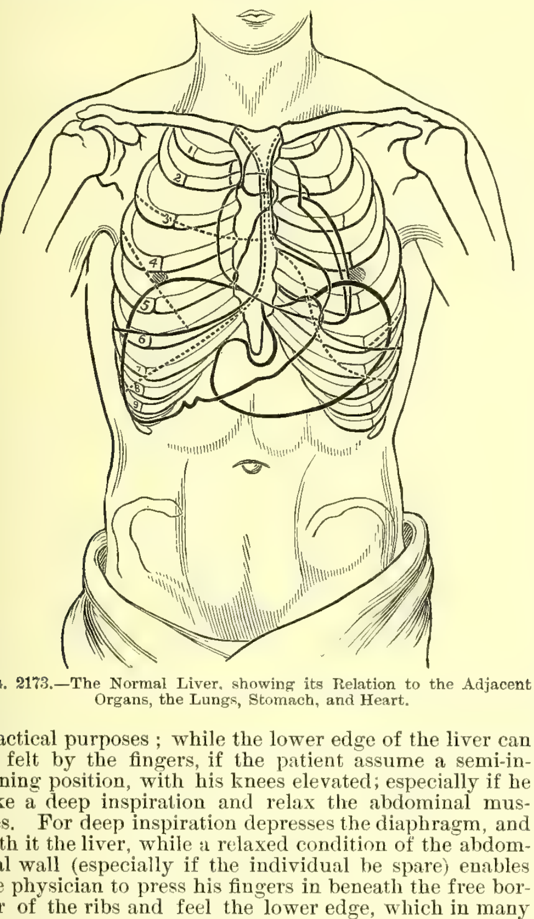

FIG. 2173.—The Normal Liver, showing its Relation to the Adjacent Organs, the Lungs, Stomach, and Heart.

practical purposes; while the lower edge of the liver can be felt by the fingers, if the patient assume a semi-inclining position, with his knees elevated; especially if he take a deep inspiration and relax the abdominal muscles. For deep inspiration depresses the diaphragm, and with it the liver, while a relaxed condition of the abdominal wall (especially if the individual be spare) enables the physician to press his fingers in beneath the free border of the ribs and feel the lower edge, which in many affections has a characteristic contour. Of course, when ascites exists, or when the bowels are distended with gas, the abnormal condition should be removed by appropriate means, in order to facilitate a diagnosis. And it is in such cases that palpation alone, or combined with percussion, will yield the most brilliant results.

There is always considerable difficulty, however, in determining the upper border of the liver. And, as if to add to the confusion, writers are not agreed upon the position it should occupy in the healthy individual. Thus, while Luschka puts the actual upper limit measured along the margin of the sternum (as in Fig. 2173), at the fifth interspace, others place it at the lower edge of the fourth or fifth rib.[4] In the middle line, however, the upper margin is generally stated to correspond with the root of the ensiform cartilage and in the mammillary line

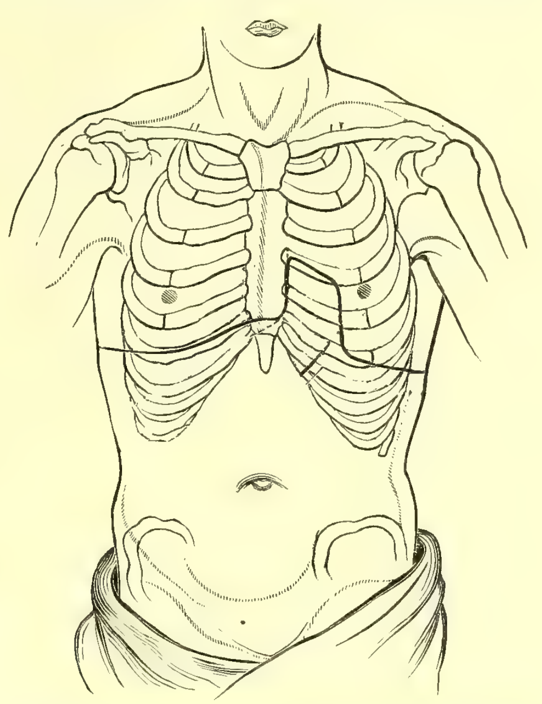

FIG. 2174.—The Area of Normal Flatness lies, as indicated in the diagram, between the sixth rib and the free border of the tenth rib.

with the lower edge of the fourth rib (see Fig. 2173). There is almost entire unanimity, however, in describing the line of absolute dulness (flatness) as commencing at the sixth rib, in the line of the nipple, and reaching to the free border of the ribs (Fig. 2174). The upper limit of relative dulness begins, according to Loomis,[5] in the fifth interspace, as indicated by the dotted line in Fig. 2173. The width of the hepatic flatness is about four inches in the line of the nipple; four and a half inches in the axillary line; while in the median it reaches from the root of the ensiform cartilage to one and a half inch below its apex. The left lobe usually extends not more than two inches beyond the median line. In the axillary line the upper limit of hepatic flatness should correspond with the seventh space (Fig. 2175); beyond the axillary line the liver flatness cannot be satisfactorily traced, because the lung intervenes; but if deep percussion reveal it, the upper limit should correspond with the ninth rib, in a line drawn downward through the upper and lower angles of the scapula (see Fig. 2176). It is claimed by some clinicians

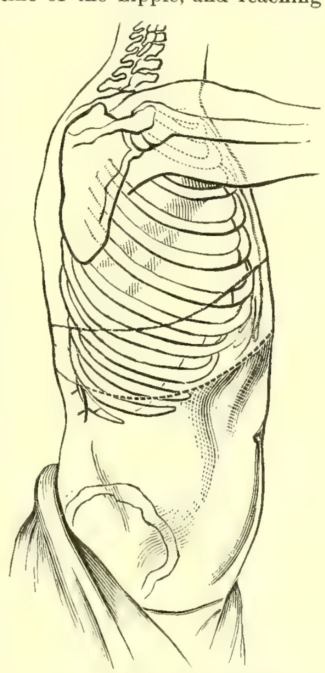

FIG. 2175.—Representing the Percussion Area of the Liver in the Axillary Line.

that the upper limit may be determined by auscultatory percussion in most cases.

When the intestines are filled with air, it is by no means easy to mark out the lower limit of the liver by percussion; but in such cases palpation may assist, if the following plan is adopted: The patient having assumed the posture that has been described, the examiner presses with one hand upon the epigastrium. Then, after the patient has taken a deep breath, and while he is slowly letting the air out, the examiner presses the fingers of his other hand under the margin of the ribs. In many cases the edge of the liver may then be felt.

It is desirable, of course, that the patient should always lie upon the back when an examination of the liver is made, else satisfactory conclusions cannot be reached. Some of the differences in opinion that have prevailed among writers are due to the fact that measurements were not always made when the patient was in this position, as will presently appear. It has been found, for example, that in a man of five feet seven inches, lying on his back, the line of flatness carried through the nipple is four inches, while a similar line drawn through the nipple of the erect individual would only measure three and a half inches, and because in the latter posture the anterior face of the liver falls away from the anterior wall of the body.

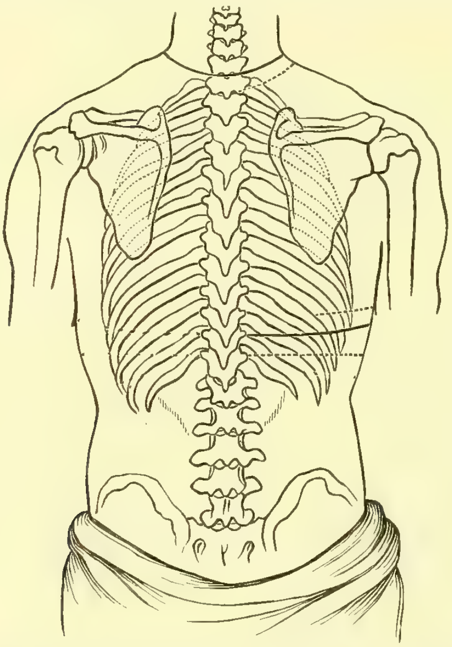

FIG. 2176.—Diagram representing the Percussion Area of the Liver from Behind. The dark line shows the upper limit of hepatic flatness; the upper and lower dotted and parallel lines indicate the upper and lower limits of dulness.

And yet, if the individual should measure six feet in height, the line of perpendicular dulness should not exceed four and a half inches even when lying upon the back,[6] and any excess over this figure is (anomalies excluded) evidence that the organ is unduly enlarged. But in any case, whether the patient be tall or short, the left limit of hepatic dulness should not extend more than two inches beyond the ensiform cartilage. As a matter of fact, it frequently happens that the left border of the liver cannot be mapped out, either because it is thin or because a dilated stomach overlaps it.

If, now, the physician has determined by percussion that the breadth of flatness in the line of the nipple (the mammillary line) is four inches, then the corresponding breadth of flatness along the median line should be three inches; in the axillary four to four and one-fourth inches; and in the dorsal four and a half to five inches; but these latter measurements may all be indeterminate, the percussion note only giving the first.

In such cases there will be no recourse but to the rules of proportion, which will yield approximative results, applicable to such forms of diseased liver as those where the organ is symmetrically increased or decreased, as in cirrhosis, acute atrophy, leucocythæmia, or waxy change.

Then supposing that the line of dulnesss is only three inches, while the standard line is placed at four and a half inches, and assuming the normal breadth to be twelve inches, the approximative breadth can be estimated by the proportion

$$4 : 3 :: 12 : x$$

The result would be nine, the probable breadth. And in the same way the approximate width of the organ might be determined by a like proportion, for taking seven inches as the standard width, the proportion

$$12 : 9 :: 7 : x$$

will determine the probable width, which would be five and one-fourth inches. This is a method that has been proposed by Harley.

A similar proportion would discover the approximative thickness of the organ.

It is unfortunate, however, that this rule has a comparatively narrow application, for often the organ does not contract or enlarge symmetrically, a fact which is specially noteworthy in carcinoma, solitary abscess, and fatty change, for in these affections the right lobe most frequently bears the brunt of the disease.

Having now taken into consideration the data which are to be utilized in estimating the size of a liver, it remains for us to consider the difficulties that are to be met with in individual cases, and which often lead the physician into serious error.

1. First, the liver may present various abnormalities. This is especially true of the left lobe, which is sometimes almost altogether absent, or of unusually large size; perhaps bifurcated or shaped like a boot. Again, the right lobe may be of unusual vertical breadth. All these anomalies I have seen.

2. An acquired deformity is not uncommon in females, where, owing to tight lacing or the suspension of their dresses from the waist, the ribs have been so forced into the substance of the right lobe that it has been compressed and driven downward; probably it has also been narrowed laterally by the same force or even rotated in its transverse axis. At any rate, it is apt to be found from one to one and a half inch lower down than in men. But in men who wear belts or go without suspenders the right lobe is similarly affected.

3. The liver may be transposed, or it may be so lightly held by its suspensory and other ligaments that the term floating liver is applicable. These changes of position are seen in cases of malnutrition. Or it may be carried up by fluid or tumors in the abdominal cavity, or even by a full stomach, while any depression of the diaphragm, or pulmonary emphysema, or a full inspiration, may carry it down. All these facts should be taken into consideration in determining whether or not the location of the liver is strictly normal.

But of more serious consequence in defining the limits of the organ are certain abnormal conditions of adjacent parts, often presenting insurmountable difficulties.

Prominent among these are: 1. The impaction of fæces in the ascending or transverse colon. 2. Abdominal tumors, especially aneurisms of the abdominal aorta, tumors of the kidneys, pancreas, omentum, or mesentery. 3. Ascites. All of these conditions make it difficult to determine the inferior line of hepatic dulness. On the other hand, all diseases of the right lung or pleura, as where the one is solidified, or the latter contains fluid, make it difficult and oftentimes impossible to map out the upper line of hepatic dulness.

The abnormal hypertrophies and changes that we have to consider embrace the following varieties: 1, fatty degenerations; 2, carcinomas; 3, scleroses (cirrhoses) in their several varieties; 4, abscesses; 5, leukæmic tumors; 6, sarcomas and other neoplastic changes, such as, 7,

cavernous metamorphoses; 8, waxy deposits; 9, hydatid disease; 10, parenchymatous alterations of the organ.

1. FATTY LIVER.—This is the most common form of liver enlargement that we have to deal with. Being a very common incident of pulmonary consumption, it is frequently met with, owing to the prevalence of the latter disease, but it is also found in cancer, chronic alcoholism, caries of the bones, and in other wasting diseases, in which events it is known as the "cachectic fatty liver." The affection is to be distinguished from that condition where healthy persons of sedentary habits, with a tendency to corpulence, and prone to indulgence in the carbo-hydrates, store up fat in the liver on physiological principles. In many cases the symptoms of a fatty liver are ill defined. Still if we discover on percussion that the hepatic dulness is marked, especially if it is increased along the mammillary line; that the organ is painless, smooth, and has a dull edge; while there is neither jaundice, ascites, enlargement of superficial veins or of the spleen, all of those occurring under the conditions named; and in the absence of symptoms pointing to the other causes of hepatic enlargement, the diagnosis of fatty liver may be made with some confidence. In such cases the constitutional symptoms are to be referred rather to the cause of the fatty change than to the diseased liver itself. They are anorexia, dyspepsia, irritability of the intestinal tract, as illustrated by constipation alternating with diarrhœa. The patient is also usually anæmic and feeble, and there is extreme sluggishness in the biliary action. Such a case occurred in a patient who entered St. Luke's Hospital in 1878. He had lived for five years in a hot climate, and had suffered from dyspepsia and intestinal hæmorrhage, followed by cough and night-sweats, which were due, it was thought, to an abscess of the liver that had penetrated the lung. The patient was a drinking man. Death was due to exhaustion and septicæmia, from the collection of pus in the right pleural cavity. At post-mortem examination the liver was found to weigh seven pounds. It was adherent to the diaphragm, and exhibited the cicatrices of an old abscess. The upper border reached to within one and a half inch of the nipple, and the lower border extended one inch below the umbilicus. Its width was twelve inches, breadth eight and a half inches, and greatest thickness four inches. The umbilical fissure was three inches to the left of the median line. A fatty liver may weigh as much as twelve to fifteen pounds or more, though it may be of normal size or even under it.

A patient, in whom the symptoms corresponded well with those already given, entered the Presbyterian Hospital in 1878. She was a widow, thirty-six years of age, of alcoholic habits. Three months prior to admission she had been taken with numbness in the lower extremities, and tingling in her back and the soles of her feet. She was anæmic, in a debilitated condition, and suffered from anorexia and insomnia. Soon after admission she began vomiting large quantities of clotted blood, and passed blood per rectum. The liver was found to be enlarged, extending four inches below the free border of the ribs and three inches to the left of the median line. The patient appeared to die of exhaustion, and at post-mortem examination the heart, liver, and kidneys were found fatty, while the pericardial sac contained about one and a half drachm of clear blood.

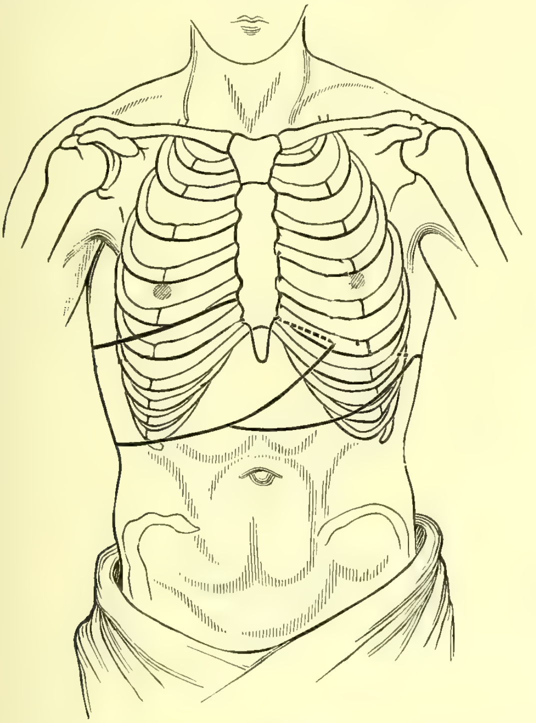

FIG. 2177.—Diagram showing how in some Enlarged Livers the Upper Limit of Flatness may reach the Fifth Rib.

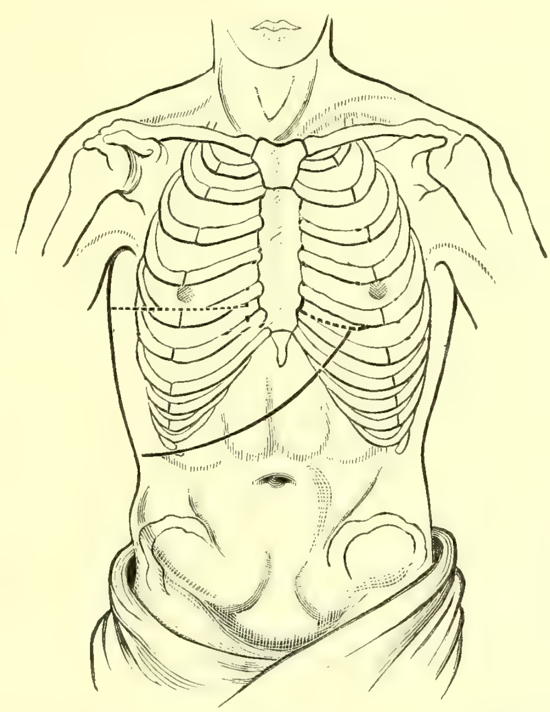

FIG. 2178.—This Diagram shows how in Enlarged Liver the Upper Limit of Flatness may extend to the Fourth Interspace.

The liver weighed twelve and a half pounds; microscopic examination showed that it was bile-stained, and more or less infiltrated with leucocytes.

2. CARCINOMA.—This disease is usually secondary, there being but few instances recorded in which it has been regarded as a primary disease; and in most of them it is probable that the primary disease would have been found elsewhere, if careful examination had been made. Under the term carcinoma are included the varieties known to pathologists as scirrhus, encephaloid, and colloid.

Such tumors occur in single or multiple deposits, and the organ may be enlarged to an extraordinary size. The primary disease is usually to be found within the realm of the portal system; either in the stomach, intestines, pancreas, or mesenteries.

The symptoms are usually obscure at first, and referable to the primary lesion. But in such cases, as where the

primary disease fails to give symptoms of sufficient prominence, as often happens, the secondary lesions will supersede in importance the primary, and we can, in consequence, note the following phenomena: Failure in strength; disorder of digestion; pains over the organ; irregular action of the intestines; progressive emaciation. Palpation often shows that the liver is irregularly enlarged. Sometimes the nodules may be outlined by compressing the abdomen with the tips of the fingers arranged in a line. Then it will be found that these nodules rise after a prolonged expiration, and fall after a deep inspiration; while the area of dulness will be extended, gradually at first, but afterward with rapidity, as the growth of cancer in this organ is swift, owing to the succulency of the tissues and the small amount of resistance that is offered. Some interference with the portal circulation will then occur; and in a large number of cases there will develop ascites; and following, or associated with it, local or general peritonitis will arise; both of which conditions make the diagnosis more difficult. Jaundice is also a frequent symptom; and when it occurs the stools are clay-colored, as in obstruction of the ducts. Often there is much difficulty in breathing experienced, and the patient finds relief from lying with the shoulders elevated. There is apt to be some fever in advanced cases; occasionally it will reach 103° to 104° F. in the later stages. Sometimes the hypertrophy of the organ is very great. Thus in a patient, fifty-four years of age, who entered St. Luke's Hospital in 1872, physical examination showed that the liver reached below the umbilicus, was hard and tender to the touch, and distinctly nodulated. The patient was ill only about six months, and died with symptoms of progressive emaciation, but without ascites, though there was swelling of the lower extremities. The disease had involved the stomach and liver, the latter weighing ten pounds. I have known such a tumor, when small, to be mistaken for an aortic aneurism. The symptoms rarely last more than a few months. Sometimes they do not manifest themselves until a few weeks before death (see article on Carcinoma, vol. i., p. 770).

3. SCLEROSIS.—*Cirrhosis.*—Recognizing under the term sclerosis an infiltration of the liver with fibrous tissue, we may subdivide it into three special varieties, dependent either upon alcoholism, syphilis, or certain obscure conditions on which pathologists are not just now agreed. Sometimes sclerosis dates from a perihepatic abscess. Finally there is the so-called hypertrophic form. We meet most frequently with *alcoholic cirrhosis*, which is by far the most common form, and one that is brought prominently to our mind by the term *hobnailed* liver, a peculiar conformation of the organ due to the shrinkage of the newly deposited fibrous material and the projection of the glandular substance on the surfaces of the organ, which in such cases has a yellow color, whence the name cirrhosis (*kirrhos*, yellow), given it by Laënnec.

The first symptoms in the subjective class are those of indigestion, which is indicated by nausea and vomiting, especially in the morning. There are also continuous symptoms of gastric catarrh, all of these disturbances being due to interference with the portal circulation, causing passive congestion of the stomach; and later, if the congestion becomes excessive, rupture of vessels in the mucous membrane of the stomach occurs, and hæmatemesis follows.

Still later, when the passage of blood through the liver has been impeded by the newly formed fibrous tissue, and before a collateral circulation has been established through the anterior wall of the stomach or other channels, diarrhœa is apt to set in from intestinal congestion, with or without actual hæmorrhage; dropsy may then supervene; later œdema in the feet and legs, afterward, though rarely, in the upper extremities, but seldom in the face unless there is some renal or cardiac complication.

At first the liver increases in size, although, as I have already intimated, some writers oppose this statement; yet it is a matter of easy proof if we respect post-mortem evidence; for, in the first place, there is often a fatty deposit combined with the cirrhotic, necessitating an increase in weight, while it is plain that new fibrous deposits must necessarily add to the size of an organ.

Of course shrinkage of the liver will eventually follow, because this peculiar form of newly deposited tissue always contracts. And, as a final consequence, the liver-tissue will be more or less compressed.

There is no constant lesion of the kidneys, although renal disease, as a complication, is not uncommon. After hepatic sclerosis has been established for a variable period the patient begins to exhibit signs of emaciation, and death is apt to be attributed to progressive asthenia, but the cardiac or renal complications may be the actual cause of death.

The spleen is generally increased in size, often very notably, for in the portal congestion it naturally suffers coincidently. Some authorities recognize a hypertrophic cirrhosis in which atrophy does not occur,[7] and French writers more especially have described a peculiar form that is associated with jaundice.

But it seems probable that if we could examine the liver in ordinary alcoholic cirrhosis at an early date of the hepatic disease, this fact would be abundantly shown. Such a case occurred in St. Luke's Hospital during my service there as pathologist. A bookbinder, sixty-three years of age, was admitted into one of the wards, after his hepatic troubles had only lasted three months. He died suddenly of erysipelas, though the hepatic enlargement had been duly noted. At post-mortem examination the liver was found enlarged, nodular, and attached to adjacent parts by adhesions. The liver weighed fifty-seven and a half ounces, which, considering his age and bodily weight, was, at the time, regarded as excessive. He had suffered from anorexia, nausea, vomiting, cough, epistaxis, and hæmorrhoids. Ascites had also developed to so marked an extent that he had been tapped.

In advanced cases of sclerosis the liver is almost always diminished in size. Exceptionally, shrinkage does not occur; this is most commonly the case when there is a considerable deposit of fat, or when thoracic disease, especially mitral affection, exists. The liver may in such case be actually larger than normal, as in the following: A painter, aged thirty-one, entered the Presbyterian Hospital, in 1878. His first symptoms related to an enlarged spleen, but subsequently intestinal hæmorrhage set in, and anorexia. Then followed jaundice, clay-colored stools, with ascites and swelling of the lower extremities.

At post-mortem examination his liver was found hobnailed, but enlarged. Its weight was seventy-four and one-half ounces. There was also acute and chronic congestion of the stomach, and of the rectum, with hæmorrhoids. The lungs contained cavities.

Syphilitic Sclerosis.—This form of hepatic disease has been under consideration since Gubler,[8] in 1852, described its appearance in children, where the lesion is characterized by an increase in the dimensions of the organ. Other clinicians have observed the disease both in children and adults, but they have not been altogether in accord as to its distinctive symptoms, and perhaps there are not many to be noted, apart from those that are elicited by physical signs, in conjunction with the syphilitic history of the individual.

From a purely pathological point of view there is more unanimity, for the appearances of the syphilitic liver in the stage of shrinkage are so peculiar that, once seen, they can never be forgotten, and yet well-known writers[9] have expressed themselves as unable to distinguish this variety of hepatitis from the alcoholic. Perhaps we shall never be able to make a clinical differentiation between syphilitic and alcoholic cirrhosis in the liver, except in an inferential manner from subjective symptoms. In fact, physical signs will often fail to give us any information; for the infiltration may be so slight that the organ will not be increased in size. Indeed, it is rarely much enlarged, but there will usually be pain over the organ, due probably to the perihepatitis that is, perhaps, constantly associated with this form of cirrhosis. If there be enlargement, we should expect it only during the actual active progress of the disease, and not in its later stages, when the deposits have all been made and

are undergoing retrograde changes. The syphilitic lesion may be due to gummy tumors, or to a general diffuse infiltration. If the gummata have been to any extent absorbed, the liver will shrink, leaving rough and deep fissures or depressions, and it may be possible, under specially favoring circumstances, to make the diagnosis by physical signs only. But owing to the adhesions between the capsule of the liver and adjacent parts it may be impossible to force the liver downward by a deep inspiration. Of course, if the patient has been a spirit-drinker, a differential diagnosis during life will be practically impossible.

The following case is illustrative of syphilitic sclerosis, with diminution in size of the liver.

A boy, musician, sixteen years of age, was admitted to St. Luke's Hospital in 1879, with the following history: From early life he has always been ailing, but had pursued the vocation of musician for a number of years, and until two months before admission to the hospital, when, in turning a somersault, he felt something give way in his abdominal cavity. Shortly afterward he had attacks of vomiting, superinduced by taking food; three weeks subsequently his belly began to swell; when vomiting occurred the swelling would lessen, and return when the vomiting ceased. Within three months he was tapped three times, and about a "pailful" of fluid was drawn at each time. Finally, diarrhœa set in, the patient having as many as ten greenish discharges daily. in appearance the boy was much undersized, seeming to be not more than ten or twelve years of age. He was also pale, emaciated, and had Hutchinson's notched teeth. After tapping, the lower border of the liver was found two and a half inches below the free margin of the ribs, in the line of the nipple. Later still, the stools became clay-colored, and crepitation was felt beneath the hand over the hepatic region. Death was due to progressive emaciation. At post-mortem examination the liver was not found enlarged, as might have been inferred, but there was marked perihepatitis, which doubtless occasioned the crepitation. I examined the liver microscopically, and found that it contained localized areas of fibrous deposit, which may have occurred about old gummatous deposits, or independently of them. This was probably an instance of hereditary syphilis; but I have noticed that in the acquired disease the organ has seldom been much enlarged.

Hypertrophic Cirrhosis with Icterus.—This is a peculiar form of hepatic enlargement that has been described by some French writers, such as Hayem, Charcot, and Gombault. The liver, it is said, *does not diminish in size at any time.* Among the symptoms is a decided jaundice, which persists without discoloration of the stools. This icterus is attributed by Cornil and the others above mentioned to the fact that the disease originates in the gall-passages, or about them. It is thought to be closely allied to the icterus that originates from stoppage of the ductus choledochus. It has been called "biliary cirrhosis." The liver may weigh five or six pounds, and the spleen is also enlarged. The symptoms are dyspepsia, pain in the hepatic region, icterus, and fever. Hæmorrhages and emaciation also follow, with ascites. There may also be delirium and convulsions. I have not met with any such cases, and they must be extremely rare, certainly in this country.

4. Abscesses.—Suppurative hepatitis is comparatively common as a cause of hepatic enlargement, even in the United States, a region not noted for hepatic disorders. Abscesses may be single or multiple. (For further particulars on the topic, see Liver, Abscess of the.)

5. The Leukæmic Liver (Splenic leucocythæmia).—In this affection the liver is frequently, but not always, enlarged. Usually the seat of the new deposit, which is of the round-celled variety, is in the branches of Glisson's capsule. Sometimes the whole liver is pretty evenly infiltrated. Since leukæmia is a blood disease the diagnosis may most satisfactorily be made by the hæmatocytometer. But the medulla of bones, the inguinal glands, spleen, and kidneys are also apt to be more or less involved; on the other hand, in Hodgkin's disease, though these organs are also more or less affected, the number and ratio of the blood-corpuscles is not altered.

This was distinctly shown in a case which occurred at St. Luke's Hospital, in 1881, during my term as pathologist in that institution.

A German girl, seventeen years of age, stated on admission that, four months previously she first experienced pain in the left hypochondrium, and that about the same time ecchymoses appeared upon her limbs. She appeared to be fairly well nourished, and not anæmic; but, examination revealed a tumor in the right hypochondrium, the dulness extending upward to within two inches of the nipple. A microscopic examination of the blood showed that the white corpuscles greatly outnumbered the red. The patient died four days after admission, of collapse, and on post-mortem examination it was found that a solid clot of blood had formed behind the peritoneum, reaching from the diaphragm to the level of the anterior superior spine. The liver was increased in size, weighed six and a half pounds, and contained a large leukæmic tumor, as big as a pear, in the right lobe, and another, but smaller one, on the under surface. The spleen weighed four and three-quarter pounds.

In another patient, with splenic leukæmia, at St. Luke's Hospital, the liver only weighed four and a half pounds, but the spleen two and a half; both the liver and stomach were displaced downward, the latter having a vertical rather than a horizontal position. Neither bones nor mesenteric glands appeared abnormal.

In this patient the number of red globules in the cubic millimetre were estimated at 1,100,000 by the hæmotocytometer; the ratio of white to red was as one to fourteen. While under treatment this latter ratio remained unchanged, but the red corpuscles increased so as to number 1,150,000, a very slight improvement. It was not found possible during life to detect this moderate increase in the size of the liver, because the ascites prevented. The inguinal glands upon both sides were involved. In another patient, at the Presbyterian Hospital, the liver was found post mortem to weigh eleven pounds ten ounces, and the spleen ten pounds seven ounces.

In Hodgkin's disease, where the symptoms are chiefly associated with changes in the lymphatic glandular tissue and adjacent parts, together with emaciation and anæmia, the liver may be smaller than usual, and free from disease. Nor is there in this disease any necessary increase in the number of the white corpuscles, or diminution in the number of the red.

6. Sarcoma.—Sarcomatous tumors are known to occur with more or less frequency in the liver. They differ somewhat in histological character, but in all the organ will be enlarged.

Such a form of disease may be suspected when the liver enlarges rapidly after the occurrence of a primary sarcomatous tumor elsewhere. When, however, the primary tumor is internal, and has not admitted of removal, it may be impossible to make a diagnosis, as in the following case:

A man, thirty-eight years of age, entered St. Luke's Hospital, in 1882, with the following history: Six weeks before admission he had been seized with pain in his right hypochondrium so severe as to cause faintness. After a short interval the pain abated somewhat, but never entirely disappeared. On further examination it was found that the patient had no difficulty in micturition, nor was there any pain radiating from the pelvis, though it was induced by assuming the standing posture, and by pressure. There was no apparent enlargement of the liver or spleen. A tumor in the epigastric region extended one and a half inches below the umbilicus, three inches to the left of it, but only slightly to the right; the upper border was adherent to the left lobe of the liver. About two weeks later the patient vomited blood at night, and the fæces were tarry in appearance. Later, cough set in with hæmoptysis. The patient died of exhaustion about six weeks after admission to the hospital. At the post-mortem examination a round globular mass, the size of a cocoanut, was found firmly attached to the vertebral column in the lumbar region; the adjoining loops of intestines

were firmly matted together; the spleen was unaffected, but the liver contained about ten secondary growths, most of which projected above its surface, and varied in size from a cherry-pit to a hen's egg, presenting appearances similar to those noted in the tumor. There was secondary implication of the lungs, right kidney, and small intestine.

Any form of sarcoma may attack the liver secondarily, but it is doubtful whether there is ever a primary disease of this nature. In a patient who died with secondary sarcomatous deposits at the Presbyterian Hospital, in 1877, the liver measured 12 × 9 inches, and weighed seven pounds.

7. Cavernous Metamorphosis.—This change in the liver is not uncommon. The disease goes by the name of the cavernous angioma. It is made up of tissue similar to that of the corpus cavernosum of the penis or clitoris, and may pulsate freely. In the livers of some of the lower animals, as in the hog, these growths are very common; often they are observed at the post-mortem examination under the form of little red blotches; sometimes they are as large as an orange. A most extensive development of this tissue occurred in a case which is here given.

A lad, aged twenty-three, admitted into the Presbyterian Hospital in 1879. His first marked symptoms were those of pain in the epigastrium, about one year before entering the hospital. Soon after those symptoms set in he was taken with vomiting, and began to emaciate and lose strength rapidly. Jaundice followed, with œdema of the legs. The bowels were now very much confined. After a while the jaundice disappeared, but the pain continued. Just before admission his symptoms suddenly became aggravated, and the stools had a clayey color. On admission, in addition to the symptoms just noted, purpuric spots were observed over the lower extremities, and oozing of blood from the anus. Dyspnœa and pain were soon marked. The patient died on the following day in a comatose condition. The urine had not indicated any renal difficulty, though it contained blood. Autopsy, by Dr. W. H. Porter, twenty-one hours after death. Body deeply jaundiced. Lower extremities œdematous. *Thoracic cavity:* the pericardial sac contained one ounce of clear, straw-colored, serous fluid. The ventricular cavities were distended with fluid blood. Valves free and sufficient. Heart substance slightly fatty; weight of organ, ten and one-half ounces, which was deficient, considering the size of the lad. Right lung entirely free from pleuritic adhesions, but the left was firmly bound throughout to the chest-walls and diaphragm. Lungs œdematous, otherwise normal; weight of both, thirty-two ounces. *Abdominal cavity:* spleen firm and very dark in color; weight, nine and one-half ounces. Kidneys intensely congested and stained yellow, probably with bile-pigment; capsules slightly thickened and adherent; weight, five and five and one-half ounces each. The stomach showed slight evidence of chronic gastritis. When the duodenum was opened the ductus communis choledochus was found absolutely occluded by a growth which surrounded the bile-duct, and was posterior to, but did not involve, the gut. The whole portal circulation was, to a considerable extent, interfered with by the new growth. The common bile-duct above the occlusion was enormously distended, being at least one inch in diameter. The gall-bladder, also, was greatly distended, and contained about twelve ounces of bile. The liver was distended with blood, and stained yellow by biliary pigment. Weight, one hundred and eight ounces, or more than double the normal. No abscesses were found at any point. The head of the pancreas was the seat of a new growth, about the size of a small orange. This lay behind the duodenum, and had grown in such a way as to completely encircle the ductus communis choledochus and occlude it. The common duct seemed to end in the centre of this growth. *Microscopic examination* gave the usual evidences of scirrhous carcinoma. The greater portion of the liver was the seat of cavernous change. It looked and felt like a sponge. By using a colored injecting fluid, and syringing through one of the smaller vessels of the liver, the cavernous tissue was injected. It was not easy to determine which vessel communicated with this new tissue. At any rate, injections through the portal and its tributaries did not reach the cavernous tissue, and other injections through the hepatic veins, presumably, were no more successful. As all the vessels were much dilated, it was difficult to decide precisely which they were. This change in the liver had not produced any marked hepatic symptoms during life, though nearly the whole gland was affected, a fact which probably made the specimen a unique one. It was also to be observed that, notwithstanding the occlusion of the common duct, there were no abscesses of the liver, as are frequently observed in such cases.

The symptoms in this form of hepatic disease, if there were any referable to the pathological conditions, were masked by those due to the cancer of the pancreas and occlusion of the common duct.

8. The Amyloid Liver.—When waxy change affects the liver, it is a secondary matter, and indicates that the constitution is suffering from some general disturbance, either from prolonged suppuration or from some exhausting disease. Though the liver is the first and principal sufferer in this disease, the spleen, kidneys, lymphatics, intestines, and probably other organs bear some portion of the burden with it.

In any case where there has been a considerable deposit of amyloid matter in the liver, this organ is notably and symmetrically enlarged, and where fat is also present, as usually happens, the organ is still further increased in size. But it is not soft in consistence; it is doughy and cuts like raw bacon, hence the name lardaceous. In conducting post-mortem examinations a diagnosis of the precise amount of waxy change is easily and quickly made, for on bathing a thin section in a watery solution of iodine, the amyloid part soon acquires a brownish color, later mahogany or rosewood, while the rest of the liver-tissue has a muddy appearance. In slight deposits of waxy material there is little alteration in the size of the liver.

A differential diagnosis is based on the following considerations: The area of hepatic dulness is enlarged in all directions, but the edge of the liver presented at the free border of the ribs is smooth and resistant. It does not give pain or tenderness on pressure. Possibly the patient may be conscious of fulness in the right hypochondrium. Ascites is not a prominent symptom. Jaundice is rare. The spleen is often, but not invariably, enlarged. There is much disturbance of the stomach and intestines; often the kidneys are involved, and if the case has been of long duration there will be symptoms of chronic Bright's disease. The disease is of long duration. Bearing in mind that amyloid change is secondary, we have good reason to suppose that relief of the primary affection will cause amelioration of the secondary; otherwise there is no form of treatment that can be recommended.

9. Hydatids.—*Echinococcus Disease.*—The tænia echinococcus is a tapeworm that has its habitat in the dog and allied members of the animal kingdom, and lives in the small intestine. It is extremely small, developing only four segments, the last one of which produces about five thousand eggs. When this latter segment has reached full maturity it is expelled from the host, as the bearer is called, and after the eggs have reached their complete development the segment swells up and bursts, so that the ova are widely scattered, and thus they accidentally may get into drinking-water and so enter the human body. Having effected an entrance they are soon provided with a boring apparatus, by which they work their way into other organs, though they seem to prefer the liver. It is characteristic of this entozoon that it preserves through life a vesicular form, surrounded by more or less perfectly developed fibrous tissue. In the human species only a single hydatid is developed, as a rule. Within the cyst is a gelatinous matrix, the so-called mother sac, within which is a translucent fluid containing large and small bodies. These bodies, which vary from a few hundred to several thousand, are the daughter vesicles. These daughter vesicles also contain secondary

vesicles. The minute bodies are the immature form of the tænia. There are other forms of hydatids, and they may contain no scolices. Hydatids may exist anywhere in the liver, and they may form tumors so large as to fill the greater part of the abdominal cavity or right side of thorax. Sometimes hydatids occasion no symptoms whatever; indeed, they may produce a tumor of considerable bulk, and yet show no indications of their presence. But in most cases there are certain signs that are pathognomonic.

The first symptoms are usually those of weight and fulness in the side, with shortness of breath and dyspepsia. It will then be found that the organ is greatly enlarged, but not symmetrically. Hydatids do not cause pain; sometimes there is a hydatid vibration. This peculiar sign is elicited by the following means: Three fingers are extended firmly over the most prominent part of the tumor, then the middle one is percussed, when a peculiar tremor is felt which is said by some authorities to be due to the secondary cysts striking against the wall of the parent cyst. Frerichs found it in about half of his cases. Jaundice and ascites are rarely present; when so, the former is due to pressure on the bile-duct; the latter to compression of the portal vein.

If a large fluctuating tumor is found to be connected with the liver, growing slowly and giving rise to neither pain, jaundice, ascites, nor constitutional disturbance, the diagnosis of hydatids may be made. It is more especially to be distinguished from abscess of the liver, and the other forms of enlargement that have been mentioned, dropsy of the gall-bladder, aneurisms of the aorta, pleuritic exudations, and cysts of the kidneys.

10. There is apt to be some enlargement of the liver in various constitutional diseases, such as yellow fever, typhoid, the remittents, etc.; but the deviation from the normal size is due to the parenchymatous infiltration of the liver-cells, and this change disappears if the patient recover from the primary disease.

Thomas E. Satterthwaite.

[1] Quain: Elements of Anatomy, eighth ed. ii., p. 380. 1877.
[2] Harley: Diseases of the Liver, p. 47. 1883.
[3] Gray: Anat. Descriptive and Surg., p. 783. 1878.
[4] Delafield: Lectures on Practice, p. 229.
[5] Loomis: Phys. Diagnosis, p. 141.
[6] Harley: Diseases of the Liver, p. 48.
[7] See Jones and Sieveking: Path. Anat., p. 623.
[8] Gubler: Gaz. Méd. de Paris, 1852, p. 262.
[9] Wilks and Moxon: Path. Anat., 1875, p. 450. Thierfelder: Ziemssen's Cyclopæd., vol. v., p. 222.

LIVER, FATTY DISEASE OF THE (*Hepar adiposum, état gras du foie, Fettleber, fatty liver*). Although, as has been previously pointed out (see article on Fatty Infiltration), the term "fatty liver" should be applied, in a pathological sense, to conditions of infiltration alone, in this article the usual clinical significance of the words is adopted. That is to say, "fatty liver" here means fatty disease of that organ, and will, therefore, necessarily include both conditions of infiltration and degeneration.

The liver of healthy persons always contains more or less fat. Hence, it is by no means possible to determine, in every instance, whether this substance is physiologically present or the result of pathological deposition. It is impossible also, in the present state of our knowledge, to draw a concise clinical picture of fatty liver. It will be readily understood, therefore, that a positive diagnosis of the condition in question is only practicable when the liver can be shown to be actually enlarged. The latter point is easy of accomplishment, however, and the ordinary methods of physical exploration are always sufficient to decide it. Often the smooth, rounded, lower margin of the enlarged organ can be distinctly felt below the border of the ribs. A soft consistence and the evenly smooth surface of an enlarged liver in a very obese person, or in a patient affected with phthisis, or in subjects afflicted with some other cachexia, or in a drunkard, or in one suffering from poisoning by phosphorus, make the diagnosis of fatty liver a very safe inference. In cases where no enlargement can be made out, the history of the patient and a careful analysis of concomitant symptoms may, of course, render the diagnosis highly probable, but never more than that.

The following considerations are not only germane to the subject in hand, but appear essential for a just comprehension of the pathology of fatty liver. Fat finds its way into the liver by direct infiltration from the blood. A large proportion of the fat thus deposited is presumably returned to the circulation. Some of it goes to make up the biliary secretion. But fat is also found within the hepatic cells by conversion of their albuminoid protoplasm into adipose material. This is true degeneration. Even in the latter case, however, a regeneration of protoplasm may take place. That failing, "fatty atrophy," *i.e.*, atrophy of protoplasm at the expense of accumulating fat, results. No more typical example of fatty degeneration of the liver than so-called acute yellow atrophy is known. This subject, being more fully dealt with in a separate article, will not be considered here.

The naked-eye appearances of "fatty liver" are found described in detail on page 49, vol. iii., of this HANDBOOK.

With the aid of the microscope the following conditions have been discovered: The fat occurs in the hepatic cells and their nuclei. At first minute granules, darker than those of the protoplasm, are deposited. Gradually they grow, and form distinct, sharply defined, glistening droplets. Still later, these coalesce to form larger and larger oil-globules. The nucleus is pushed to one side or becomes filled with fat, and often disappears completely. The liver-cells become much larger than normal, and show a tendency to assume a spheroidal shape. This microscopical analysis holds good for "fatty liver" of infiltration, just as well as for that of degeneration.

Several competent observers (Vogel, Wedal, Perls) have recently claimed to have found fatty granules in the intercellular tissue of livers diseased by adipose accumulation. The writer of this article has been able to verify this discovery.

Whatever predisposes to the accumulation of fat within the body favors fatty disease of the liver. If more fat is introduced into the economy than can be consumed by oxidation, or if an excess of other substances convertible into fat is continuously ingested, fatty liver will surely be developed. In other words, just as soon as a disproportion between the formation and consumption of fat within the economy is established, we may look for fatty liver. Thus in forced feeding, in excessive indulgence in fatty and starchy foods, and generally in persons of indolent habits, we commonly find, among other abnormal accumulations, the condition under discussion. But in apparently quite opposite conditions "fatty liver" is likewise apt to occur. Thus in the cachexia of phthisis or of cancer or of chronic dysentery, and in other wasting diseases, and more particularly in phosphorus poisoning, fatty disease of the liver is a very common occurrence. In these conditions the disappearance of fat from the subcutaneous connective tissue and other favorite sites of its deposition forms a remarkable and puzzling contrast to its excessive accumulation within the liver. It is true that, especially in phthisis, an increased proportion of fat in the blood is frequently discoverable. This so-called lipæmia or galactæmia is not incompatible with the disappearance of fat from the skin, omentum, and other localities. But exactly why seemingly identical fat should be stored up in the liver, while it is being so rapidly consumed elsewhere in the body, has never been satisfactorily explained. Ewald's idea appears to the writer the most plausible one yet offered. He points out that in cachectic conditions the consumption of fat in the body is increased quite as much as that of albuminoid substances. It is well known that individuals affected in this way are often very much benefited by fatty foods, and notably by cod-liver oil.

Now it must be borne in mind that nitrogenous waste is often associated with the pathological formation of fat. The albuminoid constituents of the cells of certain organs, more particularly of the parenchyma of the liver and kidneys, are especially liable to this twofold process of excessive production on the one hand, and exaggerated consumption on the other. The peculiar arrangements

of the blood-vessels within the organs named favors a supply of blood poor in oxygen. And it is this circumstance which is responsible for the facility that characterizes the transformation of albuminoid cell-substance into adipose material. From this exposition it would appear that there is no direct causal connection between the general disappearance of fat from the body and its excessive accumulation within the liver. That is to say, Ewald disputes altogether the view according to which the fat is carried by the blood from the wasting organs to be stored up for future use in the liver. The hepatic fat, according to him, is not storage fat at all, but fat resulting from parenchymatous degeneration.

Clinically, fatty liver is a chronic affection. For in those conditions in which an acute fatty metamorphosis is observed, the other symptoms of the case have an overshadowing significance, which makes the "fatty liver" appear as an accidental concomitant of far more important changes.

On the other hand, as already stated, we are as yet unable to assign to ordinary "fatty liver" a position of nosological precision, for the simple reason that the pathological importance of the condition in question is not yet fully understood. Doubtless the mere mechanical pressure of accumulated fat influences hepatic secretion, and this may, in a measure, account for the digestive disturbances so frequently complained of by the subjects of fatty liver. But abdominal dropsy is not observed to follow, so that the pressure upon the blood-vessels can hardly be presumed to be very great. Certainly any local discomfort that may be felt is devoid of characteristic qualities. Look where we may, therefore, special symptoms referable to the accumulation of fat in the liver are not discoverable.

From what has already been written, it follows that there is no special treatment for fatty disease of the liver. Whether it be associated with phthisis, with general obesity, with alcoholic excesses, with phosphorus poisoning, or with yellow fever, or whether it appears as a prominent feature of diseases like acute yellow atrophy of the liver, or the acute fatty degeneration of new-born infants, the primary diseased condition invariably claims our attention to the exclusion, almost, of the hepatic abnormality. Whatever is potent to correct the dominant disease will also be found to benefit the hepatic affection. In this way a seemingly paradoxical effect may at times be produced. For there are undeniably cases of phthisical fatty liver, where the forced exhibition of fats corrects the pulmonary condition, and by so doing leads to an improvement of general health, which in turn reduces the pathological accumulation of fat in the liver.

Edmund C. Wendt.

LIVER; GALL-STONES. As the name implies, gall-stones, or as they are more properly termed in medicine, biliary calculi, are concretions which form in and from the gall or bile. Although the gall-bladder is the organ in which they most commonly form and are found, still they may develop in any part of the biliary passages. Again, having once begun their growth here, they may pass into other organs of the body and continue to increase in size. Gall-stones exist in some animals as well as in man, having been observed in most of the vertebrates—oxen, pigs, monkeys, etc.—and in some molluscs. They are most common in the ox, and have been seen in the tortoise. Rarely they are discovered in birds, in fishes which have no spleens,[1] and in some insects.[2] Thudichum says wild animals never develop them, except after living some time in captivity. *Cholelithiasis*, or gall-stone formation in man, is a most important and interesting chapter in the diseases of the liver and its appendages, when its causes, proximate and remote effects, and treatment—especially in the light of recent advances in abdominal surgery—are duly considered.

Historical.—The subject of hepatic or biliary calculi is one of great antiquity, but there appears to exist no positive evidence that their occurrence in man was known and written of until about the middle of the sixteenth century.

The Egyptian priests, who in early times were in the habit of dissecting the bodies of men as well as those of animals, are said to have found gall-stones in the ibis, and it is quite probable that their existence in domestic cattle was early known.

Thudichum says that gall-stones were first mentioned by the Greek physician Alexander Trallianus, who lived after Ætius, but before the time of Paulus Ægineta (about the fifth century).

There appears, however, to be no ground for the statement which has been made, that Hippocrates and Galen mention biliary calculi in their works.

Frerichs gives Johann Kentmann the credit of first observing and describing gall-stones as found in man. In 1565 he described them as one of a series of twelve concretions which were to be found in the human body, and this series was published by Conrad Gesner in his celebrated work on fossils, which appeared the same year at Tigur. Vesalius, Gentilis (de Foligno), Fallopius, and more especially Fernel, reported cases early in the history of the subject, and the last-mentioned observer in 1643 made a study of the causes and symptoms of the disease.

Haller[3] collected and reported all the observations which had been made known up to 1764. From this date down to 1851 great advances were made in the study of the disease, and for a knowledge of the subject at this time I will refer to the work of Fauconneau-Dufresne.[4]

In Frerichs'[5] most excellent work this subject will be found carefully treated at the hands of this eminent observer and author. During the past twenty years important advances have been made in the operative treatment of the conditions resulting from cholelithiasis, and although we are unable to say that much more has been learned of the conditions which favor the formation of the calculi, we can, with great truth, say that the diagnosis is now more frequently and more accurately made, and that the treatment is more satisfactory.

Form and Structure.—Walter first gave us the result of careful and accurate investigations into the structure of gall-stones, when he published a description of the collection in the Anatomical Museum at Berlin, in 1796. It was only as late as 1814, however, that Chevreul separated, by analysis of the stones, a substance which he named *cholesterine*, and which has ever since been so called.

This *cholesterine*, which is found in combination in healthy bile, but in suspension in the cadaver and in altered bile, constitutes the greater proportion, *i.e.*, seventy to eighty per cent., of most stones, and some are composed wholly of it. When this is the case, the color is white or yellowish, and the surface usually smooth. When exposed to a flame on platinum, these calculi first melt, then burn like fatty matter, with a fuliginous flame, and leave no residue. Concentrated sulphuric acid colors them yellow. They are soluble in boiling alcohol and in ether, but insoluble in caustic potash and soda. A drop of the ether solution shows, under the microscope, the rhomboid lamellæ of colorless cholesterine. In some stones the *bile-pigments* predominate, and we have stones composed principally or wholly of biliverdin, bilirubin, cholepyrrhin, etc. They are for the most part brown, black, dark-green, or yellowish-red. They are non-crystalline, easily pulverized, do not fuse or burn with a flame, but char, leaving behind an ash. They are soluble in ether, but also in alkaline solutions. Treated with nitric acid, the same reactions and play of colors are produced as with bile. Under the microscope, according to Ch. Robin, the pigment appears as orange-yellow, red, or mahogany granules by transmitted light.

Besides these two forms we find stones having a preponderance of the biliary acids, of the fatty acids, or, lastly, of calcium carbonate, and ranging in color from dark-green or black to almost white. Other constituents which go to make up calculi are: Magnesia, chloride of sodium, iron, rarely manganese and copper, the earthy phosphates, mucus, epithelium, etc. Globules of mercury[6] have been found in a few cases. The follow-

ing is the analysis of Planta and Kékulé, which Robin thinks gives a good general idea of the composition of many stones :

Water	4.89
Salts	0.28
Bile principles (taurocholates)	0.79
Saponifiable fats	2.02
Coloring matters	0.20
Mucus	1.35
Cholesterine	90.82

Luton has given a practical method of analysis of biliary calculi which is simple and easy. It consists in subjecting a portion of the concretion to be examined to hot alcohol or some other solvent, and examining with the microscope the crystallization produced on cooling. In this way the rhomboidal plates of cholesterine, the needle-shaped, or bacilla-like crystals of cholate of lime, crystallized fatty matter, amorphous substances, etc., are made out.

In *size* calculi range from fine, sand-like, gritty bodies, which might be called biliary gravel, to the size of a hen's egg or larger. Haller[7] pointed out the fact that fine gritty deposits resembling the larger concretions are at times found in the excretory apparatus of the liver. At a recent meeting of the College of Physicians of Philadelphia Dr. Musser presented a gall-stone which was removed at the autopsy of a female, aged sixty-six, who died of colloid cancer of the omentum. The stone weighed three hundred and ninety-four grains, and was three and one-third inches long. Friedler[8] saw two large, pure cholesterine calculi, passed per rectum, whose combined weight was four hundred and forty-five grains. Roberts[9] reports a stone passed per rectum which weighed five drachms. Dr. Lessdorf[10] relates the case of a woman, fifty-eight years of age, whose gall-bladder contained a stone weighing sixty grammes. Meckel[11] has described one nearly five inches in length and four inches in circumference; and Frerichs has repeatedly met with concretions two inches long by nearly an inch in thickness. The usual size, however, will not exceed that of a large pea or a small filbert.

In *number* they likewise vary greatly. Solitary calculi are now and then found, but as a rule they are multiple, and any number that the bladder will contain may be crowded into it. In Otto's collection there is one bladder preserved which contains seven thousand eight hundred and two calculi. In one case in which I made the autopsy I found ten stones, measuring each five-eighths of an inch in length and one and five-eighths of an inch in circumference, but they almost completely filled the gall-bladder, which was thickened and contracted. In another case which I observed, where twenty-nine stones passed through a fistulous opening in the abdomen, each was about the size of a pea.

This uniformity in size and form is the rule where numerous calculi are enclosed in the bladder, but occasionally it happens that the concretions show various stages of development, some having attained their full size, while others are just beginning to form or are in the process of formation. I have before me three rounded stones which I took from a gall-bladder in the dead-house ten years ago. Two measure one and three-fourths inch in their greatest circumference, are hard, of the warty, mulberry form, have a brown color, and on section show a homogeneous hard structure of a yellow hue surrounding a small almost white nucleus. The third is but one-half the size of the others, has a smooth or but slightly uneven surface, is of a light yellow color externally, and dark brown within. The external coating, which is one-twelfth of an inch in thickness, is almost pure cholesterine. The smaller concretion would undoubtedly in time have become similar to its fellows in size and conformation; but such instances show that the conditions upon which the beginning of the calculus-formation depends may extend over a considerable period of time and be susceptible of modifications.

In *form* calculi are for the most part polyangular when discovered, having four, six, eight, or more smooth or excavated surfaces by which they articulate. They are also commonly globular or olive-shaped, and this is probably the primary form of all biliary calculi, the facets being produced by contact with other stones, more I believe from pressure than attrition. Hence, when one stone alone occupies the bladder it remains of a more or less rounded form, and, if very large, will in all probability take the form of the bladder, or become egg-shaped. Rough, warty forms are not uncommon, and are known as mulberry calculi. Cylindrical forms have usually developed in some of the bile-passages. When formed in the branches of the hepatic ducts, solid or hollow casts, or branched, coral-like concretions are sometimes met with.[12]

Other rare forms are flattened plates or leaf-like masses, usually of a dark color and metallic lustre. Six-sided stars, of a pale blue color, have been observed by Seifert.

The *color* is rarely blue as seen in the above case, but green, red, and black stones are occasionally met with. The usual colors are those between dark or greenish-brown, or chocolate, and yellowish-white. Some stones are pure white on the surface.

The *specific gravity* of fresh stones is greater than that of water; dried specimens containing air usually float. Hein gives the specific gravity of a cholesterine calculus as 1.027.

The *location* at which concretions are found may be either the point at which they have originally formed, or where they have become arrested in their escape. The gall-bladder itself is by far the most usual portion of the excretory system of the liver in which calculi originate, and in which they are found collected; and next in frequency they are found in the cystic and common ducts, where they have become impacted. Still they may form at any point along the bile-passages, even to the very commencement of the hepatic ducts. Usually, however, they are observed in the wider portions of the hepatic duct only when the common duct is filled with concretions, or so occluded that they cannot pass into it. They have also been found in the hepatic ducts of invertebrates.[13]

Morgagni collected a number of instances, from the works of observers before his time, showing that small, and even, at times, large stones are found in the branches of the hepatic ducts. Friedrichs has had eight such instances in his own practice. The ducts may, in consequence, become dilated or the concretions encysted. Berlin[14] has found the walls of the cyst and the surrounding glandular tissue in a state of fatty degeneration.

It is now admitted that calculi may originate in the small glands of mucous membranes, especially in the glandular follicles of the biliary passages, but it is a question whether their development, when encysted, does not take place by occlusion of the orifice of the follicle and hypersecretion, just as sebaceous tumors and occasional concretions form in the skin.[15]

Gall-stones often become lodged in the cystic and common ducts as the effort is being made by nature to expel them from the gall-bladder in which they have originated. But aside from these bile-courses, in which it seems but natural to find them, we are surprised at times to encounter calculi in other organs of the body. I have known fatal obstruction of the bowels to be caused by a biliary calculus which had passed into the duodenum. Occasionally, large-sized stones find their way into the stomach, where they may further increase in size, be vomited, or pass away by the bowels. Dr. Jeaffreson[16] instances a patient who vomited a large gall-stone, which it was afterward found had ulcerated its way through into the stomach. Fauconneau-Dufresne has collected eight such instances. Dr. Burrows[17] relates a case of a lady, aged eighty-four, who vomited two medium-sized gall-stones. Bianchi[18] says they have been found in the portal vein. Phœbus (1832) has reported a similar condition. They may become lodged and cause obstruction at any point of the intestinal canal, from the duodenum to the sphincter ani, and at times are found partially or wholly encysted.

In 32 cases collected by Lichtenstern, the concretion occupied the duodenum or jejunum in 10, the middle of the ileum in 5, and the lowest portion of the ileum in 17 cases.

Dr. Beekman[19] reports that at the autopsy of a woman, aged forty, who died of peritonitis, a stone was found in the transverse colon. A perforation had taken place from the gall-bladder, in which two other stones were found. Large and small stones have been found in abscess cavities in the liver—Frerichs mentions one weighing four ounces—abdominal walls, as well as encysted in the abdominal cavity outside of the bladder. They have also been found in the urinary bladder, and have been known to pass through the lungs.[20]

The *structure* of biliary concretions varies within as wide limits as do the form and color, of which we have spoken. The texture of a stone, when broken up or cut in two, is discovered to be either homogeneous or to present striæ, stratifications, or layers of different nature; or they are irregularly made up, presenting traces only of crystallization. The substances composing them may have a waxy, earthy, saponaceous, or crystalline appearance.

Most frequently there are discoverable more or less regular striæ, starting out from a central mass or nucleus, and outside of this a shell, concentric crust, or envelope, which may be thick or thin, but is almost always of a different structure, consistence, and color from the body of the stone. Rarely concentric laminæ, like the layers of an onion, make up the shell. The external or cortical layer is at times very thick, making up a great part of the length of oblong calculi. In this case it is composed usually of several laminæ. These crusts are brown, greenish, black, white, or yellow, and usually more fragile than the enclosed part.

The *nucleus*, usually formed of an aggregation of bile elements held together by mucus, and often enclosing epithelium or foreign substances, is darker than the superstructure as a rule. I have just cut in two a stone which has a small, nearly pure white, nucleus, which analysis shows to be almost pure cholesterine. A six-sided stone, from another case just examined, shows a dark-brown nucleus containing some silvery crystals (cholesterine). Surrounding this is an almost circular yellow mass with a radiating structure; outside of this a yellowish-brown layer, also radiating, and on the very exterior a white layer. The angles are formed by a thickening of the cortex at these points.

The nuclei of some stones, especially large ones, are themselves smaller calculi. Such foreign bodies as blood-clots, pieces of dried worm,[21] a needle which had penetrated the wall of the gall-bladder,[22] globules of mercury,[23] etc., have, in rare cases, served as nuclei. In one case[24] a plum-stone was found in a calculus which had formed in an abscess of the liver resulting from a perforation of the stomach.

Very rarely multiple nuclei are discovered.

Etiology.—Age appears to influence the production of calculi. It is a known physiological fact that with advancing years we find an increase in the proportion of cholesterine in the blood. Now, if this proportion hold good in the bile, as is probably the case, we have a valuable factor in determining why calculi are found so much more frequently in those of advanced years. From Walter's statistics we would be led to believe that most cases of gall-stones occurred between the ages of thirty and forty. Fauconneau-Dufresne's collected cases would, however, point to the more advanced age of from fifty to sixty years, and even from seventy to eighty, as offering the most instances; while from the 558 cases observed by Cyr, the largest number (208) were between twenty-one and thirty years, and 185 between thirty-one and forty. Calculi do form in the very young, and we must remember that their formation may extend over many years, and either never be suspected or not until middle or advanced life.

Brinton gives the average age as fifty-three and a third years. Seven years is the earliest age at which Frerichs observed gall-stones. Fiedler[25] gives 270 cases, with only 3 under twenty years of age. Dr. Walker[26] saw an infant of three months pass three hard dark green ovoid stones, which chemical analysis proved to consist of cholesterine and bile materials. Portal[27] gives three cases in which stones were found in new-born children. Bouisson discovered three calculi in the gall-bladder of a child who died with marked jaundice, and was found to have a stricture of the ductus choledochus.

This occurrence in the new-born and very young is not so much a matter of surprise when we stop to consider that, even at this early period, cholesterine is produced in considerable quantities, being found in the meconium.

Sex.—From a series of 620 cases Hein gives the proportion of females over males as 3 to 2.

Brinton states that gall-stones are found four times as frequently in women as in men.

Fiedler gives the proportion of men to women as 1 to $2\frac{2}{5}$.

In 27 cases of cutaneous biliary fistulæ resulting from gall-stones, collected by myself,[28] 20 were females, 6 males, and one was not given; making a proportion of 1 to $3\frac{1}{3}$.

The more frequent occurrence of biliary concretions in females than in males is probably due in a greater measure to the more *sedentary habits* of the former than to any other cause which has hitherto been advanced in explanation. The fact that men who lead inactive lives, taking little exercise, are more apt to suffer from the disease than others, would point to this as an important factor.

The frequency with which stones are found in the bile-passages at the autopsy of those who have been invalids, confined to the house or hospital for a long period, and especially in the bed-ridden, speaks also for this theory.

Confinement has been observed to favor the development of calculi in men who have been long in prison, as well as in stabled cattle and animals in captivity.

Habitual constriction of the abdomen by the corset, an abuse women so commonly inflict upon themselves, is to my mind a most important cause of the frequent formation of calculi in this sex. This bears out the belief of Frerichs, that the trouble depends often on purely mechanical conditions.

Diet.—Frerichs believes that infrequent meals predispose to stone-formation, the bladder not being emptied often enough. Animal food and spirits in excess have been regarded as causative.

Harley[29] found that the calculous disease was common in Russia, and attributed it to the fatty nature of the food and excessive production of cholesterine more than to the cold and moist climate.

Climate.—Powell[30] accords a certain influence to climate, and believes that the affection is very rare in hot countries.

Obesity would appear to depend on much the same organic causes as cholelithiasis, but in all probability does not itself influence stone-production. Durande and Fauconneau-Dufresne knew of their coexistence. Those who take on fat usually assimilate energetically, and have imperfect denutrition.

Diathesis.—Constitutional conditions have been accused of influencing gall-stone formation. Niemeyer considered their frequency greater in cancerous subjects. In 379 cases of cancer Rokitansky found choleliths 53 times. Primary or secondary cancer of the liver and bile-passages is, however, that with which calculi are mostly associated, pointing rather more to a local than a diathetic cause. The occurrence of biliary calculi in those of the gouty or uric acid diathesis would appear only a coincidence, and both may be due to some of the same causes.

Durand-Fardel has frequently noticed that those having cutaneous affections are subject to hepatic colic.

Petit thought he had discovered that heredity played a rôle when he found all the children of the same family successively attacked. The weight of evidence is against this, as well as against the existence of a biliary calculous diathesis, and the causative influence of any other diathesis has not been demonstrated.

Suppressed lactation and *pregnancy* are given by Dr. Jules Cyr[31] as important pathogenic elements. He mentions also *temperament, morale,* and *hygiene* as influencing cholelithiasis.

Pathology.—With the exception of epithelium, mucus, and foreign bodies, every substance which enters

into the composition of gall-stones is to be found in solution in normal bile.

Now, so long as the bile remains healthy, no change in, nor separation, nor deposit of, these elements takes place; but if from an occlusion of one of the bile-ducts, or from any other cause, the bile is prevented from escaping, and is shut up in the gall-bladder for a considerable period of time, changes are apt to occur in the bladder itself, and the bile becomes altered. Catarrhal inflammation may be induced in the mucous membrane of the bladder, and the fluid contents of the organ be so increased in quantity and so altered in quality that decomposition takes place.

This decomposition, or an inspissation of the bile from the cause mentioned, or from disease of the gall-bladder or other organ, is apt to cause a deposit of bile-elements in the form of small pulverulent, structureless masses, composed of bile-pigments, bile-resins, cholesterine, mucus, etc. In many cases the bile becomes acid, as Meckel has shown, takes on a greenish color, and throws down flaky deposits of a brownish-red or dark-brown color, found on microscopical examination to contain, epithelium, mucus, rod-like crystals or granules of cholepyrrhin, light-colored transparent crystals of bile-resin, cholesterine crystals, and occasional crystals of carbonate of lime. Hein has pointed out the important part played by catarrh of the gall-bladder in making conditions favorable for the formation of calculi. Now, these conditions undoubtedly lead to cholelithiasis or biliary gravel, and subsequent calculi formation. As early as 1790, Petit compared retention of urine and stone in the bladder with retention of bile and biliary calculi.[32] Thénard regarded the diminution of the normal quantity of soda in the bile as the cause of separation of its elements making stone formation possible.

Besides the occlusion of the common or cystic duct from a previously formed calculus, we may have the same effect produced by disease of the duct or a neighboring organ; the formation of adhesions constricting the bladder or ducts; tumors and cancer of the liver, pancreas, duodenum, or pyloric end of the stomach, causing pressure upon or involving the bladder or canal. Diseases or injuries of the liver may so affect the bile-producing function of this organ as to favor a separation of the bile-elements. Rarely is primitive or secondary cancer of the bile-passages met with and concretions not found. Oettinger[33] reports a case of primary cancer of the gall-bladder with the formation of calculi and compression of the hepatic duct. In some cases calculi may preexist and be the cause of the cancer. We shall speak of this under "complications." We would then put down as pathological factors favoring biliary concretions: 1, catarrh of the bladder and ducts; 2, other diseases of these organs, especially cancer; 3, occlusion from preexisting stone; 4, adhesions and pressure; 5, morbid changes in the liver.

Symptoms and Diagnosis.—While the calculi remain quietly in the gall-bladder, and in the absence of complications, symptoms may be almost wholly wanting, and the diagnosis be extremely difficult. Even when the concretions are evacuated by way of the intestinal tract, the only positive diagnostic sign is to discover them in the dejections. And here there are sources of error which must be guarded against. Concretions have been known to form in the stomach and intestines, and a small biliary calculus passed into the digestive tract may serve as a nucleus for the formation of a larger stone, and at the moment it is passed per rectum or vomited the patient may be free from gall-stones proper. Sometimes fat-like masses in the stools, due to the saponifying action of the bile on indigested fatty substances, are mistaken for calculi. A colleague of mine once carefully separated a large number of small, hard, oblong calculi, as he supposed, from the stool of a patient he had treated for severe hepatic colic. Upon being washed and examined more closely, they were found to be nothing more or less than the seeds of some grapes the lady had eaten. To examine the stools for stone with any expectation of success, the examination must be thorough and extend over several days after the attack of hepatic colic. Place the stools in water, and break up all hard masses and pass through a sieve if necessary. Crystals of cholesterine and fine gravel may be found when stones or even large fragments are absent.

Of course the escape of calculi through an external fistula makes the diagnosis certain.

As before said, symptoms of the existence of calculi may be absent during life. Bouillard relates the case of a woman, sixty-eight years of age, whose gall-bladder was found after death to be thickened, inflamed, and to contain ninety calculi. During life she had given no symptoms of her trouble. I have on several occasions found, post-mortem, from two to ten calculi in the bladder of patients, which, so far as was known or the history went, had given no indication of their presence. When symptoms are present they occur in the form of, 1, hepatic colic; 2, icterus; 3, cholecystitis and angiocholeitis; 4, tumor of the gall-bladder; 5, escape of calculi per rectum or through some other viscus; 6, cutaneous biliary fistulæ.

Hepatic colic is the term commonly used to designate the group of symptoms attending the attempted passage of biliary calculi from the gall-bladder into the gut, resulting sometimes in impaction in one of the ducts. The pain, which is the important feature of the attack, is severe, and often intense, culminating at times in delirium, fainting, reflex cramps, convulsions, and on rare occasions in death.[34] The onset may be gradual, and only slight epigastric pains be first complained of in the epigastrium and region of the liver, preceded by malaise, a bitter taste in the mouth, constipation, heaviness in the hypochondriac region, beginning icterus, migraine, etc. Probably in the majority of cases, however, the attack comes on suddenly two or three hours after eating, especially if to excess, at the moment that the evacuation of the bile from the gall-bladder takes place.

The severity of the pain is analogous to that of renal and lead colic, and is often attended with sensations of pulling, pinching, or the tearing of something within the abdomen. The patient is agitated and anxious, and the position of the body is frequently changed. There may be hiccough, and vomiting of half-digested substances, mixed at times with some bile. Occasionally a *hemi-epilepsy* of the right side exists.

The pain, though localized in the epigastrium and region of the liver, often radiates to the back and shoulder of the right side, and occasionally downward into one or both testicles.

The whole attack lasts from twenty-four to forty-eight hours, or may extend over several days, the pain coming in exacerbations followed by intervals of calm. It has reminded me of parturition and the process of dilatation of the perineum by the child's head, the pain ceasing as the head recedes, and I find that others have noted the analogy. The duration of pain in the expulsion of the stone is greater, but is due to much the same cause, viz., the efforts of a large body to pass through a narrow channel which must first be dilated. The exacerbation of pain ceases suddenly as the stone drops back into the bladder, or when it finally passes into the duodenum. During the attack there is usually marked tenderness in the hepatic area, with tympanitic abdomen and meteorism. An attack of colic coming on after any jolting, as a ride in an omnibus or on horseback, or other similar violent exercise, I believe to point to stone in the bladder, the explanation being that the shaking-up process has produced irritation and tumefaction about the neck of the gall-bladder, just as often is the case with a calculus in the urinary bladder.

Icterus may be wholly absent, while its presence might indicate one of several abnormal conditions. When due to biliary calculi it may appear some time after the attack of colic. It then shows itself either as a chronic condition or with a tendency to periodicity. The chronic form may be due to many other causes of permanent obstruction of the ductus choledochus. The transient icterus is the more cômmon form when due to calculi, and when periodicity is noted the diagnosis can be made with some

degree of certainty that a calculus, acting as a valve in the duct, occludes it completely at intervals, or that successive calculi are passing. At times so slight is the icterus that it should be looked for, not only upon the conjunctivæ, under the tongue, and alongside the alæ nasi, but also on the vault of the palate—and the urine should be examined.

At the end of an attack analysis will often discover bile-pigment in the urine when no icterus appears on the body. Intra-hepatic gravel or the formation of calculi in the hepatic ducts is most difficult of diagnosis. There are usually continuous dull pains over the liver, with attacks which so closely resemble intermittent fever that the most expert physicians have been deceived. In hepatic colic the pulse is small and slow, or normal. Retardation of the pulse is regarded as a pathognomonic symptom. It may be rapid from complications. Rigors and shivering may precede or accompany the onset of pain.

Cholecystitis and Angiocholeitis.—Inflammation of the biliary vesicle and of the bile-ducts, when it follows an attack of colic, points strongly to calculi as an exciting cause, especially if we find conjoined with this condition a tumor of the vesicle. The appearance of icterus and intermittence of the fever make the diagnosis more certain.

Tumor of the gall-bladder furnishes an excellent diagnostic symptom, especially if, as in some cases where the abdominal parieties are thin, we can make out hard masses within the tumor, or when, as has been observed in a limited number of cases, a sensation, and possible sound, of solid bodies rattling against each other is produced by manipulation. Petit described this sensation as resembling that produced by shaking nuts in a bag. Hydatid cyst of the liver may give much the same sensation, but should not mislead. When no such bodies are to be felt the tumor may still be due to calculus occluding the cystic or common duct, producing dropsy of the bladder, or hyper-accumulation of bile, thickening of the bladder-walls, etc. This tumor of the vesicle is usually the first stage in the process of fistula-formation, of which we shall speak again under Complications. The escape of biliary concretion by natural or unnatural passages clears up the diagnosis at once.

Diagnosis.—A positive diagnosis is fortunately not a *sine qua non* so far as treatment of the attack of hepatic colic is concerned, all varieties of colic being treated in much the same way to relieve the pain. The early diagnosis of the condition itself, however, is of vast importance. The colic ceases after a time, and is replaced by a stinging, burning, or pressing pain, or feeling of fulness. If the colic has ceased suddenly the stone has probably fallen back from the neck of the bladder, and it may not cause another attack for some time, or the pain may have ceased some time after the stone has become fixed in the cystic duct. Having the history and other signs of biliary colic to guide us, we bring to our aid (*a*) palpation; (*b*) percussion; (*c*) urinary analysis; (*d*) the thermometer (Fauconneau-Dufresne says a local elevation of temperature is shown); (*e*) the stethoscope (in conjunction with palpation); (*f*) the exploring needle.

Bartholow suggested exploring the bile-duct with a probe. He says: "The diagnosis can be reduced to an absolute certainty."

Dr. Whittaker,[35] of Cincinnati, O., publishes the case of a male, aged seventy-three, who had symptoms of total occlusion of the common duct, with jaundice, etc. On April 19, 1882, he fixed the gall-bladder by pressure from below and introduced an aspirator needle, withdrawing some bile. The following day he introduced the longest and finest of the Dieulafoy's aspirating needles, and struck a stone four and three-fourths inches from the surface in the direction of the common duct.

On May 3d Dr. Ransohoff operated on the case for him, removing two large stones weighing 138 and 162 grains respectively, one being firmly wedged into the cystic duct. There were also three small stones. Death occurred on the following day.

Dr. Whittaker claims this method of exploration as his own, and considers it the simplest, safest, and surest method of detecting stones in the gall-bladder or ducts, being easy of performance and almost painless. It certainly was efficacious in the case reported.

The exploring needle surely offers at present the best means of making a positive diagnosis. Whether it is entirely devoid of danger future experience will best prove. Many surgeons at the present day regard the procedure as one of doubtful propriety. By its means many cases of impacted stone which now pass unrecognized might be discovered and operative measures instituted.

Dr. G. Harley[36] has written a work on the subject. Luton[37] saw A. Thomas, in Reims, determine the presence of stone in a distended gall-bladder by plunging in a fine trocar, and striking the concretions.

The introduction of an exploring needle into the exposed sac of a biliary tumor is a useful means of determining its contents, but when the calculus is encysted its detection will be difficult.

Differential diagnosis must be made from *gastralgia*, which is associated with other nervous disorders and does not have so slow a pulse; from *saturnine* colic, in which pressure upon the abdomen gives relief; from *ulcer* of the stomach, in which the pain comes soon after eating and is not of the expulsive variety noted in biliary colic; from *cancer* of the same or other organ; see under "Complications." Catarrh of the bile-passages, intercostal and various other neuralgias, hydatid cyst of the liver, nephritic colic, peritonitis, poisoning, strangulated hernia, and other abnormal conditions, may have points of analogy in their symptoms which will make the attack closely resemble one of gall-stones.

In differentiating between the varied conditions which calculi themselves may produce Durand-Fardel says: "When the hepatic region, in the interval of exacerbation, is the habitual seat of pain, tension and engorgement; when, during the crisis, the tension of the hypochondrium is great, the sensibility to pressure marked and diffuse, and the pain itself wide-spread in the region, then we must regard it as the inflammatory form, and act accordingly. When the contrary conditions prevail . . . and pressure is borne, we attribute to the hepatic colic a character particularly spasmodic."

The calculi may all be contained in the common duct, while the bladder and cystic duct atrophy, making the diagnosis difficult, as in the case reported by Dr. Bogue.[38]

Complications.—*Carcinoma* has been thought to be caused by the irritation of calculi in the gall-bladder or ducts. Until recently most observers were inclined to look upon the cancer or the cancerous diathesis as the cause rather than the effect of the calculi. Several recent clinical observations would appear to confirm the belief that calculi may be the irritating cause in some cases. Quetsch[39] relates the case of a female patient who had a biliary fistula opening upon the surface, the result of long-standing calculous disease. Some of the calculi did not pass through the fistula, and carcinoma of the gall-bladder, which developed, was attributed to the irritation produced by their presence in the organ.

Frerichs notes the coincidence of cancer of the biliary system and calculi, having in eleven cases found calculi nine times. Professor Arthur Willigk,[40] of Olmütz, has written upon cancer of the liver in consequence of local irritation of gall-stones.

In the *Bollettino delle Scienze Mediche di Bologna*, 1871, is recorded a case of cancer of the liver and gall-bladder in consequence of gall-stone formation, the patient being a lady of forty-eight years. Kraus[41] reports a case of primary cancer of the ductus choledochus produced by the wedging of a gall-stone in this canal.

Hilton Fagge[42] records much the same results from observation of autopsies during fifteen years.

Complications have been noted on the side of the vascular system, such as cardio-vascular reflexes, etc.[43]

Intestinal Obstruction.—Fatal obstruction may be caused by one or more gall-stones becoming impacted in the gut. I have a personal knowledge of one case occurring in a most estimable lady, a patient of my friend Dr. Sullivan, of Flemington, N. J. A concretion the size of an English walnut was found distending the up-

per portion of the jejunum. As no jaundice had at any time been observed, it is probable that the stone reached the gut by ulceration. The stone being potato-shaped, no bile could have passed it, as at times it might have passed an angular stone on its way through a greatly dilated common duct. Dr. Woodbury [44] reported the case.

Mr. Treves [45] said, in 1884, at the London Pathological Society that up to that date forty-eight cases of obstruction had been published. In over fifty per cent. of cases the obstruction was in the lower part of the ileum; next in frequency they were found in the jejunum. He regards the occlusion as not so much mechanical as spasmodic, followed by inflammatory thickening. Opium was advised as treatment, and no operative procedure was considered justifiable. Howship [46] gives a case of fatal occlusion of the duodenum by a calculus weighing 440 grains; Bourdon one in which the stone weighed 930 grains, and occupied the sigmoid flexure. Gros [47] also reported a large stone lodged in this portion of the gut, and Hulke has seen a gall-stone just above the anus cause obstruction, acting like a ball-valve. It was removed, and recovery followed. Dr. Wilks [48] showed at the London Pathological Society two large stones, one weighing 250 grains, which were brought away by enemata after causing symptoms of obstruction. At the same meeting Mr. John Wood said he thought he had intercepted two stones in their passage, by ulceration, into the hepatic flexure of the colon. He operated on a painful tumor and cut down upon a mass of adherent thickened tissue containing the stones.

The ileo-cæcal valve and lower end of the ileum are common points of arrest, the anatomy of the parts favoring obstruction. Neill [49] reports a case of ileo-cæcal valve obstruction; Johnson [50] another, which resulted fatally. In over half the cases of occlusion collected by Lichtenstern the obstruction was in the lower end of the ileum.

Other cases of obstruction are reported by Bernard,[51] Peebles,[52] Wising,[53] Wilks,[54] Merklen,[55] Hill,[56] and Cruveilhier.[56] The last named read a note at a meeting of the Société de Chirurgie on a fatal obstruction in a lady of fifty; he considered that in such cases laparotomy should be performed. Small concretions in some instances fall into the vermiform appendix and cause perityphlitis, gangrene, ulcerations, etc. A rare case, terminating favorably, is that of Siry.[57]

Rupture and *ulceration* of the bile-ducts is an occasional complication. Wolf [58] has made record of a rare case, terminating fatally by rupture of the *hepatic* duct after violent colic caused by an impacted stone in this canal. Complications on the side of the liver may result from chololithiasis, such as infiltration of the organ with bile, and consequent changes in the liver tissue; cysts of the liver and abscesses containing concretions which may have reached an enormous size; pylephlebitis, etc.

Dr. Alfred North,[59] of Waterbury, Conn., on September 8, 1881, aspirated a cyst of the liver caused by impaction of a gall-stone in the common duct, and drew off five pints of coffee-ground fluid. The patient was a male, aged forty-five, who had previously been in good health, with the exception of seven or eight bilious attacks. Death occurred on the second day.

On the part of the gall-bladder we may have thickening of the walls, dilatation of the organ, ulceration, rupture, adhesions to neighboring organs and surrounding fibrous structures, besides cancer and other conditions already mentioned.

Cutaneous Biliary Fistula.—A case of this somewhat rare complication came under my observation five years ago. A lady, eighty-three years of age, living in Washington, D. C., had an attack of hepatic colic in 1877, followed by symptoms of intestinal obstruction lasting four days, and finally relieved by the introduction of a stomach-pump tube high up into the colon and the injection of an emollient solution. Several attacks of colic followed, and then came an interval of three years' entire freedom. In March, 1880, an attack of hepatic colic came suddenly. Chloroform and ether (it is said) were given internally; nausea and severe retching followed. The next day a constant and severe pain localized itself in the right hypochondrium and continued with more or less severity for about three weeks. Dr. D. W. Bliss was now called, and found a tender, fluctuating tumor on a line with the umbilicus and 14 ctm. to the right of it. He opened the swelling at once, and gave exit to about a pint of thick pus of extremely offensive odor. Two or three days later five calculi passed through the opening. In August, 1881, I first saw the case. The pus had then burrowed beneath the abdominal muscles—an opening had been made 10 ctm. below the original. As a result of our conference, we enlarged the original opening by cutting through the thickness of the abdominal walls, and with the finger and probe explored a large cavity with smooth walls. No stones were found. We inserted drainage-tubes into both upper and lower cavities and the fistulous tract by which they communicated, thus securing complete healing of the lower cavity and sinus. Calculi continued to pass by the upper tract until twenty-nine had been collected. The injury to the abdominal walls resulted in a large hernia at this point. A sinus remained and continued to discharge a thin fetid ichor until death, due to other complications, four years later.

Hoffmann observed eighty biliary concretions pass through the abdomen. Bloch [60] saw calculi discharged from a fistula under the false ribs. Folet [61] saw one the size of a pigeon's egg pass through at the navel. Buettner (1774) knew of thirty-eight stones being discharged at this same point. Civadierus relates the passage of one through the right groin.

The first intimation we find of any operation is in the "Lithologia" of Schurigius, where it is related that I. Fabricius removed a biliary concretion from a living man by cutting.

Thudichum, in his work on gall-stones, published in 1863, brings together 45 cases of biliary fistula; 11 collected by Soemmering in 1795, 20 by Fauconneau-Dufresne in 1851, 8 by himself, 3 by Walter, and several by Oppolzer.[62]

Dr. Kemper, of Muncie, Ind., published in 1879 eleven other cases, including one of his own. I had collected, up to the date of my paper, 20 additional instances [63] of biliary fistula opening spontaneously or by operation, omitting instances of cholecystotomy at that time added, making a total of 78 cases, including my own. Since that date I have been able to find record of some few additional cases, and if we include the cholecystotomies and extirpations of the gall-bladder which have been reported, we have a series of some 130 cases of fistula, or the conditions which would probably result in fistula or other disaster, unless treated surgically.

We meet with two classes of cases—the first where there is distended bladder, with symptoms of occlusion of the duct from impacted stone; the second, where the impacted stone has passed by ulceration through the duct or bladder-wall, or the contents of the bladder have escaped into the peritoneal cavity.

The diagnosis is often not made until the stones pass, after operation, the impression being that an abscess of the liver, or dropsy of the gall-bladder, or simple abscess of the abdominal walls, is to be encountered.

Prognosis, in any given case of cholelithiasis, should be guarded. So long as concretions remain, or the tendency to their formation exists, complications may arise which will lead to death. The prognosis for operation is favorable. Bernays [64] gives the mortality as 23.5 per cent. for cholecystotomy. Eight cases of total extirpation have been reported, with only one death directly due to operation. The prognosis in cutaneous fistula is likewise good.

Of the cases resulting in spontaneous fistula among those collected by myself, 7 recovered, 2 died—1 only after three years, and 1 from surgical interference.

In the 8 cases where the abscess was opened by the surgeon 7 recovered, and the result of 1 is not given.

We must not lose sight of the fact that many of the operated cases would probably have done badly if left to nature, and that surgical interference might have resulted in harm to others.

Death may take place suddenly in hepatic colic, from

the pain and shock alone, or from rupture of the bladder or a duct.

Prognosis in intestinal obstruction is universally bad, but now and then a case will begin to recover just as we are expecting the collapse to be followed by death.

A repetition of the attack is always to be looked for, but the prognosis for the cure of simple uncomplicated cases of gall-stone is usually good.

TREATMENT is directed against: 1, The attack of hepatic colic; 2, the conditions predisposing to cholelithiasis; 3, the stones already existing; 4, complications, fistulæ, impaction, etc.

Hepatic colic is best controlled by opium, morphine hypodermatically being the favorite mode of administration. Inhalations of chloroform in the most violent period of attack; belladonna or atropine, internally, is praised by some. Hot external applications, prolonged hot baths as in nephritic colic, often do much to relieve the severity of the attack, the patient sometimes going to sleep in the bath, but it should not be relied upon when a hypodermatic syringe can be used. It is often grateful after the severity of the attack has passed.

Emetics have occasionally been found useful, as the pain is often found to decrease after vomiting, but there is danger of injury from the violent effort. Chloral hydrate by the rectum is recommended (Cyr) in the dose of from two to eight grams in the twenty-four hours. Purgatives should be employed after the pain of the colic has ceased. Castor-oil is probably the best. Olive-oil is recommended by Ruttan and Kennedy.[65]

The predisposition should receive as early treatment as possible and this should be energetic beyond the apparent requirements of the case. Dieting must be employed, fatty foods avoided, and exercise enforced to favor the flow of bile. Drugs producing abundant bilious stools, rhubarb, castor-oil, calomel, should be given from time to time. Fresh herbs, dandelion, dog-grass, and the like, were reccommended by Van Swieten, Boerhaave, *et al.*

Lemonade and cream of tartar are recommended. Posner[66] says, "Without disease of the gall-bladder or the bile-passages, no stone-formation takes place." There are drugs which have an excellent effect in preventing the formation of calculi, in the sense that they cure this local affection of the bile-passages, thus preventing the production of the material on which the stone-formation depends.

Posner mentions as such remedies turpentine and alkaline waters, especially those of alkaline sulphur springs, all excellent anti-catarrhal remedies. The waters at the springs, or the Vichy, Carlsbad, or Ems salts, should be taken several years in succession.

Soda being a constituent of normal bile, and a diminution in its quantity being accused of favoring calculi by allowing cholesterine and bile-pigments to precipitate, this alkali becomes, theoretically, one of the most important to administer, and, practically, carbonate of soda has been found to have an advantage over the potash and other alkaline salts. This treatment was inaugurated by Hoffmann, and its efficacy appears to be the best demonstrated of all methods. It is supposed that, in completing the respiratory combustion, alkalies are inimicable to the production as well of cholesterine as of uric acid. The potash and soda salts of the organic or vegetable acids, such as the citrates, tartrates, acetates, malates, etc., are readily transformed in the economy into carbonates of the same base, are easily supported, and act well. Tumas[67] reports a case of cholelithiasis of long standing cured by turpentine.

Treatment of Stones already Formed.—At the present day attempts are rarely made to dissolve stones when once formed. In 1782 Poulletier de la Salle[68] discovered that biliary calculi could be dissolved with the aid of heat in alcohol and that on cooling the solution deposited mica-like lamellæ which he compared to boric acid. This probably gave the first impulse to a mode of treatment having for its aim the *solution* of *calculi* within the body, although we find that Durande[69] wrote a memoir on gall-stones and upon the efficacy, in hepatic colic, of the following mixture, which still is known by his name:

℞.	Sulphuric ether	15 grams.
	Essential oil of turpentine	10 grams.

M. Two to four grams daily in bouillon, or ♏ xx. in a capsule three times daily.

This probably has no dissolving action; large quantities must be taken and vomiting is caused by it. The turpentine probably has a beneficial action on any cartarrhal condition of the gall-bladder that may be present. The essence of turpentine appeared to Duparcque[70] to have such an irritating effect on the gastro-intestinal canal that he advises the following combination:

℞.	Ether	4 grams.
	Fresh castor-oil	60 grams.
	Syrup	30 grams.

As *chloroform*[71] is the natural solvent of cholepyrrhine, it has been thought useful by some and is administered in sweetened water. *Ether* has also been given. Calculi are occasionally destroyed by a natural process termed *cleavage*, fragments being found in the fæces and in the gall-bladder which could be fitted together to reproduce the entire stone. This should be remembered in connection with a proposition to crush stone in the duct. *Palpation*, mentioned under "Diagnosis" is at times of itself curative. Marrotte[72] saw symptoms of intestinal obstruction from gall-stone cease after palpation and manipulation; and Mayo[73] had obtained an equally fortunate result. Handfield Jones[74] proposed to open the abdomen in obstruction of the duct and to push the stone into the gut by manipulation without opening the gall-bladder.

Treatment by the Elastic Bandage.—Dr. Qvisling[75] states that in seven cases of gall-stone (two men and five women) he has seen good results follow the use of Martin's elastic bandage. Its action depends on the immobilization of the abdominal organs, by which the calculus is prevented from irritating the mucous membrane and from causing reflex contractions of the muscular coat of the gall-bladder. The bandage is applied rather firmly from over the upper edge of the hepatic dulness as far down as the crest of the ileum, a piece of flannel being placed under it. It may be removed at night, if desired by the patient. Its use should be persisted in until the patient appears to be definitely cured.

In exceptional cases cholelithiasis requires radical surgical treatment. This brings us to the consideration of *cholecystotomy*,[76] an operation which suggested itself to the minds of surgeons many years ago. Petit seems to have suggested it in 1733. He gives four cases which had been operated upon. They were supposed to be abscesses, and consequently do not deserve a place with the cholecystotomies of to-day. He began an operation himself and abandoned it.

His own and another case alone recovered; his with a fistulous opening through the abdomen, through which a calculus subsequently passed.

Tait gives Handfield Jones the merit of first suggesting the operation and extending it, and Dr. Sims the credit of being the first to carry out the plan. He claimed his as the first successful case on record.

Dr. Kemper claims (and justly I believe) priority for Professor Bobbs, of Indianapolis, whose case was published in the "Transactions of the Indiana State Medical Society, 1868."

He reiterates this claim in the *Cincinnati Lancet and Clinic* in 1879, and says that if it is not the first case, it is the first successful one on record. He operated in June, 1867, on a woman thirty years of age. The tumor had been gradually enlarging for four years. The diagnosis was not made. When the tumor was cut down upon, a pedicle was looked for to tie, but none being found, the bladder was incised and several solid bodies of bullet size were discharged, with a quantity of limpid fluid. The bodies were not stated to have been gall-stones, but presumably were. The incision in the walls of the bladder were stitched, the external wound closed, and recovery was rapid.

Mr. Lawson Tait has done more than anyone else to make the operation a success.

In the London *Lancet* of February 13, 1886, he gives to the profession a history of five cases of cholecystotomy, they being the five latest of his series of *twenty-one successful cases.* This is just half the number that have been reported. In the other half the mortality has been nearly fifty per cent., due in a great measure to the lateness of operating. The indications for early operation are: jaundice, tumor of the gall-bladder, frequent hepatic colic, and symptoms of suppuration.

Cholecystectomy[77] or total removal of the gall-bladder was first advocated and performed by Langenbuch,[78] who has already done it five times, with virtually four recoveries. Courvoisier, of Basle, has performed it once, and Thiriar, of Brussels, twice, successfully. The mortality so far is only 12½ per cent. Still, Tait and others condemn the procedure. Thiriar looks upon it as the least dangerous of all forms of laparotomy. It is a more radical operation than the other, and so far has been very successful. Chronic cholelithiasis has usually been the indication for this operation.

Prof. Bernays[79] has named an operation performed with success by himself in October, 1884, *ideal cholecystotomy.* After opening the abdomen he emptied the bladder of its fluid contents with a trocar, then, introducing a narrow-bladed knife into the trocar-opening, made an incision one and a quarter inch in length. Twenty stones were then removed. One large stone, engaged in the first convolution of the valve of Heister, had to be released by cutting the surrounding tissue. He then carried out Sir Spencer Wells's proposition of closing the gall-bladder by a suture and returning it to the abdominal cavity. He says:

"While applying the suture to the incision of the sac, I noticed considerable oozing of blood within the sac. This bleeding ceased, however, before I had finished the introduction of the sutures. I used black iron-dyed silk for the sutures, applied somewhat after the manner of the Czerny-Lembert suture, which Czerny and others have so successfully employed in their operations of excision of the pylorus. I first united the edges of the cut by the simple interrupted suture, using a very fine needle and the very thinnest silk. Seven sutures at regular intervals sufficed to accurately approximate the edges and close the wound. Before tying these seven sutures the sac was carefully cleansed, by warm-water injections, of some débris and small coagula that had formed within it. The sutures, having been carefully tied, were cut short, and I proceeded to introduce the Lembert sutures, which were intended to embrace only the peritoneum, and perhaps some fibres of the muscular coat. It is well to remark in this connection that after the sac was emptied and contracted the peritoneal as well as the other coats were much thickened, and in excellent condition for the application of sutures. I applied *eight* of these Lembert sutures in such a manner as to completely cover the simple interrupted sutures when tied, and not only in the length of the original cut, but so as to have one stitch of the peritoneal suture beyond the ends of the incision. No blood or any other foreign substance having escaped into the peritoneal cavity, the toilet was unnecessary, and I proceeded to close the abdominal wound in the usual manner. One year after operation the lady was in excellent health."

Impaction of calculi in the ducts and in the intestines may sometimes be overcome by manipulation. When this is not practicable, one of the operations above named is called for to remove concretions from the common or cystic duct.

It has been proposed to open the abdomen and crush the stone in the duct without opening the gall-bladder. When abscesses appear externally they should be opened early to avoid burrowing of the pus. In intestinal obstruction opium should be given to relax the spasm. Relief has occurred probably from the relaxation of collapse, just as death was looked for, in several instances; and it is probable that the inhalation of chloroform sometimes relieves hepatic colic in the same way.

Cutaneous fistulæ, once formed, require little treatment, as the patients usually do well.

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LIVER, HYPERÆMIA OF THE. (Congestion of the Liver.) A more or less persistent increase in the volume of the blood in the liver constitutes hyperæmia, and is pathological, in contradistinction to that temporary physiological increase which occurs during the period of digestion.

When the hyperæmia is due to an increased afflux of blood, it is termed a *fluxion;* when to a diminished efflux, a *congestion.* An *active* hyperæmia signifies a sudden determination of blood to the organ, or a fluxion, made manifest by definite acute symptoms; it usually subsides without structural changes in the viscus. A repetition of such an hyperæmia, and especially with an increased volume of blood in the hepatic artery, leads to the gradual development of interstitial hepatitis or cirrhosis. A *passive* hyperæmia, diminished efflux, is developed slowly, with few accompanying symptoms until after structural changes, which usually occur, have taken place.

An *active* hyperæmia is essentially acute ; a passive, chronic. Some passive hyperæmias occur in a short space of time however, as in the form that accompanies a large pleural effusion.

Mechanical hyperæmia, active or passive, is caused by an obstruction to the outlet of blood, seated in the vena cava, the heart, or the pulmonary circulation.

It is, however, well-nigh impossible to separate the various forms of hyperæmia by hard and fast lines, and clinically it suffices to consider active and passive hyperæmias, which are practically synonymous with acute and chronic congestion of the organ. The difficulty of accurate subdivision arises from the fact that the various forms blend. Three sets of vessels are involved in the occurrence of congestion. The congestion due to over-repletion in the hepatic veins differs in form and behavior from that due to portal fulness. The two forms are readily distinguished by a consideration of the primary causal factors. To distinguish the hyperæmia from excess in the portal side, from that of the hepatic artery, is clinically impossible, and scarcely practicable.

ETIOLOGY.—Active hyperæmia, acute congestion. The ingestion of *stimulating food* and *drink* causes active hyperæmia. When alcohol, fermented liquors, spices, and rich foods are taken frequently or in excess, especially by delicate persons who lead a sedentary life, the normal congestion associated with digestion becomes excessive and more or less permanent. Residents in hot climates, with or without such indulgence, are particularly prone to attacks of hepatic congestion ; hence *high temperature* has been considered a causal factor. Sudden checking of the *perspiration*, a severe and sudden, or a prolonged, *chill* or repetition of chills, is followed quite frequently by active hyperæmia. Persons living in a *malarious* region are liable to attacks of hepatic, as well as of splenic, congestion. During the *seasons* when malaria is rife, or when the changes in temperature are sudden and extreme, the disease is most liable to occur. Congestion of the liver, is found, too, in many *infectious diseases*, as relapsing fever, yellow fever, epidemic cerebro-spinal meningitis, and scarlet and typhus fever. After traumatism, a determination of blood to the injured area of hepatic tissue is always observed. It is said, also, that hyperæmia of the liver occurs in scurvy.

The suppression of customary discharges, especially of blood, causes fluxion to the liver. Cessation of the menses at the menopause, or by cold or nervous influence, and arrest of the hæmorrhages of uterine disease from various causes, are not uncommonly followed by attacks of hepatic congestion. So, also, congestion of this organ not infrequently follows the stanching of hæmorrhoidal bleeding.

It is said that habitual constipation induces passive congestion of the liver. It is difficult to prove, yet it can readily be surmised as possible, that paralysis of the sympathetic nerve causes torpor of the hepatic circulation. It is true we see in some diseases, as tubercular peritonitis, in which the contents of the abdomen are jumbled into a mass and the sympathetic ganglia degenerated, a hyperæmia of the liver—a condition which could be explained, however, by obstruction in the portal capillaries. As Thierfelder suggests, the congestion associated with diabetes mellitus may be due to paresis of the abdominal sympathetic. The sluggishness of the circulation, that occurs in persons who exercise sparingly, is markedly seen in the stasis that occurs in the liver.

Active or acute congestion of the liver, therefore, is liable to occur in persons of sedentary habits, without muscular vigor, who are high livers and reside in hot climates. It should not be forgotten, however, that its occurrence in temperate climates, though of comparative infrequency, is yet not very rare. A chill, or sudden checking of perspiration, is a frequent exciting cause. Malaria is most commonly observed, of all diseases, to excite an attack. Hepatic congestion occurs most frequently in the autumn, and usually affects individuals of middle life.

The most important and frequent causes of hyperæmia of the liver, whether in temperate or tropical climates, are mechanical. The forms of heart disease which cause backing of the blood into the venous system, as cardiac dilatation, and mitral and tricuspid valvular disease, are attended by hepatic congestion. In emphysema, interstitial pneumonia, and atelectasis, the venous flow is obstructed. The form of congestion is, under these circumstances, passive. Tumors of the mediastinum, aneurisms, and effusions in the pleura,[1] pressing upon or bending the vena cava, also cause hepatic congestion.

SYMPTOMATOLOGY.—It is manifest that the symptoms of hyperæmia of the liver differ according to the cause

Moreover, they are intermingled with the symptoms that belong to the respective causal factor. In mechanical hyperæmia, for instance, the symptoms of obstructive heart or lung disease are present, along with those of hepatic congestion. In active hyperæmia the hepatic symptoms are less complicated, and serve as a type of the acute form.

After a chill, excesses in diet, or exposure to high temperature, complaints of pain in the liver, and weight and fulness in the right hypochondrium, are made. The pain may extend to the right shoulder, is constant and associated with tenderness of the liver, excited by palpation along the margin of the ribs. Febrile reaction, not marked, attends the attack for two or three days, while general *malaise* is marked. At the same time, a bad taste in the mouth, heavily yellow-coated tongue, nausea, thirst, anorexia, epigastric fulness, and flatulency, and often vomiting, are present. The bowels, at first torpid, are relieved by diarrhœa. A gastro-intestinal catarrh usually accompanies the hepatic congestion, in which case vomiting and diarrhœa are more frequent. The ejecta from the stomach are composed of the food, an acid, glairy mucus, and bile-stained watery fluid. The stools are clay-colored and pasty, or watery, acid, and greenish, or dark-colored. Often there is some dyspnœa, and the so-called liver cough is present. Headache, usually frontal, accompanies the attack, and is associated with vertigo.

On physical examination the liver is found to be enlarged, extending two or three inches below the margin of the ribs. Its edge is rounded, elastic, and smooth on palpation.

In a day or two the conjunctivæ become yellowish, and even a light degree of general jaundice supervenes. The jaundice is due to associated catarrh of the ducts, or to pressure on them by the engorged vessels. Languor and debility continue for some time, while melancholy and hypochondriasis commonly occur. The countenance, at first flushed, or if the pain is severe, anxious and pinched, grows sallow and worn.

The urine is scanty and high-colored. It contains an excess of urates, some bile-pigment if there is jaundice, and often small amounts of albumen and sugar (functional albuminuria and glycosuria). The presence of these ingredients may be intermittent, and may vary with the diet.

If the hyperæmia persists, the overloaded state of the portal vessels results in sluggish absorption of the products of digestion, and over-repletion of the vessels of the gastro-intestinal mucous membrane. A true catarrh of the tract arises, and is all the more aggravated and persistent on account of the vascular stasis. Its symptoms replace largely those of congestion. In passive and mechanical hyperæmia, this catarrh is most marked. In these forms the liver is large, more firm but less tender on palpation. Its size, in hyperæmia due to obstruction, is variable. Depletion by a purgative, or removal or relief of the cause (cardiac dilatation, etc.), would reduce it, and a recurrence of the cause would again be followed by enlargement. This temporary change characterizes mechanical hyperæmia. An enlarged, congested liver may be temporarily increased by sudden obstruction in some other area of the blood circuit. A pneumonia or a pleural effusion may thus aggravate the hepatic engorgement, and in turn be aggravated by the old liver disease.

The stasis in the hepatic circulation may be so extreme as to cause over-fulness in the portal vessels and secondary enlargement of the organs in that area. An ascites, out of proportion to the general anasarca usually present, will arise, the spleen becomes enlarged, and the hæmorrhoidal vessels dilated. The secondary phenomena are more probable if the changes incident to overgrowth of the cellular tissue of the liver ensue. In this class of cases the liver is diminished in size and, if palpable, is very firm and hard.

Course, Duration, and Prognosis.—The course and duration are largely determined by the cause. An active congestion of the liver will subside usually in two or three weeks. The subjective symptoms are often removed, while enlargement of the liver may continue for some time. Congestions of the liver which originate on the portal side of the hepatic circulation are more amenable to treatment, and last a shorter time, than the congestions on the hepatic side. The latter are due to chronic heart and lung disease, and in their varying course, now better, now worse, depend upon the primary causal agency. The prognosis, likewise, depends on the cause. When the liver becomes enlarged from congestion, and subsequently undergoes marked atrophy, the prognosis of the hepatic trouble is serious, and it, in turn, renders more grave, day by day, the primary disease. Care must be exercised not to mistake the initial congestion of true cirrhosis for simple hyperæmia. An active congestion of a liver, in which the anatomical structures are abnormal from previous disease, is serious and may fatally terminate a slow cirrhosis or a fatty liver.

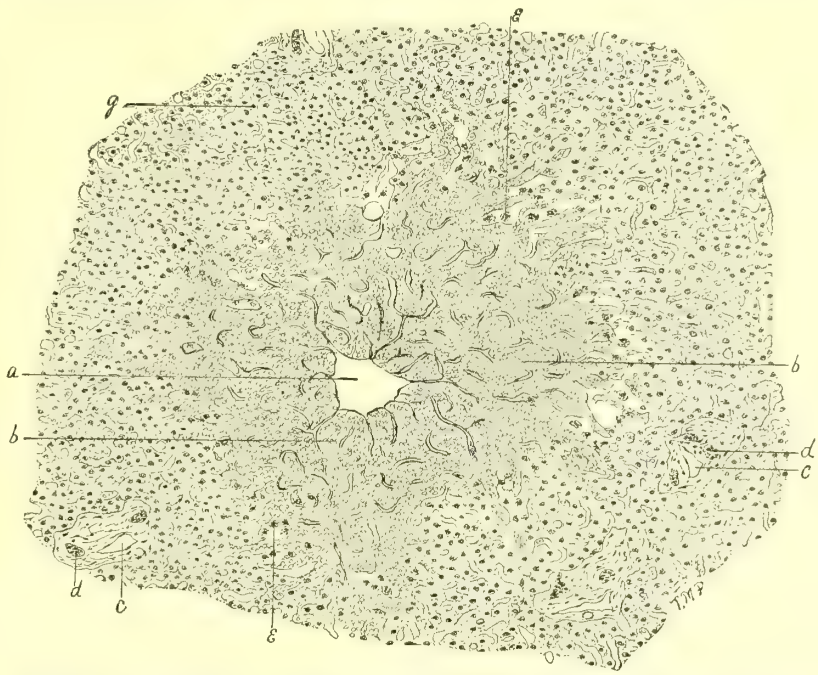

Fig. 2179.—Chronic Congestion of the Liver. (× 300 and reduced.) Complete Atrophy of the Liver-cells at the Centre of a Lobule. *a*, Dilated vena centralis; *b*, dilated capillaries filled with blood; *c*, portal vein surrounded by connective tissue; *d*, gall-ducts; *e*, atrophied liver-cells. *g*, nearly normal liver-tissue. (From Delafield and Prudden's "Handbook of Pathology, Anatomy, and Histology.")

Diagnosis.—The diagnosis is usually easy, but the condition cannot be clearly recognized unless the causal influences previously mentioned be evident. In addition to the cause, the shape and size of the liver, the gastro-intestinal catarrh, the condition of the urine, and the signs of secondary portal obstruction, must also be considered.

Morbid Anatomy and Pathology.—Before advanced secondary changes have taken place the liver is uniformly enlarged. The enlargement is most marked in the thickness of the organ. The surface is smooth, the capsule transparent, the edges thick and rounded. On section,

dark blood oozes freely from the vessels. The tissue is soft and darker in color than normal. The vessels are dilated; the enlargement of the hepatic vein in the acini is especially distinct in passive congestion, though a similar increase in size of the portal vessels occurs when the engorgement is limited to that side of the circulation. Throughout the substance of the organ numerous hæmorrhages are seen. On microscopical examination, the vessels are seen to be dilated, and their walls thickened by increased cell-proliferation and the migration of leucocytes. Atrophy from compression of the hepatic cells is marked. A catarrh of the minute ducts is often present.

In the more advanced stages the atrophy of the cells is more marked, pigmentation and fatty degeneration of the cells in the portal zone are present, to a great degree, and the cell proliferation and infiltration of leucocytes is not only seen in and about the vessel walls, but also between the hepatic cells of the individual acini. This is due to an overgrowth of connective tissue, or to greater distinctness of the cells on account of destruction of the hepatic cells. A liver that presents such histological changes is called the *nutmeg* liver. It is normal in size or lessened, firm on section. The capsule is opaque, and the surface and interior are granular, the latter gorged with blood. The acini are distinct, the central vein much dilated and dark in color. The periphery of the lobule is yellow, the centre dark red. The term "nutmeg" is applied to the marbled appearance.

In more advanced stages the overgrowth of connective tissue is extreme, and leads to great atrophy and pigmentation of the gland-elements. Crystals of hæmatin are observed free in the tissues. The liver is small, very firm, dark-red. Such is the liver of *cyanotic atrophy*. The same macroscopical appearances are seen in *cyanotic induration*, but the increase of the connective tissue is greater, the cells are more degenerated, and the vessels are more engorged. These advanced changes are located in the region of the hepatic vein, while the interstitial overgrowth in cirrhosis begins in the portal veins.

Treatment.—The first indication to be met is the removal or amelioration of the cause. The methods to be pursued are readily known and sufficiently clear, if a knowledge of the cause and mechanism of congestion is borne in mind. Thus the diet must be well selected, and bland, non-stimulating articles are to be given. Rich foods, pastries, condiments, sugars, and starches are to be avoided. Milk, eggs, beef-broth and beef-tea, lean meat, succulent vegetables, and acid drinks are required. Systematic exercise is essential, especially in sedentary subjects. Daily walks, horseback riding, sailing, are all good. Horseback riding is the best. A change of air, especially a residence by the sea, is often beneficial. Bathing, sponging, and douching is of much service.

The acute manifestations are best treated by local depletion, with morphia internally to relieve the pain. Wet cups over the liver, and leeches in the same area or around the anus, are to be used. If the pain is not so severe, mustard plasters are stimulating enough, and large poultices may be employed subsequently. Some few authorities assert that the engorgement which ensues is relieved by puncturing the liver through the abdominal walls with a long needle. Though long ago advocated, this practice has never been in vogue, but recently attracted attention by the advocacy of Dr. George Hurley.

To further assist in the depletion of the hepatic circulation, purgatives are indicated. The salines are of great value. Phosphate of soda, rochelle salts, citrate of magnesia, and other salines may be used, preference being given to those first named. If there is much nausea or vomiting it may be relieved by small doses, one-sixteenth to half a grain, of calomel frequently repeated, taken dry on the tongue. Some practitioners use large doses of the drug at once, and see evidences of liver congestion and torpor in every disease. The resinous cathartics are used by many, podophyllin being the favorite.

If the congestion of the liver be due to cold or checking of the perspiration, remedies to equalize the circulation must be administered. Saline diaphoretics or Dover's powder, a warm bath or a foot-bath, aconite or veratrum to quiet the circulation, and bromides to allay nervous excitement, are indicated. If there is much pain, small doses of Dover's powder are of great service, the ipecac which this preparation contains being of special utility. In malarious districts large doses of quinia are used. In fact, quinia and calomel form the sheet-anchor combination for many practitioners. High temperature must be combated, and the usual remedies to relieve the cardiac and pulmonary affections, that are the primary source of the congestion, administered.

There are two drugs that have acquired a great reputation in the treatment of congestion, viz., muriate of ammonia and ipecacuanha. Their use originated in the East. The muriate of ammonia is given in doses of from ten to thirty grains every four or six hours, and speedily gives relief. Ipecacuanha is given in the same way as in the treatment of dysentery. The patient must be at rest, and the dose of ipecac should be preceded by a small dose of laudanum, and by the application of a mustard plaster to the epigastrium. In this manner vomiting is often prevented. Thirty to sixty grains of the drug, every four or six hours, are given.

Alkalies are of great service in congestion of the liver. They must be administered well diluted, and on an empty stomach. It is advantageous to use the alkaline solution hot, and to sip it slowly. The natural mineral waters may be used. Those of Vichy, of Ems, and of Carlsbad, or the Hathorn and Congress waters of this country, are indicated.

The so-called grape-cure, and the whey-cure, were at one time quite in vogue in Germany, and both are, no doubt, of great value.

Of course, the patients who can afford it will be much benefited by a residence at the springs, taking a course of the waters and following the prescribed diet.

Some cases of chronic congestion of the liver refuse to yield to the system of treatment just indicated. In such, external applications over the surface of the liver are necessary. The compound ointment of iodine or the biniodide of mercury is of service. Care must be exercised to secure by the mercury only a slight ptyalism. Of more advantage than either is the nitric acid pack or bath. An ounce of the acid is added to two gallons of water and cloths saturated with the solution are applied over the liver. The proportion may be too strong and more dilution required. It causes extreme itching and burning or pricking of the skin. The acid bath is strongly recommended. Sir Ronald Martin directs that the bath should be composed of two ounces of strong hydrochloric acid and one of strong nitric in two gallons of water, at a temperature of 98° F. Both feet are to be placed in the bath; the abdomen, the hepatic region, the axilla, and the inner sides of the legs and thighs are to be sponged alternately, or the abdomen may be swathed in flannel saturated with the fluid. The process is to be repeated night and morning for half an hour. The fluid should be kept in wooden or earthen vessels, and the sponges and towels kept in cold water. The quantity of fluid may last five or six days by adding each day a pint of water which contains the proportionate amount of acid. It should be well heated to raise the temperature of the entire bulk of fluid.

After a course of alkalies, or the use of the means suggested above, the patient is enfeebled and the digestion weak. Now tonics are indicated. The mineral acids, quinine, and nux vomica are the best. With or without gastric disturbance, the chalybeate alkaline waters are of extreme value. Especially after a course at the "springs," an after-course should be taken at other springs, where a stimulating outdoor life and tonic waters would add to the vigor of the patient. In this period of convalescence the diet must be carefully selected, some mild wines employed, and particular attention directed to the regulation of the bowels by gentle saline laxatives.

Addendum.

The writer has collected some interesting facts concerning hepatic disease in a study of all the cases of liver disease presented to the Pathological Society of Philadelphia, from 1857 to 1881, inclusive. The condition of the liver was recorded 430 times, 184 times normal and 246 times diseased.

In 10 instances the liver was congested, in cases in which death occurred from accidental causes. The subjoined table indicates the proportionate frequency of occurrence of congestion of the liver, simple and nutmeg, in 246 cases of liver disease. It is of interest to note that in 36 cases of cardiac disease the liver was healthy 5 times, the seat of *nutmeg congestion* 9, and of simple *congestion*, 4 times. Nine times it was fatty; 8 times cirrhotic; 1 the seat of red atrophy (due to congestion). Of 13 instances of nutmeg congestion, 9 attended cardiac disease; 1 chronic pleurisy; 2 carcinoma (heart weak); and 1 chronic diarrhœa. The liver was enlarged 8 times in 13. The spleen was enlarged 6 times; healthy, 2; cirrhotic, 1; not mentioned, 4 times in the 13 cases. The kidneys were congested or cirrhotic in 10 of the 13 cases. Eleven of the cases were males; 6 of them were over forty, 5 between twenty and forty, and 2 under twenty. In no instance were symptoms referable to the liver recorded.

TABLE OF RELATIVE FREQUENCY OF ALTERATIONS OF HEPATIC STRUCTURE (TOTAL NUMBER OF CASES TWO HUNDRED AND FORTY-SIX).

Variety.	No. of Cases.
Fatty	80
Carcinoma	41
Cirrhotic	38
Congestion	24
Congestion, Nutmeg	13
Abscess	13
Tuberculosis	9
Syphilitic gumma	5
Hydatid disease	4
Rupture of liver	3
Hæmorrhage into liver	2
Pigment liver	3
Amyloid liver	2
"Diseased" liver	3
Leukæmic, "atrophied," red atrophy, chronic hepatitis, cavernous angioma, myeloid tumor, one each	6

J. H. Musser.

[1] Bartels: Left Pleural Effusion.

LIVER, INFLAMMATION OF THE CAPSULE OF; PERI-HEPATITIS. Peri-hepatitis, or inflammation of the capsule of the liver, may be acute or chronic. It is usually a secondary affection. The instances of primary acute peri-hepatitis are rare, and are due to direct injury. A chronic peri-hepatitis is said to arise from the long-continued pressure produced by tight lacing, or by wearing a strap about the waist to support the trousers. An hypertrophied heart may cause a similar inflammation on the blunt margin of the left lobe (Thierfelder). Secondary peri-hepatitis arises by extension of inflammatory processes seated in the neighboring structures. Affections of the diaphragmatic pleura; and of the stomach, duodenum, or pancreas, causing local peritonitis, are attended by peri-hepatitis. It may be caused by disease of the ribs lying over the organ. All forms of general peritonitis involve the portion of the membrane that covers the liver. The larger number of cases arise by contiguity from some disease of the liver. It is seen in cirrhosis, cancer, abscess, and hydatid cysts, lying near the surface. The presence of gall-stones in the gall-bladder, and the occurrence of attacks of hepatic colic, are very frequently attended by local peritonitis.

The investing capsule in peri-hepatitis is opaque and thickened from the formation of new connective tissue. The liver is intimately attached to adjacent structures. It is rendered more globular or rotund in those cases in which the capsule is the seat of chronic inflammation, and is tightly stretched over it. The adjacent hepatic tissue is not generally altered. Sometimes processes of connective tissue are sent out into the parenchyma. Inflammation about the portal fissure leads to subsequent stricture of the hepatic ducts by contraction of the inflammatory new-growth.

The symptoms of acute peri-hepatitis are often severe. Sudden, sharp, lancinating pain in the region of the liver, increased by movement, by respiration, or by pressure, is experienced. Some dyspnœa is provoked by the interference with the breathing. Marked fever attends these phenomena during the first three or four days. The presence of a friction-murmur may be detected by auscultation in some rare instances. An acute pleurisy of the right side is very strongly simulated by peri-hepatitis. Chronic peri-hepatitis is attended by dull pain, and by friction-sounds, and fremitus. After adhesions have formed the liver may not move upon deep inspiration, and in a case of extensive adhesions, symptoms not unlike cirrhosis of the liver may supervene.

The treatment is simple. Rest must be enjoined. Warm compresses or poultices to the right hypochondrium may give relief. A flying blister is almost always beneficial. In chronic perihepatitis more prolonged counter-irritation, as by iodine, is required. Morphia, by the mouth or subcutaneously, is necessary in the acute cases. Other opiates may be used. Otherwise the treatment must be directed to the cause.

It is not to be forgotten that the presence of old adhesions between the liver and diaphragm is often a wise provision. The vessels that develop in the tissue are utilized for setting up a collateral circulation, when the normal hepatic vessels are occluded or compressed. This remark has no reference to the treatment.

John H. Musser.

LIVER, MINUTE ANATOMY OF THE.—A description of the minute anatomy of the so-called "hepatic lobule" will comprise essentially that of the liver, which, throughout its entire mass, is of similar structure; and, like all other secretory organs, is supplied with blood-vessels, nerves, and lymphatics. The term "lobule" has been given to the minute capillary plexuses existing between the terminal portal radicles and the commencing capillaries of the hepatic vein, among which are systematically grouped the hepatic cells. Between these cells originate the bile-ducts. This term, lobule, unfortunately conveys (from studies in comparative anatomy) the idea of some peculiarly distinct and definite structure as existing in the liver (like the Malpighian corpuscle of the kidney), and it has been the means of confusing the minds of beginners as to the anatomy of the organ.

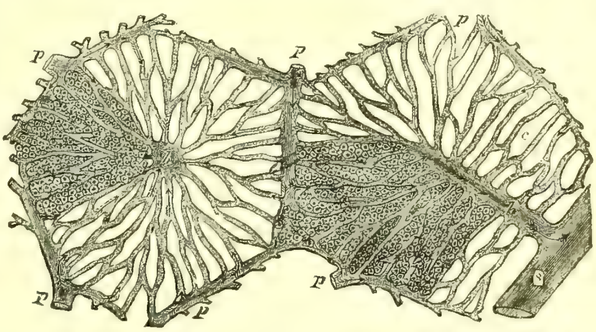

FIG. 2180.—Diagrammatic Representation of Two Adjoining Hepatic Lobules. "The left-hand lobule is represented with the intra-lobular vein cut across; in the right-hand one the section takes the course of the intra-lobular vein. *p*, Inter-lobular branches of the portal vein; *h*, intra-lobular branches of the hepatic veins; *s*, sub-lobular vein; *c*, capillaries of the lobules. The arrows indicate the direction of the course of the blood. The liver-cells are only represented in one part of each lobule." (From Schäfer, in Quain's Anatomy.)

Nevertheless, after a clear understanding of the hepatic circulation has been had, the term, with its accompanying adjectival modifications, can be retained as an aid to the study of hepatic topography. The liver, then, is a mass of lobules, *i.e.*, capillary plexuses, and an understanding of the anatomy of one is an understanding of the whole.

Let us first consider a somewhat characteristic but schematic lobule (see Fig. 2181). The vena porta enters the liver, accompanied by the nutrient artery of the gland, the bile-duct, and considerable connective tissue. All three rapidly subdivide into smaller and smaller branches, until the ordinary capillary is reached. These then converge, as do capillaries in any other part of the body, to form veinlets, then veins, and terminate in the systemic venous circulation.

Located between these ultimate capillaries are the liver-cells, arranged in somewhat regular columns, parallel to the capillaries. Between these cells are the commencements of the bile-ducts. These capillaries and bile-duct commencements are so arranged that a row of hepatic cells always separates the former from the latter. The hepatic artery entering the liver with the vena porta, branches with it, giving nutrient twigs to the neighboring

connective tissue, and sending twigs down into the lobule, to terminate in the intra-lobular veins.

Below is presented a drawing of a schematic lobule, but considered in the (unusual) longitudinal instead of customary transverse section. In it the branches of the vena porta (V.P.), or inter-lobular veins, are represented as cut longitudinally, as are likewise the sub-lobular (S.L.V.), or hepatic veins; occupying the centre of the drawing and terminating in the (H.V.) hepatic vein. Capillaries connect the V.P. with the S.L.V., and are designated as intra-lobular veins (I.V.).

The bile-ducts (B.D.) are shown as giving minute branches (I.B.D.), intra-lobular bile-ducts, which enter the lobule between the hepatic cells—shown as filling (in a tolerably regular manner) four of the inter-capillary spaces. The remaining spaces, devoid of cells, show simply the ultimate bile-ducts and intra-lobular veins. A moment's consideration and a glance at the diagram ought to convey at once a clear conception of the circulation of a lobule, and consequently of the entire liver.

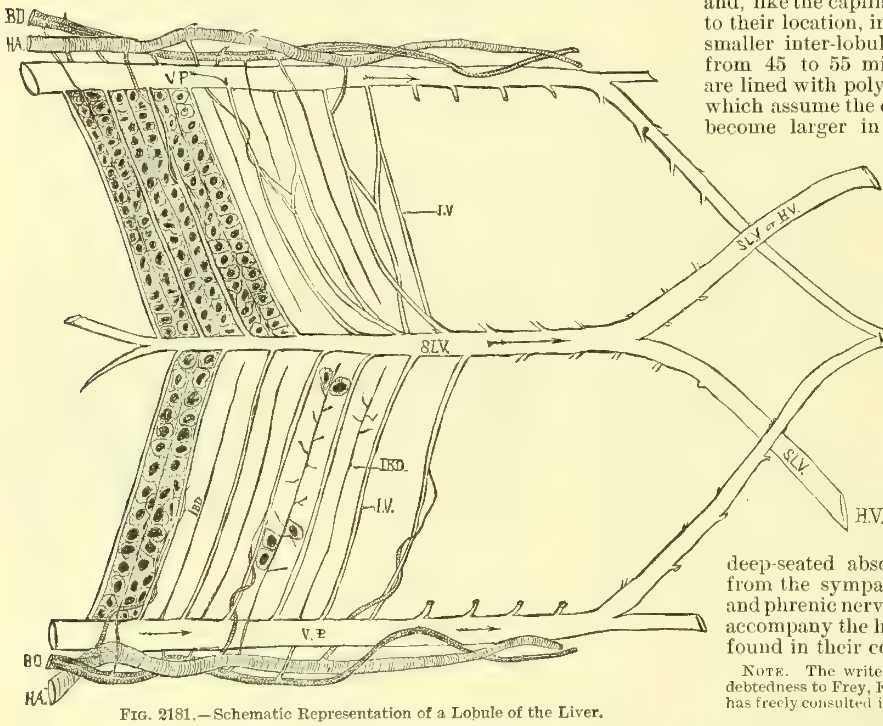

FIG. 2181.—Schematic Representation of a Lobule of the Liver.

Now, the fact obtains that in the examination of a microscopic specimen of liver-tissue, we find some lobules cut transversely, some longitudinally, some obliquely, some in which the inter-lobular veins are parallel with, and others in which they lie at right angles to, the sub-lobular veins. Arbitrarily enough, drawings and specimens of the latter only are selected by the majority for study or demonstration, and a search over the microscopic field is always necessary in order to find a characteristic one.

With a correct understanding of the hepatic circulation, there but remains within the scope of this article to present the anatomical characters of the different tissues entering into the liver-structure.

The framework consists of connective-tissue fibres derived from the capsule, together with the prolongations of the same, entering with the vessels at the portal fissure. It can be readily traced between the lobules, but great care is requisite to demonstrate the very delicate connective tissue within the lobule (Fleishl). The liver- or hepatic-cells are small, polygonal, nucleated elements, about twenty-two to thirty micromillimetres ($\frac{1}{1000}$ inch) in diameter, grouped in columns radiating between the periphery and centre of the lobule. Two columns may join as they near the centre of the lobule to form one. The nucleus usually presents one, sometimes two or more, nucleoli. The protoplasm of the cell is of a granular character, and contains fat-globules, glycogen particles, and pigment, which vary in amount at different times. Pflüger and Asp both claim to have demonstrated minute intra-cellular cavities, which connect with the ultimate bile-capillaries.

BILE-DUCTS.—By injections into the larger bile-ducts, as well as by the internal administration of sulphindigotate of sodium, the bile-ducts have been traced into very minute capillaries (1 to 2 micromillimetres $= \frac{1}{12500}$ inch) lying between the columns of liver-cells, where they *seem* to exist as channels between them without possessing a lining-membrane. These are always (Kölliker, Hering) so arranged that they are separated from the nearest capillary by about the diameter of a liver-cell, *i.e.*, the capillary in contact on one side of an hepatic cell, the ultimate bile-channel on the other. They inosculate (like the blood-capillaries) very freely within the lobule, and, like the capillaries, are named according to their location, inter- or intra-lobular. The smaller inter-lobular ducts, varying in size from 45 to 55 micromillimetres ($\frac{1}{500}$ inch), are lined with polygonal, low epithelial cells which assume the columnar character as they become larger in calibre. Rapidly anastomosing, they form finally the common bile-duct, and here possess a muscular coat in addition to their mucosa.

Lymphatics are distributed in this as in other secretory organs, *i.e.*, accompanying, and situated in, the walls of the blood-vessels. Within the lobules they become pericapillary tubules (MacGillavry).

NERVES. — This organ is not well supplied with nerves of sensation, else greater pain would be caused by deep-seated abscess. It receives branches from the sympathetic, left pneumogastric, and phrenic nerves (Landois, Pflüger) which accompany the hepatic artery. Ganglia are found in their course in the liver.

NOTE. The writer desires to acknowledge his indebtedness to Frey, Klein, and Landois, whose works he has freely consulted in preparing this article.

L. L. McArthur.

LIVER, NEW-GROWTHS OF THE: CARCINOMA.—The most important neoplasm which occurs in the liver is carcinoma. This may be present as a primary or as a secondary growth, the latter being far more common than the former.

Etiology.—Primary carcinoma of the liver is a comparatively rare affection, the vast majority of cases in which cancerous deposits take place in this organ being secondary to a primary carcinoma of the stomach, gall-bladder, pancreas, intestine, mammæ, or uterus. Undoubtedly, many of the cases of so-called primary hepatic cancer are in reality secondary to similar growths in the gall-bladder or stomach, which, from their comparatively small size, have not been detected.

Nothing is known as to the original cause of primary hepatic cancer, but the same causes which produce this disease in other organs probably obtain, in a general way, here. Hereditary influences have undoubtedly considerable influence in its production, as about twenty per cent. of the cases give a family history of cancer. Age is also an important factor in the etiology, as hepatic cancer is peculiarly a disease of advanced life, the largest

proportion of cases occurring between the ages of forty and sixty years. In 472 cases of cancer of the liver reported by different authors and tabulated by Leichtenstern, the distribution, according to age, was as follows: In 37 cases the age was between twenty and thirty; in 61 between thirty and forty; in 250 between forty and sixty; in 91 between sixty and seventy; in 33 over seventy.

Cancer of the liver is very rare in children, differing in this respect from renal carcinoma, and conforming to the general rule of carcinomatous disease. Individual cases of hepatic cancer in children have been described by Liebold ("Canstatt's Jahresber.," 1854, iv., s. 319); Farre (Frerichs's "Klin. d. Leberkrankh.," 1861); Roberts (*Lancet*, i., 3, January, 1867); and Leichtenstern (Ziemssen's "Encyclopædia of the Practice of Medicine," vol. ix.).

Sex has apparently little influence as regards the development of primary carcinoma of the liver, the number of cases being about the same in males and females. The secondary forms, however, occur more frequently in females, because of the great susceptibility to carcinoma shown by the uterus, mammæ, and ovaries. The effect of traumatism, biliary calculi, and cirrhosis in the production of this disease is, to say the least, doubtful, and is of no practical importance.

As regards the frequency of hepatic cancer, as compared with cancer of other organs, the tables of Tanchou and Marc d'Espine, as quoted by Leichtenstern, show that in 10,007 deaths from cancer, the percentage of cases occurring in the various organs was as follows: Cancer of the uterus, thirty-one per cent.; cancer of the stomach, twenty-seven per cent.; cancer of the mammæ, twelve per cent.; cancer of the liver, six per cent.; cancer of all other organs, twenty-three per cent.

The death records of the Prague Pathological Institute show that in 6,019 autopsies cancer of the liver was found 174 times, or in the proportion of one case in thirty-four. This is evidently a much larger proportion than similar records in this country would show. In the mortality records of two medical divisions of Bellevue Hospital for a period covering two years and a half, out of about 1,160 deaths from all causes, cancer of the liver was recorded as being the cause or a complication in nine cases, or in the proportion of about one in 128. These records, of course, are not very reliable, and do not compare in this respect with those to be obtained by autopsy; but they have some significance as showing the infrequency of hepatic cancer in this country as compared with its occurrence in the older countries of Europe. This I believe is true of all forms of carcinoma, and is not confined alone to cancer of the liver. The relative frequency of the primary and secondary forms of the disease is about as one to four or five. About one-third of the cases of secondary hepatic cancer follow cancer of the stomach. Aside from cancer of the stomach, metastases in the liver occur most frequently after similar growths in the mammæ, rectum, pancreas, and peritoneum, although cancer of any organ may be followed by secondary deposits in the liver. It is very unusual, however, to find metastatic deposits after carcinoma of the skin, the true epithelial cancer (Schueppel).

Pathological Anatomy.—Primary cancer of the liver occurs in three forms: 1, as one large and distinctly defined tumor; 2, as a diffuse infiltration of one or both lobes of the liver; and 3, as multiple nodules in the organ. The first two forms are the usual types, and are rather peculiar to the primary growths; while the third form is rare as a primary growth, and is far more characteristic of the secondary deposits. When the tumor takes the form of a diffuse infiltration, the general shape of the liver may be fairly well retained, although its size and weight are enormously increased; while, on the other hand, the occurrence of the growth as a single large tumor or as multiple nodules produces great deformity of the organ. The primary tumors are, as a rule, confined to the liver, or at the furthest, they extend only by contiguity to the surrounding organs—that is, they are not metastatic. When they occur in the form of single tumors, the right lobe is more frequently affected than the left, and the growth takes a more or less spherical form—displacing, compressing, or infiltrating the normal liver-tissue. Different portions of the periphery of the growth bear different relations to the glandular tissue—some parts merely displacing, others compressing, the gland and producing atrophy of it, and still other parts infiltrating the organ. The type of the growth determines to a considerable extent the relations which it bears to the liver tissue, the medullary forms tending to become more or less distinctly encapsulated, while the cirrhous type extends rather by penetration into the surrounding glandular tissue. When the cancerous growth reaches the surface of the organ, the peritoneum covering it becomes thickened, opaque, and perhaps the seat of a cancerous peritonitis. On section the tumor appears irregularly lobulated, more or less pulpy and friable, of a dirty white color, and of an irregular consistence. Indistinctly defined bands of connective tissue are seen crossing and interlacing with each other in all directions. Sometimes one lobe is entirely unaffected, while the other is almost completely destroyed by the new-growth.

Hepatic cancer occurs far less frequently as a diffuse infiltration than as a single, well-defined tumor. When it appears as a diffuse infiltration, the peritoneum covering the organ is thickened and of cloudy appearance, and may be loosely adherent to neighboring organs. The surface is coarsely granular, the elevations being about the size of a large pea. On section the organ is found to be traversed by bands of fibrous tissue interlacing and forming irregular spaces, which are filled with a soft, friable, cancerous mass. If the growth is very vascular the color may be of a reddish hue, or the surface may be a dirty yellow from the staining by bile. The appearance of both the outer surface and the cut sections is not unlike that presented by cirrhosis. By scraping the cut sections an abundant creamy fluid may be obtained, which shows the ordinary characteristics of cancerous juice. In rare instances nearly the whole gland is involved, scarcely any remnants of normal liver-tissue being found.

The third, or nodular, form of primary hepatic cancer is very unusual. Murchison thus describes a case, which is especially interesting by reason of the coexistence of cirrhosis and cancer: "Liver weighed seventy-two ounces; right was relatively much enlarged, measuring nine inches transversely, while left lobe was much atrophied and a mere appendage to right, not exceeding one and a half inch in its transverse diameter; greater part of diminutive left lobe granular on surface, and presented on section appearances characteristic of cirrhosis. . . . Whole surface of right lobe covered with prominent nodules, varying in size from a pea to a large cherry, the largest being very elastic or almost fluctuating. . . . The structure of right lobe was extremely dense; and on making a section it appeared to consist of two abnormal elements, a groundwork of firm, gray, cirrhous-looking tissue, infiltrated with a creamy yellowish juice, and containing a number of cavities up to size of a cherry, filled with a soft, pulpy, bright yellow substance; whole of right lobe appeared to be made up of these abnormal elements, and scarcely presented at any part a trace of natural glandular tissue or of bile-ducts."

Secondary cancer of the liver is a comparatively common affection, and may be developed after any form of primary carcinoma. In order of frequency it follows cancer of the stomach, uterus, mammæ, intestines, and ovaries. Not infrequently it quite overshadows the primary growth by the enormous size attained, and the varied and characteristic symptoms produced. Before death, probabilities of the existence of a primary cancer of some other organ can often be inferred only from analogy and from the multiple form of the hepatic growth, since the symptoms and signs arising from the primary tumor may be so slight as entirely to escape detection. A case which was under the observation of the writer during the preparation of this article well illus-

trates this point. A cancer of the liver was secondary to a similar growth affecting the cardiac orifice of the stomach. The gastric cancer produced no constriction of the orifice, and was absolutely unaccompanied by any symptoms whatsoever; while the hepatic cancer attained the enormous weight of sixteen pounds, and produced severe and characteristic symptoms. It is sometimes very difficult or quite impossible to determine absolutely, in a given case, whether an hepatic cancer is primary or secondary to a growth affecting some other organ. The hepatic tumors may be much larger and apparently older, and the degenerative changes may be much farther advanced, and yet be the secondary growths. It is only through the possibility of following the route taken by the cancer particles that such questions can be answered. In cases of this kind numerous veins and lymphatics, filled with cancerous growths, can sometimes be discovered, which give unmistakable evidence of the course followed and of the manner of extension (Schueppel). Without these it would be impossible to infer the relation of the different growths to each other. In view of our knowledge of the usual relations in such cases, the assumption seems warranted, in any case where there is a cancer implicating simultaneously the liver and any one of the abdominal organs whose blood-supply contributes to the portal system, that the hepatic growth is the secondary formation (Schueppel).

Primary carcinomata of the liver are subject to the same forms of degeneration which are found in carcinomata of other organs. Secondary carcinomata of the liver usually appear in the form of multiple nodules disseminated throughout the organ. They also occur as single growths of large size, or as diffuse infiltrations of the organ; but these types are very unusual. In the nodular form the individual tumors vary in size from that of a pea to masses as large as a child's head. They may be of a dense consistence, or, as is more often the case, they may be soft and semi-fluctuating. Sometimes the centres of many of the masses have undergone degenerative changes—they have softened, and cysts have been formed filled with a cancerous fluid more or less tinged with blood. When the softening in the nodules is very general this form is sometimes called cystic cancer. In other cases portions undergo fatty degeneration, become cheesy, are in part absorbed, and the centre of the nodule, if situated on the surface of the liver, becomes depressed or umbilicated. The capsule of the liver over the new-growths is generally thickened, opaque, and adherent. There may be adhesions to surrounding organs, or to the parietal peritoneum, from a circumscribed peritonitis. The color of the growths is usually a dirty grayish-white, but if they are very vascular it is reddish, or it may be yellow from bile-staining; or, if the cancer is of the melanotic type, it is a dark, brownish-black.

The number of nodules varies within the widest limits. Rarely there may be but one, and, again, there may be hundreds of smaller or larger masses scattered everywhere through the organ, underneath the capsule and in its substance.

The tumors are generally more or less circumscribed, and occasionally are distinctly encapsulated. As a rule, however, they are not surrounded by a distinct capsule, but the growths have become developed in the organ and have displaced the normal tissue, so that this is found enveloping them. The liver is usually greatly deformed, and may reach an enormous size. Dr. E. G. Janeway has told the writer of a case in which the organ weighed twenty-five pounds. During the preparation of this article the writer performed autopsies on two cases, in which the weight of the organ was twelve and sixteen pounds, respectively. This size is not infrequently attained. When the growths are numerous and of large size the normal liver tissue may be almost destroyed, not more than one-third or one-fourth remaining. The portion of the gland between the nodules is generally about normal. The hepatic substance apparently is not often compressed, although the vessels may be greatly dilated, but seems rather to be simply replaced by the cancerous tissue.

Frequently a certain degree of icterus is developed, and then both the hepatic tissue and the cancerous masses become bile-stained. Icterus generally develops only when the growth involves or compresses the gall-ducts, thus preventing the escape of the bile.

The gall-bladder and ducts are also commonly the site of secondary growths, and some of the portal vessels or hepatic veins are frequently filled with soft, cancerous thrombi.

Of course, in cases of secondary cancer of the liver there are, as a rule, similar deposits in other organs, and the lungs, especially, are likely to be affected.

The microscopical appearances of primary hepatic cancer do not differ materially from those of carcinomata of other organs. The medullary type is the one usually found. The connective tissue is developed to a comparatively small extent, and the alveoli are large. The cells contained in the spaces vary in a general way, as they do in carcinomata of other organs.

The secondary forms show for the most part exact reproductions of the structure of the original growths. Consequently the nodules present great variations in histological structure. They may be of the scirrhous, medullary, or colloid type. The cylindrical-celled cancers are common, since hepatic growths are so often secondary to primary growths of the stomach, where this form is the usual one. In these the alveoli are long and tubular, very like the tubular glands, and are lined by deep cylindrical cells.

Something should be added in regard to pigment cancer or *melano-sarcoma* of the liver. This is a very rare form of hepatic cancer. A few cases of primary growths of this kind in the liver have been reported, but usually they are secondary to similar growths in the eye. They appear as a diffuse infiltration of the organ, or as multiple nodules of varying size and consistence. On section these nodules present a dark-brown or brownish-black appearance, with here and there lighter-colored, grayish patches. While preparing this article a case of this kind occurred in the hospital service of the writer. It was apparently a primary growth in the liver, and there was no history given of the existence of a tumor of any kind. However, it was noticed that one eye had been enucleated, and probably the hepatic growth was secondary to a primary growth in this organ. There was no recurrence of the growth in the eye-socket, and it was impossible to gain any history in regard to this point; but in view of the extreme rarity of the primary growth, it seems probable that this was the case. Possibly the history in some of the other supposed cases of primary melano-sarcoma of the liver may have been the same as this. In the case referred to the growth in the liver was in the form of an enormous mass, involving a large portion of the right lobe of the liver, with smaller nodules, varying in size, disseminated through the remainder of the organ. The tumors were of a dense, fibrous consistence, and in large part were of a very dark brownish-black color. There were a few smaller tumors, which were of a light color, and were cystic. A portion, of course, of the larger tumors was also of a lighter gray color. There were secondary deposits everywhere throughout the body, in the heart, lungs, peritoneum, mesenteric glands, brain, ribs, vertebræ, cranial bones, etc. The appearance and structure of these deposits were the same as those of the hepatic growths.

Nodules were found involving the seventh and eighth ribs on the right side, just a little external to the angles. The osseous substance at the points affected was completely replaced by the new-growth. The bodies of the second, third, and fourth dorsal vertebræ were similarly affected, and the growth had extended to, but not implicated, the membranes of the cord. Death occurred in this case in coma, with convulsions confined to the left side. There was a small tumor in the paracentral lobule on the right side, and several other small growths in different parts of the cortex.

Symptomatology.—In the majority of cases, cancer of the liver is accompanied by symptoms so characteristic, that there is no difficulty in quickly arriving at a diagno-

sis; but occasionally the growth may remain so small, or be accompanied by so few characteristic symptoms, or be so overshadowed by the primary growths or the complications, that its presence is only revealed at the autopsy. In cases of this kind the symptoms are very indefinite. The patient's general health seems to be failing, he loses strength, his weight decreases, he has vague pains in the back, abdomen, and limbs, his appetite fails, and he may have some nausea or vomiting, or disturbance of digestion, and constipation; the color of his skin becomes changed, and finally a marked cachexia develops. The most careful examination does not reveal the presence of any perceptible organic disease, still the patient rapidly loses ground; finally œdema of the lower extremities develops, and perhaps ascites or jaundice appears, and the patient dies of exhaustion. The autopsy reveals the presence of numerous cancerous nodules in the liver, with or without the presence of a primary cancer of the uterus, ovaries, stomach, or pancreas. These, however, are not the features in the majority of cases, for cancer of the liver has a marked tendency to attain a considerable size, and the enlargement of the liver—whether the growth is of the nodular or diffuse form—when taken in connection with the age and history of the patient, and the absence of any other sufficient cause for the increase in size, will at once arouse suspicion of the nature of the disease. We shall take up the symptoms usually found in the order of their importance and frequency.

The enlargement of the liver is the most important point in the diagnosis, and is often the first indication of serious disease. This enlargement is usually considerable, and may sometimes be enormous, so that the larger part of the abdominal cavity is occupied by the growth, and the diaphragm is pushed up to the second or third intercostal space. No other form of disease which occurs in the liver produces such a great increase in the size as carcinoma. The organ often weighs from fifteen to eighteen pounds, and occasionally as much as twenty-five pounds (Janeway; Axel Key, *Hygeia*, Bd. xxvii., 1865). Within a year the writer has seen four cases, where the weight of the liver was from twelve to sixteen pounds.

Carcinoma of the liver usually occurs in the nodular form, hence the enlargement is irregular, and the presence of the individual nodules projecting from the surface may be easily detected through the abdominal wall. When the patient has become much emaciated, and the nodules are of large size, the projections which they may cause may sometimes be readily seen. Not only does the surface become nodular, but the border becomes very irregular, and masses of the new-growth can be felt extending beyond it. Occasionally it is possible to make out a depression in the centre of one or more of the nodules (umbilication). The consistence of the growths varies within the widest limits. They may be hard and resistant, or they may be soft and semi-fluctuating. The growth of these masses is sometimes so rapid that the increase in size is easily perceptible from week to week. In the month preceding the preparation of this article, four cases of carcinoma of the liver occurred in the different hospital services of the writer. In two of these the rapid increase in size of individual nodules could be readily made out.

The enlargement, in some cases, assumes the form of a single large tumor, affecting either the right or left lobe, and then may project upward, pushing up the diaphragm, or downward into the abdominal cavity, or backward against the spinal column, causing erosion of the vertebræ, or forward, producing a prominent projection of the anterior abdominal wall. Again, the cancer may appear as a diffuse infiltration of the liver. In such cases there is a symmetrical and uniform enlargement of the organ, and the differential diagnosis is rendered more difficult.

Pain is the symptom which, perhaps, stands next to enlargement in the order of frequency. This is present, to a greater or less degree, at some time in the course of the disease, in a large proportion of cases. However, it may be almost entirely absent throughout the whole course. When present, it varies in character and severity, and may be dull and heavy, or agonizing in its intensity. It usually increases as the tumor grows larger. The patient is sometimes almost free from suffering during the day, but his nights are rendered sleepless by the severe, constant or paroxysmal pain. It radiates to the shoulder, back, and loins. Tenderness on pressure over the liver is often marked, and may be excessive directly over the nodules. This is due to a circumscribed perihepatitis, and occasionally, as the result of this, there may be found on palpation friction fremitus, and on auscultation a friction murmur. The severity of the pain in different cases seems to bear a fairly constant relation to the amount of peritonitis, and to the position of the nodules as regards the peritoneum. When the nodules are deeply seated and do not involve the peritoneum, the affection may be accompanied with but little pain. There may also be pain in different parts of the body, due to the development of secondary growths.

Icterus is present in about forty per cent. of the cases. Sometimes it is very marked, and appears early in the disease. As a rule, it is only developed when there is obstruction of the bile-ducts, from either compression or obliteration. Sometimes the obstruction is due to enlargement of glands in the portal fissure, and to compression of the ducts. When the ducts are not involved, nearly the whole of the liver substance may be destroyed without the production of jaundice. The coexistence of enlargement of the liver with persistent jaundice, especially in old subjects, should always arouse the suspicion of carcinoma, as this is the most frequent cause of this combination of symptoms.

Œdema of the lower extremities and ascites are present in many cases in the later stages of the disease. The cause of these symptoms is usually compression or implication of some of the large branches of the portal vein, or pressure upon the vena cava. The fluid found in the abdominal cavity is generally a simple dropsical effusion. However, there may be a cancerous peritonitis with effusion. In these cases there is great distention of the abdomen, and tympanitis, the liver is pushed up, the abdominal walls are rigid, pressure causes much pain, palpation shows the existence of rounded masses in the abdomen, and there is a large collection of abdominal fluid. Hectic fever comes on and, in short, the case presents the symptoms and appearances characteristic of tubercular peritonitis, and is supposed to be this. In other cases there is a large collection of ascitic fluid which appears early, and a diagnosis of cirrhosis may be easily made. In place of a cancerous peritonitis a chronic exudative peritonitis may be set up. This commences as a circumscribed perihepatitis, and gradually extends, finally implicating the whole of the peritoneum. There may also be an acute peritonitis, resulting from the rupture into the peritoneal cavity of a soft, medullary, cystic, or fungating, cancerous nodule.

The spleen is rarely enlarged. This constitutes an important point in the differentiation of cancerous enlargement of the liver from that due to hypertrophic cirrhosis, or amyloid change. If the spleen is the seat of secondary deposits, however, it may also be enlarged.

Rarely the superficial abdominal veins become enlarged, but this is not often the case unless there is considerable obstruction to the portal circulation.

The general constitutional symptoms are, for the most part, those referable to the cancerous cachexia, and are more or less indefinite, and not characteristic. There are loss of strength and weight, progressive emaciation, disordered digestion, loss of appetite, nausea, and perhaps vomiting, constipation with occasional attacks of diarrhœa, indefinite shifting pain in the extremities, back, etc. If the hepatic cancer be secondary to cancer of the stomach, the gastric symptoms may be more severe, although sometimes, even in these cases, there are scarcely any symptoms that can be referred to the stomach. The writer recently had under observation a case of carcinoma of the liver, secondary to carcinoma of the cardiac orifice of the stomach, in which ulceration had extended almost completely around the orifice, but no constriction or obstruction had been produced. In this case there were absolutely no gastric symptoms at any time in the

course of the disease. The urine is scanty and highly colored, and sometimes contains various abnormal coloring matters, the nature of which is not fully known. When jaundice exists the biliary coloring matters are, of course, found in the urine. Indican is often present and may exist in considerable quantity. In a few cases leucin and tyrosin have been found (Griesinger, "Archiv d. Heilk," 1864, 1. Jahrgang, S. 385). The presence of albumen or casts is accidental. The skin becomes dry, wrinkled, and thin, and has a peculiar but characteristic discoloration in cases where jaundice does not exist. The discoloration is that of the cancerous cachexia.

As a rule, hepatic cancer is entirely unaccompanied by fever throughout its whole course. Not infrequently there is a slightly subnormal temperature, and this is especially apt to occur near the end of life. But, on the other hand, cases which have been free from pyrexia throughout their course, may develop a high temperature just at the end. A case of melano-sarcoma or pigment-cancer observed by the writer, and previously referred to, had a high temperature during the last two or three days of life. The autopsy did not show the presence of any condition to account for it, excepting the presence of the carcinoma. In some cases there are periodic and irregular exacerbations of fever, occasionally preceded by a more or less marked chill. The writer has observed a case of this kind. In very rare instances the disease may be accompanied by fever from the beginning to the end. Of course, in those cases where there are complications, such as pleurisy or peritonitis, there may be fever which is entirely independent of the new-growth.

The pulse is not much influenced, as a rule, as regards frequency. It may be slightly retarded or somewhat quickened, and as strength is lost becomes progressively weaker.

The other symptoms that occur are for the most part accidental or due to complication. As death approaches in protracted cases emaciation and cachexia in excessive degree are present.

Diagnosis.—In the majority of cases there is no great difficulty in differentiating cancer of the liver from the other forms of hepatic diseases, and only in a few instances where the liver remains of a small size and the affection presents no marked or characteristic symptoms, is the diagnosis difficult or impossible. There are a number of questions, bearing indirectly upon the subject, which are of value in arriving at a diagnosis. Cancer of the liver, in nearly three-fourths of the cases, is secondary to cancer of some other organ; hence, the existence of hepatic enlargement with a primary malignant growth of some other organ, or the development of such enlargement after the removal of a cancer of the mamma, uterus, ovary, etc., is very significant. An hereditary history of cancer is found in about twenty per cent. of the cases. A large proportion of all cases occur between the ages of forty and fifty years. The forms of disease which are most likely to be mistaken for cancer are abscess of the liver, cirrhosis, amyloid degeneration, chronic catarrh of the bile-ducts, or impacted gall-stones, and multilocular hydatids. As regards cirrhosis and amyloid degeneration, the history, in the one case of alcoholism, and in the other of syphilis, caries of the bone, or some chronic suppurative process, throws much light on the probable nature of the enlargement. These points, when taken in connection with the remainder of the history, the general symptoms, the enlargement of the spleen in both these diseases, the absence of the cancerous cachexia, and their more chronic course, will usually render the differential diagnosis possible. Abscess of the liver may at first be mistaken for cancer, but the history and the course of the disease will soon reveal the error. Abscess, although at first often unaccompanied by fever, soon produces marked pyrexia with irregular and frequent chills. Jaundice, ascites, and œdema are absent. If a tumor is perceptible, an exploratory puncture with the needle of a hypodermic syringe and the withdrawal of pus, establishes the diagnosis.

Chronic catarrh of the bile-ducts, or impacted gall-stones, may produce an enlargement of the liver with persistent jaundice, and if occurring for the first time in an old person may be diagnosed as carcinoma. There may be with these affections more pain, nausea, vomiting, and progressive emaciation. These diseases, however, are not accompanied by ascites or œdema; their development is rapid, the enlargement, as a rule, is not nodular; there is usually some elevation of temperature, and the duration of the disease is much longer.

Multilocular hydatids may closely resemble carcinoma, but cases of this kind are so rare in this country that they can be practically thrown out of our consideration. The long duration, however, the absence of the cancerous cachexia, and the enlargement of the spleen exclude carcinoma.

Reference has already been made to the possibility of mistaking cancer with peritonitis for a tubercular peritonitis.

Duration and Prognosis.—The difficulty of establishing the exact time of the beginning of carcinoma of the liver renders it impossible to determine accurately the duration of the disease, and consequently only approximate estimates can be given. In the majority of cases the course is very rapid, and the time is short that elapses, after the disease has become sufficiently developed to render a diagnosis possible, to the time of death. Not infrequently there have been indefinite gastric symptoms and mental delusions present for a long time before the marked advent of the disease.

In nineteen cases recorded by Leichtenstern, including those of Frerichs and Murchison, analyzed with reference to this point, the average duration was twenty weeks.

Treatment.—There is very little to be said under this head. We have no remedies which have any influence in removing or checking the growth of carcinoma, consequently the treatment must be wholly symptomatic, and be directed to the relief of the various symptoms as they arise, and of the suffering incident to the disease.

Sarcoma, Gumma, Lymphoma, Adenoma, Tubercle, Etc.—The new-growths found in the liver aside from carcinoma, are of little importance. A few cases of primary sarcoma of this organ have been reported, but they are exceedingly rare, and cannot be diagnosticated during life. Melano-sarcoma has been referred to in connection with carcinoma. Secondary sarcomata of the liver are sometimes found after primary growths in other organs, but, with the exception of the melanotic type, they usually exist only in the form of small nodules, and are not accompanied by marked symptoms. In rare instances they reach a very large size, and then resemble closely carcinoma. Gummata sometimes appear in the liver in the form of isolated nodules scattered throughout the organ. They vary in size from that of a pea to that of a walnut, and are surrounded by translucent grayish bands of fibrous tissue, which often penetrate into the surrounding liver-substance. On section and microscopically, they show the appearances of gummata in other organs. Their presence, when unaccompanied by syphilitic cirrhosis, is rarely the cause of any decided symptoms. When numerous and of considerable size, they may produce a nodular condition of the organ which closely resembles that caused by carcinoma. However, the history, the effects of treatment, and the course of the disease will render the diagnosis easy. Numerous gummata of small size are sometimes found in the liver of new-born children.

In leucocythæmia and pseudo-leucocythæmia, small accumulations of round cells, *lymphomata*, are often found in large number disseminated through the liver. These little masses are usually deposited in the inter-lobular connective tissue, but they may be also present in the substance of the lobule, and are sometimes so numerous as to produce considerable enlargement of the organ.

In typhoid fever, diphtheria, small-pox, and scarlatina the so-called miliary lymphomata may be present in the liver. These are composed of small masses of lymphoid cells lying in a delicate reticulum of connective tissue. They may consist only of a hyperplasia of the lymphoid tissue normally found in the organ.

Adenomata constitute rare forms of new-growths in the liver, and occur in two forms: 1st, as a diffuse infiltration of the organ; 2d, as multiple nodules. Clinically they may present most of the symptoms found in carcinoma, but the affection is of longer duration and does not produce the characteristic cachexia. As regards histological structure, they sometimes possess essentially the same structure as normal liver-tissue, or they may resemble very closely carcinoma.

In the course of a general tuberculosis, small miliary tubercles in countless numbers are frequently found in the liver. These vary in size from those which are microscopic to those which are one or two millimetres in diameter. In rare cases the so-called solitary tubercles are found here. They are of considerable size, sometimes reaching that of a walnut, and have cheesy centres. In the periphery of the nodules there may be a new-growth of connective tissue. These masses are not numerous and are scattered throughout the organ.

Cavernous angiomata are of not infrequent occurrence. These tumors are of small size and have no practical significance. When situated on the surface of the organ, they form soft, slightly elevated, dark-bluish masses. Sometimes they are circumscribed, and sometimes blend imperceptibly with the normal liver-tissue. Microscopically they are seen to consist of irregular inter-communicating cavities filled with blood. The walls are formed of connective tissue and often contain blood-vessels. These tumors are believed to be formed by the dilatation of the liver capillaries and atrophy of the liver-cells.

Dilatation cysts and cysts of apparently new-formation are occasionally found in the liver. The dilatation cysts are formed from the bile-ducts as the result of some obstruction in their course. The cysts of new-formation are usually of small size, and sometimes occur in connection with similar changes in the kidney. In a case recently seen by the writer, where there was a remarkable cystic change in the kidneys (one kidney weighing fifty-seven ounces and the other fifty-nine), numerous small cysts were found scattered through the liver, and in addition there was a new-growth in the left lobe apparently of a cancerous nature. The nature of these cysts is not well understood.

Fibromata, gliomata, lipomata, and neuromata of small size have been described as occurring in the liver, but they have no practical significance.

Hermann M. Biggs.

LIVER, SYPHILITIC INFLAMMATION OF THE. Both anatomically and clinically, *syphilitic hepatitis* and *peri-hepatitis* are worthy of separate mention.

In congenital syphilis the liver is one of the internal organs most frequently involved. The process is diffused. Acquired syphilis is made manifest by an inflammation of the capsule, or by circumscribed areas of inflammation (gumma). Gumma or syphiloma is also found in the congenital form of the disease.

In the diffused form of inflammation the organ is enlarged and indurated. The capsule is thickened and opaque, but the process does not extend into the hepatic tissue from the surface. Large areas of the hepatic structure are transformed into a pale, hard, dense tissue. The liver-tissue is destroyed. The absence of granulations, and the great extent of the fibrous mass, alone distinguish it from true cirrhosis. An extensive change may be found by microscopical examination, which was not apparent to the naked eye. It occurs in the early stages of the disease. On microscopical examination there is found an increase of the inter- and intra-lobular connective tissue, shrunken granular liver-cells, in many of which the nuclei are obscured or entirely lost. New bile-ducts, or rather, an appearance that simulates them, is observed, and new blood-vessels (capillaries) are formed.

In syphilitic peri-hepatitis the distinction from ordinary peri-hepatitis is made only by the increased denseness and thickness of the new tissue. Syphilitic gummata are presented in the form of large caseating masses, or of an abundance of small tubercular-like masses, uniformly infiltrating the hepatic tissue. The suppuration and absorption of gummous masses, or the destruction of large areas of liver-tissue by pressure, causes an appearance of lobulation on the surface of the organ. The gummata are most frequently developed in the suspensory ligament, the connective tissue of Glisson's capsule as it enters the liver, or along the course of the portal vein.

The *symptoms* of syphilitic hepatitis are usually combined with other evidences of the general disorder. In adults the symptoms of a peri-hepatitis long-continued are usually the only sign of hepatic change. In infants with congenital syphilis, rarely in the acquired form in adults, the liver is much enlarged, its border is thickened, rounded, or nodulated. On the surface of the liver, nodules or small protuberances are detected on palpation, and sometimes deep furrows are felt. A peri-hepatitis may be detected by palpation, by a friction-murmur, and by fixation of the liver, movement synchronous with respiration being absent.

The enlarged liver causes a sense of weight and fulness in the right hypochondrium. Pain is often present, and severe and persistent in accordance with the degree of inflammation of the capsule. Some tenderness is shown on palpation. In infants, drawing up of the legs and crying are the signs of pain. In adults, the attendant symptoms are those of cirrhosis of the liver, with the other general and local symptoms of constitutional syphilis. Ascites, hæmorrhages from the mucous membrane of the stomach and bowels, and diarrhœa, are common in little children. *Icterus* is rare, and when present is usually due to the pressure of the enlarged glands in the hepatic fissure. Albuminuria and other evidences of amyloid disease may be present. The spleen is almost always enlarged from amyloid disease or congestion. The lymphatic glands generally, may be enlarged. A pale, earth-colored complexion is characteristic of congenital syphilis. The affections of the skin, mucous membranes, and bones common to the constitutional vice are present, or the signs of their former existence are evident.

The history, the co-existing lesions, and the local manifestations, are all important to remember in the diagnosis. The disease has been confounded with cancer of the liver. The longer duration, the greater hardness of the nodules, the slower growth of the entire mass and of the individual nodules, together with enlargement of the spleen, and albuminuria, serve to distinguish syphilitic hepatitis.

The course of syphilitic hepatitis is insidious, the duration long, and the prognosis of the congenital variety very serious. Cases are recorded of recovery from acquired visceral syphilis, and we often see the remains of syphilitic hepatitis on the post-mortem table.

The treatment, of course, is the treatment of constitutional syphilis. Iodine or iodide of potassium and mercury must be administered internally, and tonics and stimulants given in accordance with the general indications. In extreme marasmus, tonics are used, and anti-syphilitic remedies withheld.

John H. Musser.

LOBELIA, U. S. Ph.; Br. Ph. (*Herba Lobeliæ*, Ph. G.: *Lobélie enflée*, Codex Med.; Indian Tobacco). The flowering herb of *Lobelia inflata* Linn., order *Lobeliaceæ*. This is an annual herb from twenty to fifty centimetres (eight to twenty inches) high, with an upright, branching, leafy stem and thin oval, nearly or quite sessile, slightly hairy leaves. Inflorescence composed of spike-like racemes, terminating the strongly excurrent stem and the branches, making altogether a lax pyramidal, leafy panicle. Flowers small, consisting of a five-toothed calyx adherent to the ovary and becoming markedly inflated in fruit; a labiate corolla with a narrow tube open on the apparently upper side to its base, and a five-lobed border of which the two lobes next the fissure are erect, narrow, and pointed, the other three broader and spreading; stamens, five, syngenesious, ovary two-celled with innumerable microscopic ovules. Seeds very fine (about as large as

lupulin grains, which they resemble in mass), light-brown, oblong, with a handsome reticulated testa. All parts of the plant contain, when fresh, an acrid, milky juice, and have an exceedingly sharp, peppery, tobacco-like taste. Lobelia is an abundant pasture-weed, growing in most parts of the United States. The knowledge of its use was received from the aborigines, and is several centuries old. The leaves and tops are officinal, their general description is given above. The separated seeds are also an article of commerce, and stronger than the whole herb.

FIG. 2182. — Lobelia Inflata; Flowers and Fruit. (Baillon.)

COMPOSITION.—The most important ingredient of Lobelia is a volatile liquid alkaloid *lobeline*, "an oily yellowish fluid with a strong alkaline reaction, especially when in solution. In the pure state it smells slightly of the plant, but more strongly when mixed with ammonia. Its taste is pungent and tobacco-like, and when taken in minute doses it exercises in a potent manner the poisonous action of the drug. It dissolves in water, but more readily in alcohol or ether. It neutralizes acids and forms with some, crystalline salts." Although volatile, it is decomposed by a high heat. Lobelia contains also *essential oil* and a doubtful substance, *lobelacrin*, probably a compound of lobeline and *lobelic acid*.

ACTION AND USE.—This herb has had in times past an extensive exployment in this country at the hands of irregular practitioners of the "Thompsonian" school, and the more modern "Eclectics." Despite its very active and dangerous qualities, it is still not infrequently called for as a family medicine. Regular physicians have never used it extensively, but neither has it been altogether neglected by them. It was in far more frequent demand fifty years ago than it is now. In small doses it creates a feeling of burning or smarting in the mouth, œsophagus, and stomach, from its locally irritant action. Nausea, giddiness, prostration, and vomiting are also the results of small and moderate medicinal doses. In fact, it used to be used chiefly to produce nausea and vomiting. In large and poisonous doses it is an alarming depressant of the tobacco and tartar emetic kind. Numerous cases of fatal poisoning by it, when taken for therapeutic purposes, have occurred. Death is produced by paralysis of the respiratory functions as well as by depression of the heart's action. Coma and convulsions sometimes occur. It has been considerably used in small doses as an ingredient of nauseating cough-mixtures and for asthma, and in larger emetic ones in spasmodic and actual croup, but is not to be recommended.

ADMINISTRATION.—The dose in substance as a nauseant is one or two decigrammes; as an emetic, say one gramme and a half (gr. xx.). A drachm of the powdered leaves has caused death. The preparations are the Vinegar (*Acetum Lobeliæ*, U. S. Ph.), strength $\frac{1}{10}$, in diluted acetic acid; and the Fluid Extract (*Extractum Lobeliæ Fluidum*, U. S. Ph.), strength $\frac{1}{1}$. *Lobeline* is not commercial.

ALLIED PLANTS.—The order is a small one, its principal genus being *Lobelia*, of which several species have been proposed in medicine, and others are in common cultivation for ornament. One species, the Cardinal flower (*Lobelia cardinalis* Linn.) is the most showy of all our wild flowers.

ALLIED DRUGS.—The depressant emetics, in particular, Tobacco, *Veratrum*, Antimony, Turpeth mineral, etc. *W. P. Bolles.*

LODI ARTESIAN WELL. *Location*, in Clay County, Ind., fifty-eight miles west of Indianapolis.

ACCESS.—By Indianapolis & St. Louis Railway.

ANALYSIS (Dr. Pahle).—One pint contains:

	Grains.
Carbonate of magnesia	0.082
Carbonate of lime	0.252
Chloride of sodium	62.808
Chloride of magnesium	6.692
Chloride of calcium	5.991
Sulphate of potassa	0.100
Sulphate of soda	0.267
Sulphate of magnesia	0.407
Sulphate of lime	6.944
Phosphate of lime	0.150
Iodide of magnesium	trace
Bromide of magnesium	0.110
Silicic acid	0.065
Sulphur (mechanically suspended)	0.625
Nitrogenous organic matter	0.100
Total	84.593
Gases.	Cub. in.
Carbonic acid	Undetermined.
Sulphuretted hydrogen	0.99
Oxygen and nitrogen	Undetermined.

G. B. F.

LOGWOOD (*Hæmatoxylon*, U. S. Ph.; *Hæmatoxyli Lignum*, Br. Ph.; *Bois de Campêche, Bois d'Inde*, Codex Med.). The heart-wood of *Hæmatoxylon campechianum*

FIG. 2183.—Branch of Logwood Tree. (Baillon.)

Linn.; Order, *Leguminosæ, Cæsalpinieæ*. This is a small, spreading, irregularly branched tree, with a dark, rough bark on the trunk and larger branches, and light-brown, white-spotted twigs. Wood rather hard and close, divided into a light-colored alburnum and a red heart-wood. Leaves abruptly pinnate, with four pairs of small obovate leaflets about the size of those of white clover. Flowers in axillary racemes, small, nearly regular, sepals, and petals five, stamens ten, ovary a two- or three-ovuled, stalked legume. This is a native of Central America, especially of Honduras and Yucatan. It takes one of its names from Campeche. It is also naturalized and cultivated in the West Indies, where it grows freely.

It is supposed that logwood was used by the aborigines

for dyeing before the arrival of Europeans, but this is not known with certainty. It was, however, imported into England in the latter part of the sixteenth century, and shortly after interdicted for a time as yielding poor and fading colors. It was introduced into the London Pharmacopœia about a hundred and fifty years ago.

The collection is simple enough. The trees are felled when ten years old or so, with trunks somewhat larger than a man's thigh, the yellowish sap-wood is chopped away, and the heart-wood cut in billets three or four feet long, and dried. In this shape it is imported and sent to the dye-mills. When first cut these logs are of a light-red color, but by exposure to the light and air they become dark-brown, and finally almost black upon the surface, sometimes dark-bronze and iridescent. The inside becomes by time a rich reddish-brown. In the course of manufacture it is cut, by heavy machines with rapidly revolving knives, into fine chips, in which condition or in powder it is purchased for pharmaceutical purposes. It has a sweetish, astringent taste, and colors the saliva pink.

Logwood contains about ten per cent. of a sweet-tasting, crystalline coloring substance, *Hæmatoxylin*, readily soluble in hot water or alcohol, but nearly insoluble in cold water. It turns red upon exposure to sunlight, and gives violet solutions in the presence of alkalies and air, due to the formation of *hæmateïn*. Melted with potash, it yields pyrogallic acid.

Action and Use.—This substance is infinitely more used in the arts than in medicine, being an important dye and foundation for inks. In microscopical work, a few years ago, the purple solution of extract of logwood or of hæmatoxylin was a favorite stain, acting with great rapidity and bringing into prominence the nuclei of cells. As a medicine it is a mild and rather agreeable astringent, useful in subacute diarrhœa of children and phthisis, but no better than a dozen other astringents. The extract is officinal (*Extractum Hæmatoxyli*, U. S. Ph.), made by exhausting with boiling water and evaporating to solidity. It is essentially that of the market, which is prepared on an enormous scale for dyeing purposes.

Allied Plants.—This is the only plant of its genus; for the order see Senna.

Allied Drugs.—See Sandal-wood, Red.

W. P. Bolles.

LONGEVITY, or the *natural* length of life, is a subject of which we have scarcely any precise knowledge. We know that certain species do not surpass a certain length of individual existence; we possess extensive statistics as to the ages at which death occurs in the human race (see Mortality); and we have a theory of death (see Growth, § III., vol. iii., p. 399); but concerning the causes which fix the natural duration of life for the individuals of a species, we have only a few vague notions of little value. We can say that there is a certain amount of vitality, and when it is exhausted death ensues, and that the longevity depends on the original amount of vitality and the rate of its exhaustion. A great deal has been written, more or less, in this vein upon longevity; therefore, it is desirable to recognize that amplification of this and similar texts is an unprofitable waste.

Longevity is usually employed in English to express the *natural* length of life, and not the actual length of life (*Lebensdauer*), independent of the cause of death. Properly speaking, the natural length of life is the age reached by an organism at the time of death occurring from causes inherent in the organism itself. The age at which an animal is killed by some enemy or accident, evidently has nothing to do with its natural lease of existence; the same is true of many diseases, of all such as have extraneous causes. On the other hand, we ought to include all cases where death ensues from internal causes, such as defects of organization, new-growths, etc. To ascertain the average natural life of man, we must first be able to classify all causes of death as inherent or accidental, and then base our calculation upon the deaths of the first-mentioned class only; but at present such a classification is impossible, and an exact scientific discussion of longevity cannot be undertaken. The current conception of longevity is different from this, in that the natural age for man to attain is regarded as that which a normally built, healthy person may reach, who escapes from dangerous or wasting maladies, and from serious accidents and undue strains of all kinds. This very nearly agrees with the scriptural three-score years and ten, which is actually about the age to which persons who live successfully beyond the prime of life attain; thus, according to Déparcieux the expectancy of life at forty years is twenty-nine years additional.

There are many statements of extreme old age reported, as, for example, of the well-known Thomas Parr, who was said to have lived to be 152 years and some months. But none of these cases is sufficiently attested. The difficulty arises in proving the identity of the person. As Sir George C. Lewis pointed out, the extreme authentic limit is 106 years; it has recently been asserted that this has been very slightly surpassed by an English lady. Flourens, in an interesting little work ("De la Longévité humaine, 2me Ed., Paris, 1855), assumed that in man and animals there is the same fixed relation between the length of the period of growth and that of life, viz, 1 : 5. The end of growth is marked for him by the union of the epiphyses with the main bones, occurring in man at 20 years. "Man," he writes, "grows for 20 years, and lives five times 20 years, that is to say, 100; the goat grows for 8 years, and lives for five times 8 years, that is to say, 40 years; the horse grows for 5 years, and lives five times 5 years, that is to say, 25 years; and so with others." It need hardly be remarked that this is in no sense a general law; even as stated, there are innumerable exceptions to it, and, moreover, the union of the epiphyses nowise marks the end of growth. Flourens, in common with many others who follow in the lead of Buffon, Haller, and others of the last century, regard 80 to 100 years as the natural term of life, because it is the age often attained by well-formed, healthy persons. In fact, it is quite true that, under the *optimum* of all the circumstances, a human being may live about one century.

The longevity, under favorable circumstances, of some of the more familiar and important animals, may be given as follows: Horse and cat, 40 years; dog, 20; pigs, 20; mice, 6; rabbits, 12; guinea-pigs, 10; elephants, 200; whales, it is supposed, several centuries; parrots and ravens, 100 years or more; hens, 15; canaries, 12 to 15; pigeons, 10; toads, 40; pike and carp, 200 years; crayfish, 20; most insects one year, but some, like bees, several years, others again only a few weeks or months; snails, 1 to 4 years; sea-anemones (actinia), over 50 years. These data do not rest, any of them, upon sufficiently exact and extensive records.

For the changes of old age in man see Senility.

Charles Sedgwick Minot.

LONGMUIR'S WELL. *Location*, Rochester, Monroe County, N. Y.

Access.—By New York Central & Hudson River, New York, West Shore & Buffalo, and Erie Railways.

Analysis (Temperature, 52° F.).—One pint contains:

	Grains.
Carbonates of lime and magnesia, with trace of oxide of iron	1.48
Chloride of sodium	6.52
Sulphate of soda	6.99
Total	14.99
Gases.	Cub. in.
Carbonic acid	Small quantity.
Sulphuretted hydrogen	2.16

G. B. F.

LORDOSIS (Syn.: Incurvation of the spine: Fr., *Lordose, Ensellure*; Ger., *Vorwölbung der Wirbelsäule*). A deformity in which there is a curvature, with forward convexity, of a portion of the vertebral column. As a rule the lumbar spine alone is affected, except in the case of compensatory incurvation; and in the very rare instances in which lordosis has been observed primarily in the dor-

sal region, it was due to inflammation of the osseous structures, and will not, therefore, be treated of in this article. The deformity is often compensatory in character, and is caused by the efforts of the patient to maintain an equilibrium. It occurs as a temporary condition in pregnancy, when the trunk is thrown back as a counterpoise to the weight of the gravid uterus, but may become permanent in women who have borne a number of children in rapid succession. It exists also in patients suffering from ovarian or other abdominal tumors. Curbstone peddlers, who carry their wares in front of their bodies, suspended by a strap from the shoulders, often acquire lordosis. Another cause of the deformity is seen in the tilting of the pelvis in consequence of congenital dislocation of the hips, or of hip-disease, or anchylosis with flexion of the thigh. Lordosis from contraction of the posterior spinal muscles occurs in paralysis of the abdominal muscles. It takes place also in paralysis of the pelvic extensors, as a result of the patient's effort to transfer the centre of gravity backward. In kyphosis of the dorsal spine, from whatever cause, there is compensatory lordosis in the lumbar region. Incurvation of the lumbar spine is also a prominent symptom in the condition known as pseudo-hypertrophic paralysis.

The appearance presented by a patient with lordosis varies according to the cause producing the incurvation. When the pelvis is tilted forward, as in dislocation or anchylosis of the hips, or paralysis of the abdominal muscles, the shoulders are thrown little, if at all, behind the line of the buttocks. But when the cause exists in an increase of weight anterior to the centre of gravity, or in paralysis of the spinal extensors, the plane of the pelvis is but little altered and the shoulders project far backward, overhanging the plane of the body, just as occurs in persons descending a steep hill. It is this appearance that has probably suggested a mode of treatment advanced for the cure of peddlers' lordosis, and that resulting from repeated pregnancies or abdominal tumors, and remaining after the cause has been removed. This consists simply in walking up a hill several times a day, returning in a carriage, or by steps, or walking backward. Where this method is not practicable the same results may be attained by standing for a considerable time each day upon an inclined plane; or the seat of the chair may be so constructed that it can be raised anteriorly, so as to force the patient to flex the spine as he sits. Another plan of treatment, advocated by Renier and De Saint-Germain, is based on the principle of Swedish movements. A strong elastic cord is attached to the arms of an armchair in such a way that when the patient sits the band rests against the lordosed portion of the spine. The patient then grasps the arms of the chair and endeavors to push himself back until the vertebral column rests squarely against the back of the chair. The cord is gradually set farther forward in succeeding exercises, until finally there is barely space enough left for him to seat himself in front of it. In the paralytic forms of spinal incurvation a persevering trial should be made of electricity. In some cases much can be effected by a suitable mechanical support based upon the principle of extension, by which the weight of the head and upper extremities is transferred, as far as possible, directly to the pelvis without the intervention of the spinal column. This may be accomplished by means of axillary crutches supported through lateral uprights on a firm pelvic band, or by a well-fitting plaster-of-Paris corset applied during suspension. The latter affords the better support and is cheaper, but possesses the disadvantage of being more irksome to the patient, and less cleanly. As lordosis occurs chiefly and primarily as a compensatory phenomenon, it is of course necessary to first remove the cause before attempting a correction of the resulting deformity.

Thomas L. Stedman.

LOS ANGELES AND PASADENA. (For detailed explanation of the accompanying chart and suggestions as to the best method of using it see Climate.) The city of Los Angeles is the largest town in Southern California, and the great business centre for the extensive fruit and wine trade of that region. The population of the town in 1880 was 11,311, and has increased rapidly during the past six years. Appleton's "Handbook of Winter Resorts" for the winter of 1884–85 gives the population as about sixteen thousand. Dr. Walter Lindley, in a paper recently read before the Kings County Medical Society, gives 45,000 as the population of the town. Los Angeles lies upon the western bank of a small river, at a distance of seventeen miles back from the Pacific coast and not far from half-way between the coast line and the principal chain of the Coast Range Mountains. From Santa Barbara it is distant about eighty miles in an E. S. E. direction; from San Francisco it is distant three hundred and fifty miles in a S. E. direction. The soil is clayey and the water-supply is indifferent. These circumstances, added to the situation of the town in a valley and to its being so much of a business centre, render Los Angeles a decidedly less desirable resort for invalids than are some of the smaller inland towns of Southern California. One of these, Pasadena, lying but seven miles distant from Los Angeles, has acquired the reputation of being perhaps the most perfect sanatorium of California. Dr. W. M. Chamberlain states that, in his judgment, Pasadena "is the point of election for by far the larger number of invalids;" that its soil is "light and dry;" its water-supply "of the best quality;" and that it lies "from five to six hundred feet higher than Los Angeles on an elevated triangular plain." He commends it especially "for all cases of renal disease, all cases of pulmonary trouble attended with free secretion, and for enteric, rheumatic, and neuralgic affections." The suburbs of Los Angeles, where the surrounding hills are "crowned by many fine residences," he pronounces to be "beautiful and salubrious." But of the "more compact portions of the city" he states that they "are liable to typhoid and zymotic disease," and that "the general sanitary condition has the defects which are generally found in a rapidly growing town." These quotations are from a paper entitled "Notes on the Climatic and Sanitary Conditions of Southern California," read by Dr. Chamberlain at the New York Academy of Medicine on October 19, 1886, and published in the New York *Medical Record* of October 30th. This interesting paper contains much other valuable information respecting Southern California. In the absence of climatological data from Pasadena the accompanying chart, representing many of the climatic features of Los Angeles, is given, as showing approximately the meteorological peculiarities of the entire inland portion of Southern California. The reader's attention is, however, called to the fact that climatic contrasts between neighboring points are especially pronounced throughout the State of California, and that variations in elevation above sea-level and in distance from the seacoast, which, in most regions, would be considered of no practical account in reckoning climatic chances, deserve very great consideration, even in Southern California, despite the common possession by all points throughout this region of climatic characteristics which sharply differentiate it from the rest of the State and of the United States. Warm winters, comfortably cool summers, very low rainfall, and rainfall so distributed as to divide the year into a dry and a so-called "rainy" season, almost unparalleled preponderance of cloudless weather, and (in consequence of the low latitude) a long duration of the daily sunshine in winter—all these are characteristic of every portion of Southern California. In comparative humidity of the atmosphere lies the chief difference between its coast stations and those lying at greater or less distances from the coast line. Thus the mean relative humidity of San Diego, on the coast, is 70.9 during the winter season, 73.6 during the spring season. At Los Angeles the mean relative humidity in winter is 63.6; in the spring it is 70.4. The decided difference between the winter figures of the two places, despite the fact that Los Angeles lies but seventeen miles distant from the coast and at a moderate elevation above sea-level, is worthy of attention. The mean winter temperature of San Diego is 54.5° F.; that of Los Angeles is 53.5° F. The mean daily range of temperature of San Diego, during the

Climate of Los Angeles, Cal.—Latitude 34° 3′, *Longitude* 118° 15′.—*Period of Observations, July* 1, 1877, *to December* 31, 1883.—*Elevation of Place of Observation above the Sea-level,* 283 *feet.*

	A			AA	B		C	D	DD	E		F		G	H
	Mean temperature of months at the hours of			Average mean temperature deduced from Column A.	Mean temperature for period of observation.		Average maximum temperature for period.	Average minimum temperature for period.	Mean daily range deduced from Columns C and D.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest number of days in any single month on which the temperature was below the mean monthly minimum temperature.	Greatest number of days in any single month on which the temperature was above the mean monthly maximum temperature
	7 A.M. Degrees.	3 P.M. Degrees.	11 P.M. Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.		Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.		
January....	45.4	60.2	51.0	52.2	54.9	49.4	62.9	42.8	20.1	82.0	71.0	37.0	30.0	19	23
February...	46.5	61.8	52.3	53.5	57.9	50.1	63.9	44.7	19.2	86.0	70.5	42.0	28.0	24	21
March......	48.5	64.0	54.3	55.6	58.5	51.1	64.4	45.3	19.1	99.0	73.5	42.6	35.3	25	20
April.......	50.9	66.8	56.1	57.9	61.4	55.9	69.2	49.0	20.2	94.0	80.0	48.0	39.0	22	19
May........	53.5	71.9	59.9	61.7	62.7	61.0	74.8	52.3	22.5	100.0	86.1	47.0	39.5	20	15
June........	58.1	76.0	62.4	65.5	68.8	63.4	78.5	56.6	21.9	103.5	81.0	52.0	47.0	18	24
July........	60.3	79.4	64.5	68.0	71.1	64.2	82.0	58.9	23.1	98.1	84.5	55.0	51.2	23	25
August.....	60.8	80.9	66.1	69.2	71.0	66.4	83.4	59.2	24.2	99.8	87.0	57.0	50.0	22	20
September..	58.7	79.6	65.1	67.8	71.9	64.5	82.4	57.2	25.2	103.5	91.0	53.0	44.0	23	22
October.....	54.1	73.2	60.3	62.5	64.3	60.9	75.4	51.4	24.0	96.5	80.0	44.0	42.5	22	19
November..	49.3	68.7	55.7	57.9	62.1	55.2	70.7	46.2	24.5	86.0	80.8	45.0	34.2	22	24
December..	48.0	63.9	53.2	55.0	56.4	51.9	65.9	45.0	20.9	88.2	76.0	38.0	30.0	22	20
Spring......	......	......	......	58.4	60.0	56.0	....	....	....	......	......	......	......	......	......
Summer....	......	......	......	67.5	69.5	64.7	....	....	....	......	......	......	......	......	......
Autumn....	......	......	......	62.7	65.0	60.7	....	....	....	......	......	......	......	......	......
Winter......	......	......	......	53.5	55.3	51.1	....	....	....	......	......	......	......	......	......
Year........	......	......	......	60.5	61.6	58.4	....	....	....	......	......	......	......	......	......

	J	K	L	M	N	O	R	S
	Range of temperature for period.	Mean relative humidity.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall.	Prevailing direction of wind.	Average velocity of wind, in miles, per hour.
						Inches.	From	
January....	52.0	62.9	8.5	17.5	26.0	2.05	N.E.	5.5
February ..	58.0	66.3	9.5	13.0	22.5	2.78	N.E.	5.7
March	63.7	71.9	10.8	12.5	23.3	1.95	W.	5.2
April.......	55.0	70.1	12.5	10.2	22.7	1.73	W.	5.4
May........	60.5	69.1	11.8	13.5	25.3	0.60	W.	5 4
June.......	56.5	69.1	17.2	8.5	25.7	0.02	W.	5.1
July	46.9	69.4	19.7	10.4	30.1	....*	W.	4.9
August	49.8	68.9	13.7	16.0	29.7	....*	W.	4.5
September.	59.5	68.4	11.6	17.1	28.7	....*	W.	4.6
October....	54.0	64.0	11.6	16.4	28.0	0.62	W.	4.8
November.	51.8	57.3	9.3	18.8	28.1	0.95	N.E.	4.9
December .	58.2	61.5	8.6	17.4	26.0	3.82	N.E.	5.0
Spring.....	64.7	70.4	35.1	36.2	71.3	4.28	W.	5.3
Summer ...	56.5	69.1	50.6	34.9	85.5	0.02	W.	4.8
Autumn ...	69.3	63.2	32.5	52.3	84.8	1.57	W.	4.8
Winter.....	60.2	63.6	26.6	47.9	74.5	8.65	N.E.	5.4
Year.......	75.5	66.6	144.8	171.3	316.1	14.52	W.	5.1

* Amount inappreciable.

season now under consideration, is 16° F.; at Los Angeles the mean daily range during the same season is 19.8° F.; for at Los Angeles the mercury rises higher by day than it does at San Diego, one hundred miles farther south, and it falls to a lower point during the night at the former than at the latter place.

These points of difference will serve as types of those existing between various points in Southern California, and, as such types, will demonstrate the especial importance of the study of "climats de localité," as Dr. Fonssagrives aptly terms them, in this region. A large and excellent map of the whole State of California may be found in the New York *Medical Journal* of October 30, 1886. It accompanies the publication of the valuable paper by Dr. Lindley, of Los Angeles (entitled "Southern California: a Climatic Sketch"), to which reference already has been made. In this paper Dr. Lindley tells us that at Los Angeles there are "only from twelve to twenty rainy days" during the "rainy" season. During the spring months fogs, coming in from the sea, sometimes occur at places lying at an elevation above sea-level of less than one thousand feet. These fogs occur during the early morning, before 9 or 10 A.M. "During these months the dew-fall is also considerable. . . . At a distance from the coast of from about twenty-five miles onward, where the altitude is 1,000 feet and upward, there are many pleasant locations where fogs are unknown and where the constant purity and dryness of atmosphere are a remarkable feature" (*loc. cit.*). The vicinity of Pasadena is said by Dr. Lindley to have an altitude of from 1,000 to 1,200 feet. His experience during six years as physician to the Los Angeles Orphans' Home leads Dr. Lindley to the belief that summer disturbances of the intestinal tract are never prevalent among children at Los Angeles, and that "scarlet fever, diphtheria, measles, and whooping-cough, usually run a very mild course." Dr. Chamberlain says that he has "never seen more fresh-colored, strong-limbed, and bright-eyed children," than he saw in Southern California. Dr. Lindley considers a residence in Southern California to be beneficial to dyspeptics; not merely on account of the climatic advantages, but also, in part, because of the good food which may there be had. Dr. Chamberlain also has a good word to say of the Southern California market; making special allusion to the beef, mutton, fish, and game, as well as to the fruits for which the country is famous. Careful investigation appears to have proved that hay-fever does not originate in Southern California, and that cure of the disease is often attained there, while relief has been the universal rule (Dr. Lindley, *loc. cit.;* also *Southern California Practitioner*, July, 1886). Of intermittent fever Dr. Lindley says that it "never develops in Los Angeles County," and he gives good grounds for this statement; it is his belief that the same is true of other portions of the health-region of Southern California. "A short residence in Los Angeles, assisted by ordinary treatment, cures" those who come there suffering from malarial poisoning, and "a permanent residence gives them perfect immunity." For asthma also, Dr. Lindley recommends the whole region, and especially Riverside, sixty miles east of Los Angeles, and Newhall and Ravenna, thirty miles north of Los Angeles. Concerning pulmonary phthisis he says: "My own experience has been that the great majority of patients with consumption do well in the immediate vicinity of Los Angeles, but that the best place is a few miles nearer the mountains, in altitudes ranging from 1,000 to 2,000 feet." The California State Board of Health selected the Sierra Madre Valley, twelve miles east of Los Angeles, as deserving the first place among sanatoria for phthisical patients (*loc. cit.*).

Finally, Dr. Lindley very wisely recommends that patients who come to California for the relief or cure of pulmonary phthisis, should reside with some of their own family in a hired or purchased private cottage rather than in a hotel or sanatorium, and he strongly urges that those who merely stay during the winter shall not hasten home too early in the spring, but shall remain away until the middle of May or of June. Such patients, he says, "had far better remain during the summer;" as that is the season "when the atmosphere, even near the coast, is almost perfectly aseptic."

Throughout its extent, taking into consideration both sea-coast and inland stations, the whole region of Southern California is probably unequalled as a sanitary (and sanatory) residence in winter by any other portion of the United States. For cases of pulmonary phthisis it is excellent, some of its stations being especially so; but, until the local climates of the region are better understood and until a more extended series of clinical observations has been made, it will be difficult to decide precisely which cases of pulmonary phthisis should be sent to California, which to Colorado, and which to Florida. The very variations, as to certain factors of climate, existing between points which are not far remote one from another but which are differently placed in respect to altitude and distance from the sea-coast, together with the desirable climatic peculiarities of *all* points throughout the region taken in common in all probability combine to render Southern California suitable to consumptive patients of various constitutional types, or advanced to various stages of the disease. Such adaptability to different types and stages of consumption within so limited an extent of territory can hardly be found elsewhere in the United States. General dryness of soil, abundance of sunlight, and moderate humidity of the atmosphere, together with a warm temperature in winter, render the whole of Southern California desirable as a winter residence for almost all classes of invalids. For beauty of scenery the whole country is notorious. Many of its resorts, and Pasadena among the number, have excellent hotel accommodations.

Huntington Richards.

LOUÈCHE, LOËCHE, OR LEUK, is a Swiss resort, lying in a narrow valley on the southern slope of the Gemmi, at an elevation of 4,250 feet above the sea. The climate is rather raw and subject to sudden changes, and fogs are frequent. There are twenty-two thermal mineral springs, but many of them are not used, and only one, the Lorenzquelle (Source de Saint-Laurent), is employed to any extent internally. The following is the composition of this spring. (Temperature 124° F.) Each litre contains:

	Grammes.
Potassium chloride	0.0065
Calcium sulphate	1.5200
Magnesium sulphate	0.3084
Sodium sulphate	0.0502
Potassium sulphate	0.0386
Strontium sulphate	0.0058
Calcium carbonate	0.0053
Magnesium carbonate	0.0096
Ferrous carbonate	0.0103
Silica	0.0360
Phosphates, nitrates, and ammonium salts	traces
Total solid constituents	1.9907

The gases are nitrogen, oxygen, and carbonic acid.

The waters are used internally to some extent, but baths are chiefly employed. These baths are of several hours' duration; both sexes bathe at the same time, and the bathers amuse themselves by playing chess, cards, and other games on floating tables.

The diseases treated at Loëche are chiefly eczema, psoriasis, and other forms of skin affections. Much benefit is also derived from the baths by subjects with enlarged joints following gout and rheumatism. The season lasts from the middle of May to the end of September. Good accommodations can be had at moderate prices.

T. L. S.

LOUISVILLE ARTESIAN WELL. *Location and Post-office,* Tenth Street near Main, Louisville, Ky.

ACCESS.—By the numerous lines of railway centring at Louisville.

ANALYSIS (Professor J. Lawrence Smith).—One pint contains:

	Grains.
Carbonate of soda	0.237
Carbonate of magnesia	0.204
Carbonate of iron	0.032
Carbonate of lime	0.520
Chloride of potassium	0.528
Chloride of sodium	77.690
Chloride of magnesium	1.847
Chloride of aluminium	0.151
Chloride of calcium	8.216
Chloride of lithium	0.013
Sulphate of potassa	0.463
Sulphate of soda	9.037
Sulphate of magnesia	9.667
Sulphate of alumina	0.225
Sulphate of lime	3.679
Phosphate of soda	0.193
Iodide of magnesium	0.044
Bromide of magnesium	0.058
Silica	0.111
Organic matter	0.089
Loss	1.015
Total	113.959

Gases.	Cub. in.
Carbonic acid	0.77
Sulphuretted hydrogen	0.25
Nitrogen	0.17

The therapeutic properties are those of a strong saline cathartic.

This well is in a paper-mill, and is 2,086 feet deep. At the orifice the water has a temperature of 76½° F. At the bottom it is 86½° F.

G. B. F.

LOVAGE ROOT (*Radix Levistici*, Ph. G.; *Livèche*, Codex Med., root and fruit), *Levisticum paludapifolium* Archers; (*Ligusticum Levisticum* Linn.; *Levisticum officinale* Koch, etc.); order, *Umbelliferæ.* This is a large, aromatic, perennial herb, with a short, thick, fleshy rootstock, from which several large, simple roots are given off below, and three or four stout, upright, slightly branching stems above. It has large, compound leaves, with broad, ovate, or wedge-shaped, pinnately-cut leaflets, and compound umbels of small, yellow flowers. Fruit oblong, ovate, its mericarps dorsaly flattened; lateral ribs conspicuously winged; oil-tubes single in each furrow. All parts of the plant have a strong and rather agreeable fragrance due to its peculiar essential oil, and the root contains also considerable resin. When fresh, the stem and leaves exude a yellowish latex upon being broken.

Lovage is said to be truly wild only in Southeastern Europe (Bosnia and Servia, Flückiger), but it has been cultivated for centuries in other parts of Europe, and is extensively naturalized. That of commerce comes principally from Holland, Germany, and France. The "root" is most in demand, although the seeds have more oil. It consists of the rhizome split or quartered, and, more abundantly, of the roots themselves, either whole or split. The pieces are of a brown, gray-brown, or black color externally, transversely marked near the top, elsewhere deeply longitudinally wrinkled and shrivelled; section white, yellow, or reddish; resin canals visible; texture spongy and flexible. Odor and taste peculiar, aromatic, resinous, bitterish-sweet, angelica-like. *Essential oil, resin* (yielding umbelliferone), *malic* and *angelic acids, gum,* and *sugar* are among its constituents; to the two first it owes its medicinal value, whatever that may be.

It is a rather pleasant stimulant, aromatic and diuretic, of the angelica and musk-root kind, with no active properties. It is sometimes given as a diuretic in dropsies from heart-disease, etc., also for catarrh of the bladder, and for chronic bronchitis. It is, however, very little used in this country, and even abroad has degenerated mostly to the level of a household herb among the country people.

ALLIED PLANTS.—Scotch Lovage, *Ligusticum Scoticum*

Linn., growing on salt marshes along the New England coast, has a fleshy root of similar odor. For the order, see ANISE.

ALLIED DRUGS.— Sumbul, Galbanum, Celery, Parsnip, and more remotely, hundreds of aromatic and resinous substances. *W. P. Bolles.*

LOWER BLUE LICK SPRINGS. *Location and Post-office,* Blue Lick Springs, Nicholas County, Ky.

ACCESS.—To Carlisle, on the Kentucky Central Railroad, thence by stage to Springs, ten miles.

ANALYSIS.—Saline contents in the wine pint:

	Grains.
Carbonate of lime	2.9568000
Carbonate of magnesia	0.0169459
Alumina, phosphate of lime, and oxide of iron	0.0447974
Chloride of sodium	64.1072102
Chloride of potassium	0.1740979
Chloride of magnesium	4.0488960
Bromide of magnesium	0.0302546
Iodide of magnesium	0.0056371
Sulphate of lime	4.2495744
Sulphate of potash	1.1166738
Silicic acid	0.1377792
Loss	2.2158335
Total	79.1040000
Gases.	Grains.
Sulphuretted hydrogen gas	0.303129
Free carbonic acid gas	2.724996
Specific gravity	1.007

The water also contains strontium, barium, lithium, and traces of oxide of manganese, and apocrenic and crenic acids.

The therapeutic properties are those of a strong saline-sulphur water.

These springs are located on the Licking River, in the northern portion of Kentucky, the scene of Daniel Boone's conflicts with the Indians. The hotel accommodations are ample, the climate healthful, and the scenery attractive. *G. B. F.*

LUHATSCHOWITZ is a watering-place in Austria, situated in a valley in the Carpathian Mountains, at an elevation variously given as from 600 to 1,500 feet above the sea. The valley is protected against the northerly winds, and the climate is in consequence rather mild and pleasant. There are numerous mineral springs, only four of which are, however, used to any extent for therapeutic purposes. The following is the composition of these four springs, as given by Kisch in Eulenburg's "Real-Encyclopädie." In 1,000 parts of water there are of:

	Johannis-brunnen.	Louisen-quelle.	Armand-brunnen.	Vincenz-brunnen.
Sodium chloride	3.631	4.359	3.353	3.063
Sodium carbonate	3.287	0.844	....	....
Sodium bicarbonate	3.495	6.766	6.640	4.286
Lithium bicarbonate	0.003	0.002	0.002	0.001
Magnesium bicarbonate	0.109	0.101	0.112	0.083
Calcium bicarbonate	0.907	0.826	0.903	0.878
Strontium bicarbonate	0.013	0.002	0.019	0 015
Barytum bicarbonate	0.007	0.010	0.010	0.011
Ferrous bicarbonate	0.017	0.033	0.024	0.019
Manganous bicarbonate	0.005	0.004	0.006	0.006
Potassium chloride	0.278	0.210	0.207	0.233
Sodium iodide	0.022	0.023	0 016	0.017
Sodium bromide	0.009	0.011	0.013	0.033
Calcium phosphate	0.004	0.008	0.004	0.004
Organic matters, etc	0.070	0.069	0.021	0.059
Total solid constituents	11.857	13.268	11.330	8.708

The waters are taken internally, sometimes mixed with milk or whey, and are employed externally in the form of baths, douches, and inhalations; pine-needle and mud baths are also used. Luhatschowitz is frequented by sufferers from catarrh of the respiratory or digestive mucous membranes, scrofulous affections, gastric and hepatic disorders, diseases of the female organs of generation, and gouty and rheumatic troubles. The season lasts from the middle of May to October 1st. The bathing accommodations are good. *T. L. S.*

LUMBAGO, sometimes called lumbodynia and myalgia lumbalis, is characterized by pain in the muscles and fascia of the lumbar region. It is usually classed among the group of disorders commonly known as muscular rheumatism, though it is more than probable that the pain is neuralgic in character rather than rheumatic; in other words, that the disease is, strictly speaking, a myalgia, and is not always, at least, dependent upon the essential pathological conditions which pertain to rheumatism. It may be confidently expected, moreover, in the course of time, as medical knowledge expands and becomes more precise in its application, that the domain of "rheumatism" will be correspondingly contracted, and that after a while many of the so-called rheumatic affections will have more correct nosological positions assigned them.

The attack may be acute, sub-acute, or chronic. The pain may be on one or on both sides of the lumbar spine, and may be developed gradually, commencing as a dull aching sensation, steadily increasing in severity; or it may, more frequently perhaps, occur suddenly, without warning, and be violent at the very outset.

No heat, redness, or swelling, and little, if any, constitutional disturbance is observed, but more or less tenderness of the affected muscles is usually present.

The affection is destitute of anatomical characters. Voluntary movements of the lumbar muscles occasion pain, and sometimes severe pain is caused by involuntary movements, or by spasmodic and cramp-like contractions of the sensitive muscles. It occasionally happens that no obtainable degree of quietude and no possible position will secure immunity from suffering.

An attack of lumbago may last from a few hours to several weeks or months, marked, in some instances, by intermissions or remissions of variable duration.

The common exciting causes of lumbago are violence done to the muscles by straining, lifting, riding, etc., exposure to cold, and to drafts of air.

It is important to distinguish this from other affections which give rise to pain in this region. It should not be confounded with diseases of the kidneys or of the surrounding structures, with diseases of the vertebral column or of the spinal cord, with abscess, with the passage of renal calculi through the ureters, with aortic aneurism or lumbo-abdominal neuralgia, or with certain rectal or uterine disorders. By noting the circumstances attending the advent of the attack, and by a system of exclusion, the diagnosis can, as a rule, be made with ease.

The treatment of lumbago has for its object the relief of pain, and the correction of any exciting or sustaining cause. Anodynes are usually required. Opium, in some form, hypodermatically or by the mouth or rectum, is the most trustworthy of this class of remedies. Cathartics, especially mercurial cathartics, are often indicated. Quinine, salicylic acid or salicylate of sodium, alkalies and alkaline waters, and the bromides, are useful remedial agents. The local hypodermatic use of cocaine may prove serviceable in some cases. Sinapisms, stimulating and anodyne embrocations, hot fomentations, turpentine stupes, blisters, the hot iron, exposure of the surface to the direct heat of an open fire, and galvanism to the painful parts, have all yielded good results.

In acute cases rest in the most comfortab*l*e posture is essential. Faradization, friction, and kneading, are helpful in the latter stages of some attacks to restore tone to the enfeebled muscles.

Local depletion by means of cups is, to say the least, of doubtful propriety. Dry cupping, however, is not open to the same objections.

In debilitated states of the system roborant remedies must be administered. The tendency of this affection to recurrence should be combated by cold sponge-baths, outdoor exercise, avoidance of excessive clothing, and by the employment of local and general invigorating measures. *James B. Baird.*

LUNGS, ABSCESS OF. Cavities resulting from abscess, if those of tubercular and metastatic origin be excluded, are rare lesions. Pulmonary abscess is met with occasionally in cases of lobar pneumonia in adults, and more frequently with lobular pneumonia in children. In the latter they are either scattered through the lungs in

small numbers or may be abundant and closely packed together.

Trousseau ("Clinical Medicine") and Chomel ("Dictionnaire de Médicine," Paris, 1842) met with only two cases each of abscess accompanying lobar pneumonia in the adult in an experience of twenty-five years. Abscesses may occur with acute pneumonia, and in such cases are not likely to be mistaken for tubercular phthisis, or they may occur several months after the acute attack, in cases where partial consolidation of the lung-tissue has remained. They vary in size, from that of an almond to that of a man's fist, and may be so large as to destroy nearly the whole lung. They are not enclosed within sharply defined, firm walls, but are gradually lost in the surrounding tissue, the pus becoming more consistent the farther it is from the centre, until a pus-infiltrated texture is reached, which gradually blends with the natural substance of the lung (Hasse, "Pathological Anatomy").

When the contents of the abscess have been discharged, the physical signs are the same as those of cavities due to other causes.

Sometimes perforation into the pleural cavity occurs, and then we have signs of hydropneumothorax. In those cases which open into the bronchi the expectoration is purulent and usually copious, the increase in the expectoration generally occurring suddenly, and its character changing and becoming diffluent after having been viscid. They are usually situated at the base of the lung, but occasionally are in the middle or upper lobe. They are usually single, but in a few instances several have been found. The other lung remains healthy. Such cases may terminate in cicatrization, but as a rule the prognosis is bad. The abscesses go on enlarging, and finally wear out the patient by the constant drain on the system. The slight constitutional disturbance that in some cases accompanies the abscess, especially when it remains stationary or does not enlarge rapidly, is remarkable, and the easy respiration, the regular action of the heart, the infrequent cough, and the healthy color give little indication of the gravity of the condition.

Donald M. Cammann.

LUNGS: DISEASES OF THE BRONCHIAL GLANDS.

Syn.: Fr., *Adénopathie Trachéo-bronchique;* Ger., *Krankheiten der Bronchialdrüsen.*

History.—It is to M. Noël Gueneau de Mussy that we are specially indebted for our knowledge of the diseases of the bronchial glands. M. Barèty has supplemented his labors in a monograph "L'Adénopathie Trachéo-bronchique." Tauchon (Paris, 1867) and others have described some of the changes in these glands which accompany phthisis in the adult, while MM. Rillet and Barthez, in their work "Traité des Maladies des Enfants" (Paris, 1861), and Dr. West, in his lectures on diseases of infancy and childhood, have given full descriptions of the same changes in children under the head of bronchial phthisis.

Dr. Quain, in the "Dictionary of Medicine," has given a careful and complete *résumé* of some sixty cases from personal observations.

Tumors and enlargements are more especially considered in connection with intrathoracic tumors.

Classification.—Upon a pathological basis, diseases of the bronchial glands are classified under the conditions affecting lymphatic glands generally. They are subject to the following changes:

1. Inflammations: (*a*) acute; (*b*) chronic; (*c*) specific.
2. Morbid deposits and growths: (*a*) pigmentation; (*b*) cancer; (*c*) tubercle; (*d*) syphilitic growths (tertiary); (*e*) albuminoid disease.
3. Hypertrophy and atrophy.

Anatomy.—Since the greater portion of the symptoms arising from disease in the bronchial glands are due to implication of adjacent parts, either through inflammation or from pressure, exact knowledge of the anatomical relations is of the utmost value in determining the significance of any given symptom.

The largest group of glands lies just below the bifurcation of the trachea, between the right and left bronchus. They are in relation, laterally, with the bronchi; anteriorly, with the pericardium, arch of the aorta and pulmonary artery; and posteriorly with the aorta, vena azygos, œsophagus, and pulmonary plexus of nerves. Smaller ganglia are situated upon the anterior, posterior, and superior surfaces of the right and left bronchi. Those upon the right are the larger, and are in relation with the arch of the aorta, the brachio-cephalic and subclavian arteries, the brachio-cephalic and azygos veins, and the pneumogastric and recurrent laryngeal nerves. On the left they are in relation with the extremity of the arch of the aorta, the origin of the left subclavian and common carotid arteries, the subclavian vein, and the pneumogastric nerve with its recurrent branch.

Afferent vessels reach the glands from the lungs, pleuræ, neck, etc. The blood-supply is through the bronchial arteries.

Pathology and Morbid Anatomy.—The pathological processes which occur in the bronchial glands are in no respect different from those which take place in other lymphatic glands. The resulting anatomical changes assume special importance through their mechanical effects.

In many instances, when the glandular disease is slight the anatomical disturbances cause such marked symptoms as to obscure, or divert attention from, the more serious associated conditions.

1. *Acute inflammation* is attended by cellular infiltration, with increase of lymphoid elements and retention of lymph, resulting in enlargement of the glands and softening of their parenchyma. When this process is rapid, or if due to specific poisons, suppurative and necrotic changes may follow. More commonly resolution takes place, and the glands return to their normal size.

2. *Chronic inflammation* is characterized by similar but more gradual cellular and lymphoid changes. In connection with these, fibrous growth is more marked; the glands become greatly enlarged, in some cases permanently, and their capsules are thickened and form adhesions with surrounding tissues. Resolution is seldom complete, and if long delayed the glands become contracted and indurated.

When suppuration results, the pus may find its way, by an ulcerative process, to the free surface of a bronchus, into the œsophagus or pericardium, or into the substance of the lung or lumen of a blood-vessel; or the contents of the abscess may undergo caseous, calcareous, or cystic degeneration. Even in the acute form suppuration rarely takes place with sufficient rapidity to allow rupture directly into the connective tissue, and in the chronic forms protective inflammation with adhesions is always present.

3. *The specific inflammatory changes* present no peculiarities in pathological processes.

4. *Pigmentation* (see Lungs: Pneumonokoniosis).—Carbonaceous and other deposits in the bronchial glands seldom cause more than the lightest grades of inflammatory changes, owing to the slight irritating nature of the foreign matter and the slowness with which it is deposited. The glands become more or less enlarged, and variously pigmented. In extreme cases they are entirely black, firm, hard, and gritty on section, resembling a lump of coal. The glandular tissue is partially atrophied and absorbed. When suppurative changes supervene, the discharge from the resulting abscess is at first black, and though gradually becoming lighter, is not entirely free from pigment until the entire gland has been removed by suppuration.

5. *Cancer.*—Cancerous developments in the bronchial glands follow similar disease of the lungs, pleura, or mediastinum, and are of like character. Primary cancer is infrequent. The pathological and anatomical changes present no peculiarities.

6. *Tubercle.*—Secondary tuberculosis occurs, to a greater or less degree, in all cases of pulmonary phthisis in the adult. In children, on the contrary, the glandular changes are often the more extensive and important. The pathological process is commonly one of general tubercular infiltration. The increase of epithelioid cells and the lymphoid infiltration are evenly distributed through-

out the gland, or the process may start from several centres, or be confined to one extremity of the gland. It is seldom that the deposit presents the form of gray miliary tubercle. In connection with these changes the glands enlarge, and at first are softer than normal, but as the process advances and implicates the entire gland they become firm and resistant, resembling tuberculous pulmonary consolidation. In the second stage the usual softening takes place, and tubercular glandular abscesses are formed which follow the course of other abscesses described above ; the ulcerative process, however, which leads to rupture of the abscess-wall, being preceded by tubercular infiltration.

7. *Syphilis.*—Syphilitic deposits are usually tertiary. Gummy deposits may lead to extensive enlargement, with subsequent caseous or suppurative degeneration.

8. *Albuminoid degeneration* is exceedingly rare. When present, the glands are usually enlarged, firm, and tense ; occasionally they are atrophied. On section they present the usual waxy, glistening, homogeneous appearance, and give the characteristic reaction with iodine.

Etiology.—The lymphatic diathesis, inherited tendencies, and general malnutrition are here, as elsewhere in the body, predisposing causes of glandular disease. Some statistics have seemed to show a slightly greater predisposition among females, and an increasing liability to such disease after puberty.

West and others consider the disease as very frequent among infants and young children.

Of the exciting causes, acute inflammation of the pulmonary tissue or pleura is the most frequent. Thus a simple bronchitis, a pneumonia, pleurisy, or empyema, etc., may each be followed by an acute or chronic inflammation of the bronchial glands, resulting in resolution, abscess, or caseous degeneration.

So frequently have these glands been found enlarged in cases of whooping-cough that Noël Guéneau de Mussy was led to attribute the enlargement to the direct irritation of a specific poison, and to consider the spasmodic element in the cough as due to pressure upon the pneumogastrics by the enlarged glands.

Other observers (Barlow, *Lancet*, 1879, vol. ii., p. 124), however, have reported cases in which the pneumogastrics were not only pressed upon, but even involved in the inflammatory processes surrounding the gland, without the presence of any cough. Still further, many cases of whooping-cough, in which the spasmodic element was specially marked, exhibited no change in the bronchial glands post-mortem. More exact observation also shows but little resemblance in the cough of pertussis to that due to irritation of the recurrent laryngeal nerve.

Both acute and chronic inflammatory changes have been observed in the bronchial glands in connection with most of the specific blood diseases, more especially in typhoid fever, measles, scarlet fever, and pyæmia.

In these conditions the changes are part of a general lymphatic inflammation, and are seldom of sufficient extent to attract attention during the life of the patient.

Absorption of various forms of dust to which certain classes of workmen are exposed, with the consequent filling and clogging of the glandular passages, may lead to either acute or chronic inflammation, ending in atrophy or suppuration and abscess. Such a result is exceedingly rare, however, considering the number of cases of pneumonokoniosis in which the glands become partially or completely filled with extraneous matter.

As already indicated in the sections on classification and pathology, the specific causes of cancer, tubercle, syphilis, and amyloid degeneration are exciting causes of disease in these glands.

Finally, many cases of enlargement, induration, or suppuration with secondary changes will be found, in which no exciting cause is apparent beyond the lymphatic diathesis. Simple inflammation seldom causes suppuration, such a result following more certainly from septic irritation, as in pyæmia or tubercle.

Symptoms.—In the earlier stages, and, indeed, throughout the entire course of the disease, unless the glands form decided tumors, the symptoms will be almost entirely rational. Since they are due solely to pressure, and as the glands involved in different cases will not be the same, nor always enlarge in the same direction, it is evident that the symptoms will vary greatly in their order of development and relative importance in different cases. There are no characteristic symptoms.

1. *Cough* is the most frequent as well as the earliest symptom. This may be due to pressure upon either a bronchial tube or the recurrent laryngeal nerve. In the former case it will resemble the cough of simple bronchitis. When due to pressure on the nerve it will be more harsh and laryngeal in character, and in some cases will have a distinct spasmodic element. When the irritation is severe it may be a persistent dry hacking, with or without paroxysmal exacerbations. More rarely it is deep, hollow, and metallic, or resembles the cough of an animal.

2. *Expectoration* attending the bronchial form of cough is quite constant. At first white and frothy, it gradually becomes muco-purulent when the glandular processes are acute and rapidly extending, or changes to a tenacious, mucous sputum with the more chronic processes. Should a glandular abscess open into the bronchial tubes, it will be evidenced by a more or less free purulent expectoration, mingled, it may be, with cheesy or even calcareous matter. After such an opening has occurred, an intermittent purulent discharge will continue indefinitely, or until the abscess has healed. When cough is due to nerve compression, expectoration is slight or entirely absent. No appreciable modification in the expectoration will be observed when the glandular disease is secondary to other pulmonary lesions.

3. *Hæmoptysis* is present in a small proportion of cases. When due to intense pulmonary congestion, resulting from prolonged paroxysms of coughing or obstruction to the pulmonary veins, it is usually capillary in character, and appears at first either as streaks in the sputa or in moderate amount as clear, bright-red blood, followed later by darker masses and small clots. When due to bronchial ulceration or erosion of a vessel in the wall of a glandular abscess, it is more profuse in character, appears suddenly, and may continue for several days, or even result in death.

4. *Pain* is one of the most frequent symptoms. In character it does not differ from that occurring with other forms of intrathoracic tumors. It has been described as dull and heavy, as a tightness or compression, and in a few cases has been spasmodic.

It is usually associated with some decided tenderness on pressure, and when once present is quite persistent, even when varying greatly in intensity.

It is most frequently located posteriorly between the spine and border of the scapula, opposite the bodies of the fourth, fifth, and, in a few cases, the sixth dorsal vertebræ. Less commonly it is felt in front, near the edge of the sternum or under the clavicle, with occasionally a point of pain and tenderness in the axillary region, causing it to simulate intercostal neuralgia.

5. *Dyspnœa* is often a prominent symptom. One fatal case is reported in which it was the only symptom. Its intensity depends less upon the absolute size of the tumor than upon the direction and nature of the enlargement. A comparatively small tumor or rapid inflammatory exudation may compress a primary bronchus sufficiently to cause most intense dyspnœa.

When due to compression of a bronchial tube, or of the lung-substance, the dyspnœa is persistent and unvarying. In a small proportion of cases it appears to depend upon implication of the laryngeal nerve and unilateral paralysis of the larynx. It may be paroxysmal, or even assume the characteristics of spasmodic asthma with decided nocturnal paroxysms, and it is occasionally so severe as to force the patient to assume the erect position. Quain gives the proportion in which this spasmodic element is well marked as one in fifteen.

6. *Dysphagia* is a quite common symptom, and is due simply to compression. It is present in about fifteen per cent. of cases. It comes on slowly, is persistent, and varies only with the changes in the size of the glandular tumor. It is first noticed and most marked as regards

solid food, but in one or two cases it was almost confined to liquids.

7. *Change of voice* is present only when the recurrent nerves are implicated. There may be loss in volume and force in connection with the dyspnœa of bronchial obstruction, but distinct changes in character are probably always of nervous origin.

Hoarseness is the earlier and may be the only change. It occasionally passes into complete aphonia. In these cases paralysis of one or both vocal cords can be recognized by the laryngoscope.

8. *Nausea and vomiting* are rare symptoms, due to implication of the pneumogastrics. M. de Mussy considers them more frequent when the left nerve is affected.

9. *Venous compression.*—Compression of the ascending veins seldom causes any marked symptoms. Anorexia and the general disturbances of digestion have only an indirect relation to venous obstruction.

Compression of the veins coming from the head is more frequent, causing cyanosis, congestion, and œdema of the face and neck, and rarely of the upper extremities. Epistaxis results from the same cause.

PHYSICAL SIGNS.—*Inspection* is usually negative. It may show: 1. The œdema, puffiness, etc., just mentioned, of the face. 2. Slight prominence of the upper sternal, and infraclavicular regions. This is exceedingly infrequent; it was noticed in none of sixty cases reported by Quain. 3. Slight flattening of the affected side. It is the more frequent change, and is probably induced by bronchial occlusion and partial pulmonary collapse. 4. Diminished motion of the affected side. It may be present alone or in connection with either enlargement or contraction. 5. No change in either size or motion. Most cases will be of this nature.

Palpation will show decreased vocal fremitus when bronchial compression has affected very decidedly the amount of air in either lung.

Percussion.—Dulness is the most constant physical sign, and will indicate, by the area over which it is present, and its character, both the size of the glandular enlargement and its nearness to the surface. It is usually best marked behind, between the scapula and spine, extending in extreme cases from the fourth to the sixth, or even seventh, dorsal vertebra. Less frequently it may be obtained in front, over the manubrium sterni, and below the sternal end of the clavicle.

Rarely pulmonary collapse causes partial dulness over a greater or less area. Abscess cavities communicating with the bronchial tubes are seldom, if ever, of sufficient size to affect the percussion note.

A compensatory emphysema may possibly give a vesiculo-tympanitic tone over the healthy lung.

Auscultation.—The respiratory sounds will be variously modified by the size of the tumor and its relations to the pulmonary tissue and bronchial tubes.

Weakness or entire absence of vesicular murmur is the more frequent change. It is due principally to bronchial obstruction, but in some cases is caused by direct compression of the pulmonary tissue. In the former case the change may be observed over a considerable area, or even an entire lung, but in the latter it will be more localized.

In an almost equal number of cases the respiratory sounds are loud and harsh, or even distinctly tubular. These changes are found only over the seat of the disease, and depend upon partial compression and closure of the alveoli.

A venous hum, heard best at the root of the neck, and more common in children, is usually present when there is decided compression of the descending venous trunks.

DIAGNOSIS.—It is evident from the foregoing description that, in the earlier stages at least, a positive diagnosis is impossible. In no two cases will the symptoms or their order of development be alike.

They indicate only some form of intrathoracic growth, and may all be present with mediastinal tumors or thoracic aneurism.

Mediastinal tumors are more frequently primary, those of the bronchial glands secondary.

Malignant growths are more common in the mediastinum, while inflammatory processes and tubercular deposits more frequently affect the bronchial glands.

With mediastinal growths, especially of the anterior mediastinum, disturbances of circulation usually precede those of respiration, the contrary being the rule in disease of the bronchial glands.

Although both show a tendency to extend inward, mediastinal tumors are much more frequently attended by enlargement and bulging of the chest-wall.

Distinct physical signs can usually be obtained earlier in mediastinal than in glandular disease.

In thoracic aneurism, also, the early symptoms are those connected with the circulation, while respiratory disturbances, both subjective and physical, are developed late. The arterial murmur, aneurismal bruit, with a thrill and heaving impulse on palpation, are valuable points of differentiation. In aneurism the area of dulness increases along the course of the artery or rises into the neck, while in bronchial gland enlargement it is more fixed, increases less laterally, and is more common behind than anteriorly. Diminution and delay of the radial pulse upon one side and cardiac hypertrophy are occasional symptoms of thoracic aneurism.

Erosion of the sternum, so frequent with aortic aneurism, does not result from disease of the bronchial glands.

PROGNOSIS.—The most important element in prognosis will always be the nature of the pathological process.

Malignant disease here, as elsewhere, terminates fatally, and tuberculosis will have a similar ending. Syphilitic growths, simple enlargements of scrofulous origin, and subacute inflammatory processes may often be arrested and a practical cure effected when the nature of the disease can be recognized early. In such cases the extent of the growth, the rapidity with which it is extending, and its relations to and effects upon adjacent tissues must form the basis of any prognosis. The more serious complications are those arising from implication of the laryngeal nerves and obstruction of the vessels. Glandular abscesses which open into bronchial tubes may be followed by recovery, but are more frequently fatal, either immediately or from prolonged suppuration and exhaustion.

TREATMENT.—The cases in which treatment has proven distinctly effective have been simple chronic enlargements of either scrofulous or syphilitic orgin. The iodides, with iron and cod-liver oil internally, and counter-irritation between the scapulæ, have been the most successful measures employed. The iron and iodine may be given separately or in combination. For syphilitic cases in which large doses of iodide are required the former method is to be preferred, but in scrofulous disease the sirup of the iodide of iron may be given with equally good results.

Cod-liver oil is always a valuable remedy, and especially so with children and in the lymphatic diathesis. Even cases of tuberculosis may be delayed and greatly benefited for a time by its use, and whatever the nature of the disease, the oil may be employed with success for its general nutritive value.

The persistent use of small (gr. $\frac{1}{60}$ to $\frac{1}{40}$) doses of the bichloride of mercury has occasionally benefited some cases even when no syphilitic element was present, and may be tried when the iodides are unavailing.

Counter-irritation over the seat of the disease is always of decided value. It may be obtained by the use of any of the more persistent counter-irritants, as the tincture of iodine, iodine liniment, blisters, or the actual cautery.

The special symptoms require palliative treatment.

The cough is seldom relieved by expectorants, and is best controlled by sedatives and antispasmodics. Codeine, morphine, and chloroform inhalations, in the spasmodic form, are the most certain in their effects, but the bromides, belladonna, Hoffman's anodyne or chlorodyne, are of value, and may suffice in some instances.

Pain is best relieved by anodyne lotions, and when severe, by hypodermics of morphine. For local applications, laudanum, belladonna, chloroform, or camphorated liniments may be employed.

Dyspnœa is more safely relieved by chloroform inhalations and the ethereal preparations than by opium or other narcotics.

The enforcement of general hygienic and tonic measures will greatly increase the efficacy of any form of treatment. *Charles E. Quimby.*

LUNGS, EMPHYSEMA OF THE.—For the first description of emphysema we are indebted to Laënnec. Two varieties are usually described—the *vesicular* and the *interlobular.* The former is by far the more frequent of the two and is always understood when the term emphysema is used. The essential feature of the vesicular variety is the dilatation of the air-sacs, while in the interlobular form there is an accumulation of air in the connective tissue between the lobules and in the walls of the air-sacs. Emphysema is almost invariably chronic and exceedingly slow in its progress ; but occasionally it seems to develop with considerable rapidity.

Pathology.—The seat of the disease depends somewhat upon its cause. Usually both lungs are involved, and preferably the upper lobes and the anterior borders. If it is compensatory and due to bronchial obstruction, the dilated air-sacs will be in the neighborhood of the obstruction. If from pleuritic adhesions, the anterior borders are most commonly involved, and if from forced inspiration, as in cases of whooping-cough, etc., the seat is usually the apex and anterior borders. It is rarely that all parts of both lungs are equally affected, but collapsed portions will be found surrounded by dilated air-sacs. The lung is usually lighter in color than normal, and the dilated air-sacs may be seen on the surface as small globular projections, varying in size from that of a pinhead to that of a pigeon's egg, or larger. It pits readily on pressure by the finger, and the depression disappears slowly or not at all, showing marked loss of elasticity. The lungs crepitate less on pressure, and sink less quickly in water than normal. They are increased in size and often meet in the median line in front, the left lung covering the superficial cardiac area, and pressing the heart downward and to the right. The inferior borders extend lower than normal, depressing the diaphragm and the underlying abdominal organs. On removing the anterior thoracic wall the lungs bulge forward, showing upon their surfaces the marks of the ribs and intercostal spaces. Sometimes they are small, owing to the collapse of a number of the air-sacs, which more than compensates for the extra space occupied by the dilated ones. If confined by pleuritic adhesions they may be prevented from overlapping in the median line. In senile emphysema the lungs are small on account of the atrophy which takes place in the tissues in old persons. In slight cases we find a moderate dilatation of the infundibula and of the air-sacs, with diminished prominence of the alveolar septa. The dilatation increases, the alveolar septa become atrophied, and the walls between the air-sacs thinner, and openings are formed between the different sacs of the same lobule and between the different lobules at the central portions where the walls are thinnest. Several sacs may coalesce, their intervening walls becoming atrophied and remaining as irregular bands or prominences on the walls of the enlarged cavity. In some cases the connective tissue is hypertrophied, so that the walls of the cavities appear thickened. Sometimes fatty granular matter is seen in the walls of the dilated air-sacs. Whether this is in the capillaries themselves or in the cells of the intervening tissue is uncertain. Probably it is in both. The circulation through the pulmonary capillaries is obstructed, and the capillaries themselves become atrophied and undergo absorption, while other capillaries in the neighborhood become dilated and partially compensate for the obstructed circulation. The obstruction to the passage of blood through the lungs is finally so marked that the pulmonary artery and the walls of the right cavities of the heart become dilated and hypertrophied, and undergo fatty and granular degeneration.

Regurgitation through the tricuspid orifice throws the blood back on the general circulation, producing hypertrophy of the left ventricle and secondary changes in the liver, kidneys, spleen, brain, and gastro-intestinal tract. Bronchitis, either as a cause or a complication, is almost invariably found associated with emphysema and gives pathological evidence of its presence.

In the interlobular variety the wall of an air-sac ruptures and air finds its way into the septum between the sacs and into the connective tissue between the lobules, and may extend along the bronchi into the mediastinum and thence find its way beneath the integument of the neck and trunk. It may also extend beneath the pleura, in which case the walls of the resulting cavities form prominences on the surface of the lungs. Interlobular emphysema is rarely present except as an accompaniment of the vesicular variety.

Causes.—Emphysema may be either primary or secondary ; that is, it may occur independently of any recognized change in the lungs, or it may be the result of organic lesions.

The majority of cases seem to be dependent on some change in the walls of the alveoli. In those cases in which the disease is inherited the alveoli are large and their walls thin ; and in the latter are found molecules of fat, or an increase in the amount of fibrous tissue. Of twenty-eight emphysematous persons examined with reference to heredity, eighteen had either a father or mother, or both, similarly affected, and of fifty non-emphysematous people three only sprang from emphysematous parents. Of fourteen persons emphysematous from childhood all came of emphysematous stock ; whereas, of fourteen first affected late in life two only were of emphysematous parentage. Such facts render it extremely probable that heredity has a strong bearing in the causation of emphysema.

Sometimes distention and rupture of the alveoli have followed forced expiratory efforts, as in violent coughing or laughing, parturition, etc. In rare instances it is produced by strong inspiratory efforts. But in these cases it is probable that there already exist some degeneration and weakening of the alveolar walls.

Often emphysema is the result of some organic disease of the lungs, or of pressure upon the bronchi by aneurism, tumors, etc. In the great majority of cases bronchitis not only accompanies, but precedes the emphysema, and seems to bear some causative relation to it, but precisely in what manner cannot be defined with certainty. Laënnec supposed it to be due to obstruction of the bronchi by plugs of mucus. He believed the inspiratory to be more forcible than the expiratory act, and that during inspiration the air entered through partially obstructed bronchi and the force of expiration was too feeble to force it back again past the obstruction. Thus the air was imprisoned within the air-cells and swollen bronchi, and dilatation took place, partly by the force exerted by expiration and partly by expansion of the enclosed air by heat. This theory, however, is untenable, as we know that the force of expiration is one-third more powerful than the force of inspiration. Dr. Gairdner, of Glasgow, gives another explanation. He also attributes the emphysema to obstruction of the bronchi by means of plugs of mucus, which lead to collapse, not to dilatation of the air-sacs connected with the obstructed tubes. In expiration the plugs may be forced from the smaller into the larger tubes, where there is less obstruction. But in inspiration they will be forced back again and thus the free entrance of air into the sacs will be interfered with, while its exit may readily take place. Again, expiration being more forcible than inspiration, air may be forced past obstructions in expiration which it cannot pass in inspiration. In this way collapse of the air-sacs connected with the obstructed tubes occurs, more air passes into the neighboring sacs connected with unobstructed bronchi, and dilatation takes place. In other words, the emphysema in the vicinity of the collapsed lobules is compensatory. In support of this view it is said that the tubes connected with emphysematous portions of the lung are usually unobstructed, and that careful examination will show the presence of collapsed air-sacs. Any cause preventing expansion of a portion of the lung may produce compensatory emphysema in an-

other part. Examples of such causes are : Pneumonia, hypostatic congestion, pressure upon a bronchus, and pleurisy.

Interlobular emphysema is produced by forced expiration, as in violent coughing, straining at stool, parturition, etc., and is usually preceded by the vesicular variety. It may also occur with wounds of the lung from external violence.

SYMPTOMS.—The one important symptom of emphysema is dyspnœa. At first the dyspnœa is not marked, and the patient may not be conscious of it except on violent exertion, such as running up stairs, jumping, or singing. It increases so gradually that such persons will often assert that it is only occasional, and that usually their respiration is perfectly free. The dyspnœa goes on increasing gradually, and there may be exacerbations from time to time, due to temporary bronchial spasm, an overloaded condition of the gastro-intestinal tract or of the portal system, or from accompanying bronchitis. Several causes aid in producing the dyspnœa. The obliteration of some of the capillaries diminishes the surface over which the blood is exposed to the influence of the air, and so requires increased frequency of respiration to enable it to become sufficiently oxygenized. The depression of the diaphragm by the enlarged lungs requires increased exertion to accomplish the act of inspiration, which is another element in producing the dyspnœa. Of most importance, however, is the loss of elasticity in the lung-tissue itself, which causes the air to be expelled slowly and with difficulty during expiration, and, by not displacing the foul air and supplying fresh oxygen, tends still further to embarrass respiration. Whether the disease be congenital or acquired, the increase in the dyspnœa is usually gradual, although occasionally it occurs quite rapidly. It is usually proportional in amount to the duration of the disease, and is rarely paroxysmal until it has considerably advanced. After a time the asthmatic paroxysms become distressing and frequent. Cough is commonly present, but is due to an accompanying bronchitis, and is not a symptom dependent upon the emphysema *per se*. Pain is not present, as a rule, but a feeling of uneasiness and aching oppression in the chest is felt, being due to want of air. Fever may be present on account of the bronchitis, but emphysema by itself does not occasion rise of temperature—in fact, the temperature may be below normal. The pulse is weak and not increased, but usually diminished, in frequency. Between the slight dyspnœa of beginning emphysema and the distressing symptoms of advanced cases, the contrast is great. As the disease progresses the cough is more distressing, and is apt to be paroxysmal. The paroxysms may last a considerable time, the patient only ceasing from coughing to catch his breath ; the breathing becomes labored, the face is flushed or livid, the veins of the face and neck are swollen, and the whole body is covered with perspiration from his exertions. The paroxysms increase in frequency, and less relief is obtained in the intervening periods. The dyspnœa remains marked at all times, the extremities are cold, and the face has a bloated, dusky, anxious appearance which is somewhat characteristic. The pulse is feeble, and may be irregular. The interference with the circulation through the pulmonary capillaries increases, and the right heart becomes dilated and hypertrophied.

The venous system throughout the body is gorged with blood. Hyperæmia and subsequent organic changes occur in the liver, spleen, kidneys, and gastro-intestinal tract. The urine contains albumen. Dyspepsia is present, due to a catarrhal condition of the stomach and intestines. Ascites and an accumulation of fluid in the pleural cavity occur and increase the dyspnœa. The legs become œdematous, blue, and cold, and the skin breaks in places, allowing the serum to exude. Emphysema in the majority of cases is essentially chronic, and is chiefly dangerous to life, through its complications. Aside from its danger to life, it naturally interferes with the active pursuit of business or of pleasure. In exceptional cases the patient remains about the same for a considerable time, or may even experience a slight improvement, but in most instances there is a slow and steady advance. The prognosis will depend upon the progress already made and upon the presence of complications. The presence or absence of dilatation, hypertrophy, and valvular disease of the right or left heart, of nephritis, of hepatic and gastro-intestinal disturbances, must be considered. Death not infrequently results from some intercurrent disease, as pneumonia, cerebral hæmorrhage, or paralysis of the heart.

Physical Signs.—Inspection shows bulging of the upper portion of the chest beneath the clavicles, and of the upper part of the sternum. This bulging, when marked, gives the chest a rounded or "barrel-shaped" appearance. The bulging is rarely uniform over the whole chest. The clavicles are raised and brought forward, and the chest, even at the end of expiration, has somewhat the appearance that it usually presents at the end of full inspiration. Sometimes, in old persons, the lungs are atrophied instead of being enlarged, and the bulging is then absent. During inspiration the movement of expansion is reduced to a minimum, and the lower part of the chest may even be drawn inward. Expiration is much prolonged, exceeding inspiration in length. By palpation, vocal fremitus may be increased, diminished, or unchanged. The apex-beat of the heart may not be felt, or it may be displaced downward and to the right. The percussion note is increased in intensity. Usually the pitch is lowered. Occasionally the pitch is raised, especially when the emphysema is accompanied with extreme distention of the thoracic walls. The quality is less pulmonary, and approaches the tympanitic ; it has been called vesico-tympanitic resonance. This resonance may extend over the pericardial region. Little variation is observed in the percussion note between the extremes of inspiration and of expiration. On auscultation the vesicular element of the respiration is feeble or suppressed. Inspiration is shortened. Expiration is longer than inspiration, often being in the ratio of four to one, instead of one to four. This is not invariably the case, and in some advanced cases expiration and inspiration are of equal length. The bronchial element of the respiration may be feeble, or absent, or increased, producing harsh respiration. It may be harsh in inspiration and absent in expiration. Bronchitis and dry pleurisy are frequently present and yield their appropriate signs, the râles in such cases being due to these diseases and not to the emphysema itself. Emphysematous lungs lying between the heart and the chest-walls will enfeeble the heart-sounds over the aortic and mitral areas. The pulmonary second sound is accentuated. A dry, crackling sound, resembling the crepitant râle, is heard in rare instances, together with a grazing frictional sound, and is said to be a sign of interlobular emphysema when the collections of air are sub-pleural and form projections on the pleural surface.

TREATMENT.—The treatment may be considered under two heads: first, by drugs; and second, the treatment by other means. If emphysema is the result of faulty nutrition, as is supposed, iron would naturally be indicated in most cases. The tincture of the chloride may be prescribed, or some of the milder preparations, as the albuminate. It should be given for a time, and then, after an interval, be again given. The mineral acids, bitter vegetable infusions, etc., are appropriate in certain cases. The treatment is chiefly palliative, and although in some temporary improvement may follow, a cure need not be expected. The drug which seems to be especially beneficial is the iodide of potassium. This, in doses of from five to fifteen or twenty grains, three times a day, either alone or in combination with arsenious acid, from one-thirtieth to one-twentieth of a grain, will usually give some relief to the dyspnœa. Quebracho is useful for the shortness of breath, and may be given in the form of the fluid extract in doses of from ten to forty minims. Relief may be obtained from the burning of pastils of belladonna, eucalyptus, etc., or by nitre or various other papers. The asthmatic attacks are sometimes relieved by one drug, and sometimes by another, and after a time we can usually find the one that suits each particular case best. Morphine and atropine combined, either by the

mouth, or better still hypodermatically, will usually afford relief. The inhalation of compressed air is extolled by some. The best arrangement is a closed chamber into which the air is pumped, until a pressure of one and a half to two atmospheres is reached. This, however, is expensive, and is not always available. Compressed air may be used without the patient himself being immersed in it, and can now be obtained readily in all large cities, or pure oxygen may be tried. The object is to supply more oxygen to the blood and so relieve the breathing, and at the same time equalize the amount of blood in the venous and the arterial systems. The appetite is thereby usually increased. Attention to hygiene is often of more importance than the use of drugs. Regularity in habits and moderation in eating should be practised. Indulgence in rich or indigestible food should be avoided, and at the same time the diet should be nutritious. Violent efforts of all kinds, as running, laughing immoderately, or singing, should be guarded against. Moderate exercise should be taken, and a good deal of time spent in the open air. Change from a cold to a warmer climate is often beneficial, but no rules applicable to the majority of cases can be laid down. After trying a number of localities, each case will usually find some one place especially beneficial, but another person suffering from the same disease will not be equally benefited, and may be positively injured by residence in the same locality. When a place is found where the dyspnœa is diminished, and relief obtained from the asthmatic attacks, the patient should spend most of his time there. Attention should be paid to the complications which so frequently accompany emphysema. Bronchitis calls for appropriate remedies. Iodide of potassium is especially beneficial in such cases. The treatment of complicating diseases of the heart, liver, kidneys, and gastro-intestinal tract is of importance, but will be more appropriately considered under the diseases of the respective organs. *Donald M. Cammann.*

LUNGS, HYPERÆMIA OF THE. Hyperæmia, or congestion, means an increase of blood in the part. It may be either active or passive. In the former there is an increase in the amount of blood sent to the part; the blood is arterial. This is the condition found at the beginning of all acute inflammations. Passive hyperæmia is due to an interference with the return of blood from the part.

PATHOLOGY.—The lung contains more blood and less air than normal, is heavier, and does not pit readily on pressure. The blood-vessels in the bronchi and walls of the air-sacs stand out prominently. On section a frothy, sanguinolent fluid exudes from the bronchi. The lung is of a dark-red color, and in chronic cases dark-bluish, red, or black. The walls of the sacs, and the epithelium and interstitial tissue of the lung are swollen. In some cases the vessels and the lung-tissue are so swollen, and the sacs and bronchi so filled with blood, that scarcely any appearance of cellular structure remains. A lung in this condition is said to be splenified, from the resemblance it bears to the spleen. In hypostatic congestion we find much the same condition. If the air-sacs cannot be completely emptied by pressure, and if small pieces of fibrine are found in their contents, giving the section an indistinct mottled appearance, we have what is called hypostatic pneumonia.

CAUSES.—There may be an undue amount of blood forced into the lungs by increased force of the heart's action, by undue attraction of blood toward the part, or by there being some obstruction to arterial flow elsewhere. There may be an obstruction to the outward flow of blood in the lungs themselves, by pressure from without, as in case of aneurism or thoracic tumor, or by the backward pressure of the blood-column from mitral obstruction or regurgitation. Sudden changes from cold to heat, the inhalation of irritating gases or vapors, the ingestion of cold drinks when the person is heated and perspiring, are causes of hyperæmia. In the continued fevers, and in all diseases long continued and wasting in character, there is a tendency to hypostatic congestion of the lungs, more especially at the posterior bases.

SYMPTOMS.—As most cases of hyperæmia are accompanied by more or less œdema, it is difficult to distinguish the symptoms of the two conditions. Between slight and extensive hyperæmia, the severity of the symptoms varies widely. In slight cases there is moderate dyspnœa, a flushed face, a strong pulse, a moderate amount of cough and expectoration. A sudden and nearly complete congestion of both lungs may cause sudden death, and be marked by extreme dyspnœa, distressing cough, and abundant expectoration of a semi-sanguinolent character. Between these two extremes the symptoms vary with the amount of the hyperæmia. If it comes on suddenly—even if no extensive area of the lung is involved—the dyspnœa may be marked, and the cough frequent and distressing. If it comes on gradually—even if the area invaded be large—the dyspnœa may be slight and perhaps scarcely noticeable, except on exertion. The expectoration is serous in character and stained with blood. In extreme cases all the symptoms attending diminished aëration of the blood are present—coldness and humidity of the lips and extremities, prostration, shallow and hurried breathing, a sense of anxiety, a feeble pulse. The temperature may be elevated. The physical signs are not well marked, and in slight cases one may gain little knowledge from them. The percussion note is raised in pitch over the seat of the congestion. On auscultation the vesicular element of the respiration is muffled and confused. The bronchial element of the respiration is either feeble or harsh. Fine or coarse râles are sometimes heard, and may be due to an accompanying pleurisy, or may be produced by fluid in the larger bronchi.

An acute hyperæmia of the lungs may prove fatal within a few hours, but the usual duration is from two to four or five days, and the termination may be by resolution or occasionally by pulmonary hæmorrhage, or it may pass into an inflammatory condition. The passive form, associated with heart lesions or continued wasting disease, usually comes on slowly, and is subject to periods of improvement under treatment. These cases are liable to sudden attacks of œdema which are apt to end fatally. The presence of marked dyspnœa and watery, blood-stained expectoration, with the absence of chill, of pneumonic sputa, and of marked elevation of temperature, will usually be sufficient to distinguish hyperæmia from pneumonia.

TREATMENT.—If the hyperæmia be extensive and threaten life, active measures should be at once employed. Cupping should be practised over the seat of the hyperæmia or over the whole chest, for the purpose of diminishing the supply of blood in the lungs. Dry cups are to be applied if the patient is feeble and gives evidence of exhaustion, but wet cups may be used for plethoric patients. Hydragogue cathartics are beneficial. The dyspnœa and feeling of anxiety may be relieved by steam inhalations and the application of mustard to the extremities. A hot-air bath relieves the overloaded pulmonary vessels, and often gives relief from distressing symptoms. If the congestion is caused by feeble action of the heart, appropriate remedies, as digitalis, aromatic spirits of ammonia, alcohol, or ether, should be administered. Hypostatic congestion accompanying exhausting disease should be relieved by stimulants and proper dietetic management. Change of position from the back to either side, or even to the prone position, is an important part of the treatment in such cases, and should not be neglected.

Donald M. Cammann.

LUNGS, INFLAMMATIONS OF THE. There are five different varieties of inflammation of the parenchyma of the lungs, viz.:

1. *Croupous* or *lobar pneumonia*, in which the air-vesicles go through a process similar to that of laryngeal croup.
2. *Catarrhal* or *lobular pneumonia*, which is a catarrhal affection of the air-cells identical with a pre-existing one of the contiguous bronchioles.
3. *Interstitial pneumonia*, which is a chronic affection of the vesicular epithelium and intercellular and interlobular connective tissue.

4. *Hypostatic pneumonia*, in which passive engorgement is liable to result in an inflammatory process.

5. *Embolic pneumonia*, in which an embolus produces a pulmonary hæmorrhagic infarction, or metastatic abscess.

1. CROUPOUS PNEUMONIA. — *Etiology.*—Most writers have regarded age as a prominent factor in the causation of this affection, and suppose early childhood and old age to be measurably exempt. The female sex is likewise supposed to be similarly favored, but no rational explanation has been given for any such essential partiality. When we consider that females of all ages and males in the two extremes of life are less exposed to the exciting causes than adolescent and middle-aged males, it is easy to understand why the latter should furnish more than their numerical ratio of subjects. Intemperance, privations, hardships, and previous ill-health are predisposing causes to this disease, by diminishing the natural powers of resistance. Those leading out-door lives enjoy a high, though not absolute, degree of immunity, as exemplified by the contrast between soldiers in the field and in barracks; while inmates of prisons, convents, and manufacturing establishments furnish more than their share of cases. The explanation is, that constant exposure under favorable hygienic conditions increases resistance to cold, while housing in a warm atmosphere, particularly if impure, lowers the tone of health and causes greater susceptibility to sudden changes of temperature, which cannot altogether be avoided. Statistics show that the British army furnishes fewer cases now than formerly, and that enlisted men have always been more liable than officers. This is explicable from the facts that the men are better clothed and are under better hygienic conditions now than they formerly were, and that officers have always enjoyed advantages in these respects over the men.

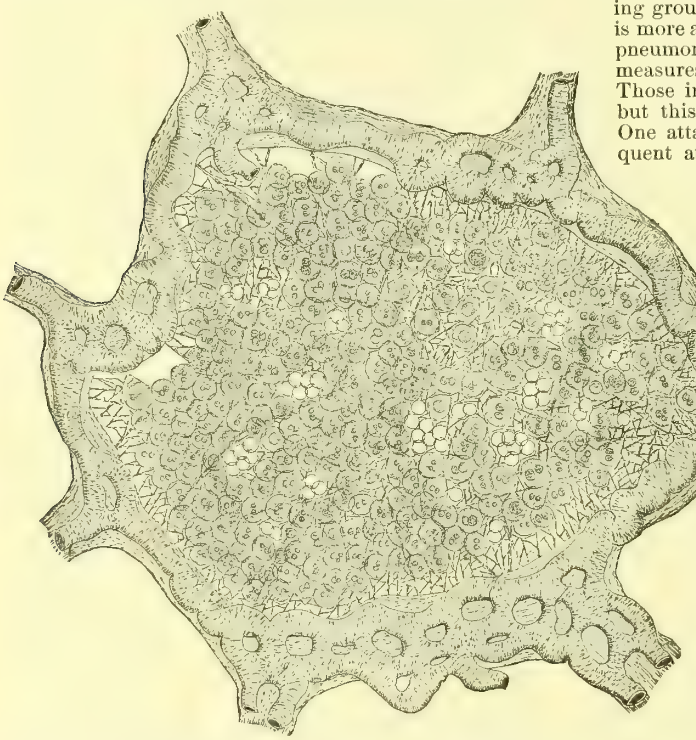

FIG. 2184.—Lobar Pneumonia—Red Hepatization. (× 850 and reduced.) A single air-vesicle with its blood-vessels artificially injected. (From Delafield and Prudden's "Handbook of Path. Anatomy and Histology.")

Among the exciting causes, exposure to great and sudden changes of temperature is justly to be regarded as the most productive, though this is by some disallowed. It is true that pneumonia prevails in warm climes, but it is indisputable that it occurs chiefly in the cold months of the year, and at other times it is usually an accompaniment of "taking cold." A great variety of traumatic affections of the chest are exciting causes, such as penetrating wounds, falls, blows, inhalation of hot and irritating vapors, gases, etc. Malaria must be regarded as occasionally an original cause, and in miasmatic localities it is an almost constant complicating agent of the state of engorgement. Indeed, some writers have gravely asserted that pneumonia is essentially a malarial disease, from its sudden access with a rigor followed by fever of a paroxysmal type, as is found where paludal fevers prevail.

The fact that pneumonia sometimes apparently assumes an epidemic character and pursues a more definite course than most inflammatory affections led the German pathologists, more than ten years ago, to the conclusion that it is a general rather than a local disease, and that it is infectious in its nature. This view has been adopted by many American writers, and the doctrine is gaining ground. It is admitted that croupous pneumonia is more amenable to treatment than the other forms of pneumonia, and that it may be aborted by energetic measures (v. Jürgensen in "Ziemssen's Cyclopædia"). Those in vigorous health are less liable than others, but this is not true generally of infectious diseases. One attack rather predisposes an individual to subsequent attacks than protects him. It is true that the tendency, without interference, is toward resolution, except in malarial complication, but regularity of course cannot be maintained of a process which may terminate spontaneously in three days or may extend over a period four times as long.

In 1882 Griffini and Cambria found bacteria in the blood and sputa of persons affected with croupous pneumonia. A liquid containing the bacteria was injected subcutaneously into dogs and rabbits, which soon died of septicæmia without pulmonary lesions. Their conclusion was, that the bacteria were not the cause of pneumonia. In 1883 Ziehl, Friedländer, and Frobenius found micrococci in the sputa of patients suffering from pneumonia, even before they became rust-colored. This micrococcus is described by Friedländer as oval-shaped and enclosed in a capsule, which features he regards as characteristic. In 1884 Dr. Lambrosa found the ovoid micrococci of Friedländer in the lungs of a subject dead of catarrhal pneumonia associated with measles. In 1885 Paulowsky, of St. Petersburg, found on gelatine plates exposed to the open air microbes corresponding in appearance to Friedländer's M. pneumoniæ. Inoculations of these were made upon dogs, rats, guinea-pigs, and mice, which afterward presented appearances of pneumonia. Other experiments in inoculation of these microbes and their cultures have been made with various and contradictory results. Small doses of liquor ammoniæ, injected by means of a syringe into the trachea of healthy animals, have been followed by pneumonia, provided the animals survived a few days.

In 1885 Sternberg announced that the M. pneumoniæ of Friedländer is identical with micrococci constantly found in the saliva of many healthy individuals, especially those living in warm climates; and also identical with micrococci found by Pasteur in the blood of rabbits which had been inoculated with the saliva of a child dead of hydrophobia. This microbe he proposed to call M. Pasteuri. Sternberg made the discovery of this microbe in 1880, and the same year made repeated inoculations with the original microbe and its cultures upon rabbits, with generally fatal results within forty-eight hours. He found, however, that it was necessary to introduce the instrument into the pulmonary substance in order to pro-

duce fibrinous pneumonia, and this plan did not always succeed; while simple subcutaneous injections were followed by septicæmia without involving the lungs. In either case the microbes were found afterward abundantly in the blood.

In 1886 Sternberg acknowledges a specific distinction between Friedländer's M. pneumoniæ and his own M. Pasteuri, but holds that both occur in the blood and pulmonary exudations of croupous pneumonia. A notable pathogenic distinction is the fact that M. Pasteuri kills rabbits, while Friedländer's does not. Sternberg avers that M. Pasteuri, which is found in the saliva of healthy persons in various parts of the world, occurs in the exudate of croupous pneumonia with greater uniformity than does Friedländer's micrococcus; and believes that Talamon and Salvioli, in their published experiments, used the former rather than the latter.

Fränkel has found that M. pneumoniæ does not disappear from the sputa on subsidence of the disease, but remains for some weeks, though with diminished virulence.

Thost, of Hamburg (quoted by Sternberg in 1886), has discovered Friedländer's micrococcus abundantly in the nasal mucus of ozæna, and has proved by cultures and inoculations that it is fatal to mice, but not to rabbits.

The latest announcement (August, 1886) is, that Professor Weichselbaum, of Vienna, has discovered four kinds of microbes in pneumonic lungs, which he names respectively Diplococcus P., Streptococcus P., Staphylococcus aureus albus, and Bacillus P.

In the judgment of the present writer, it seems probable that various microbes habitually occur in the sputa of croupous pneumonia, but very improbable that any of them is either the remote or exciting cause of the malady. It is reasonable that diseased lungs and their exudations should prove to be a favorable soil for the growth of micro-organisms, but unlikely that the organisms constantly present in the saliva of healthy individuals should become pathogenic when accidentally inhaled into the sound lungs of others. A necessary condition of the inoculation which shall produce pneumonia is that the instrument be thrust into the lung-structure, while we know that various injuries to the chest are followed quickly by the same result. On the old supposition that pneumonia is a local inflammation, it is not strange that an extensive inflammatory process should follow the slight puncture of a needle into lung-substance, when it carries a poison which produces fatal septicæmia by inoculation into the cellular tissue.

Morbid Anatomy.—The inflammatory process of croupous pneumonia rarely involves less than an entire pulmonary lobe, often more, and sometimes both lungs. It usually begins in the lowest lobe and progresses upward; but in old and cachectic subjects the attack often begins at the apex.

Three separate stages of the disease are recognized: 1. That of engorgement; 2, that of red hepatization (Fig. 2184); 3, that of gray hepatization, sometimes called purulent infiltration. In the first stage the lung has become somewhat heavier, but still floats on water. It has lost elasticity, crackles but little on pressure, and on section a reddish tenacious liquid exudes from the air-cells. In the second stage no air remains in the alveoli, which are filled with plugs of coagulated fibrine, mingled with blood and extending into the bronchioles. The cut surface presents a granulated appearance. The substance is now heavier than water, friable, and strongly resembles the liver in color, specific gravity, and resistance to pressure. In the third stage the hæmatin has disappeared from the effusion, and the substance is gray, though still granular, solid, and heavier than water.

When resolution takes place in the second or third stage, the exudation undergoes fatty metamorphosis and is dissolved in a serous effusion. The solution is partly removed by expectoration, but mostly absorbed. In the third stage there may be little or no purulent infiltration, or it may run into abscess instead of resolution. It is not to be presumed that all cases take this regular course. Indeed, separate tracts have been found *post mortem* in the same subject exhibiting the three different stages; and careful physical examination sometimes shows considerable intervals in the extension of the disease to separate lobes of the same lung and to the other lung. The lung-substance contiguous to the hepatized tracts often becomes congested and œdematous.

FIG. 2185.—Acute Lobar Pneumonia, with the Production of Organized Tissue in the Air-spaces. (× 130 and reduced.) Section of a number of air-vesicles containing organized tissue. (Delafield and Prudden.)

In case sufficient serum to dissolve the previous exudation is not effused, it can neither be absorbed nor removed by expectoration; in other words, no resolution takes place, but the alveoli remain filled with a cheesy substance. In some cases *post-mortem* clots are found in the right heart, extending into the veins. These result from pulmonary obstruction reflected backward through and beyond the heart.

In a large proportion of cases the pleura shares the inflammatory process, which is followed with more or less effusion. This complication is apt to leave its common legacy of adhesions between the costal and pulmonic surfaces of the pleura.

Symptoms and Course.—Croupous pneumonia is usually ushered in with a distinct rigor, lasting from half an hour to several hours, and more marked than in any other disease, save malarial and yellow fevers and septicæmia. Convulsions sometimes occur in young children at the onset. The body-temperature rises to 103° or higher within twenty-four hours, with corresponding acceleration of pulse, and respiration hurried out of its usual ratio of one to four pulsations, so that the ratio sometimes becomes one to two. The face is flushed; there is severe pain in the chest, back, and limbs; an abundant white

fur appears upon the tongue ; the appetite disappears ; great muscular prostration ensues ; a tendency to cough is restrained, on account of pain in the inflamed chest. The sputa are not abundant, but so viscid as to adhere to an inverted vessel.

In the second stage the sputa become rust-colored from extravasation of blood, which is thoroughly diffused. The fever increases, and is attended with an evening exacerbation of $\frac{1}{2}°$ to 2° F. The pulse, which was full and strong in the first stage, in severe cases is still more accelerated and loses force and volume, from obstruction in the lungs, in consequence of which a scanty supply of blood reaches the left heart. Thirst often becomes urgent ; the bowels are constipated ; the renal secretion is scanty, with increase of urea and decrease or disappearance of the chlorides, and sometimes appearance of albumen.

Under ordinary management, and even without medication, the fever usually terminates by crisis from the third to the seventh day, and the other symptoms rapidly subside, while resolution takes place. In some cases, instead of resolution by crisis within a week, the fibrinous exudation extends, fever and other symptoms continue, extreme prostration ensues, with delirium or stupor, and involuntary evacuation of urine and fæces. When purulent infiltration takes place in the third stage there is no crisis, and resolution is delayed, with a general condition similar to that just described.

In aged subjects, or those in previous bad condition, adynamic symptoms are found in place of the regular course of the malady, with absence of pain, cough, and sputa ; and a diagnosis of "catarrhal" or "gastric" fever may be made, unless a careful physical examination be undertaken. Without such exploration pneumonia may be mistaken for delirium tremens in drunkards, who present the rational symptoms of the latter disease, lacking those of the former.

Rapid sinking and death may result from pulmonary congestion or œdema in the first or second stage, and autopsy will reveal the right heart filled with clots extending backward into the veins. More rarely engorgement of the cerebral sinuses and veins causes coma and speedy dissolution. Purulent infiltration is indicated by slight rigors ; while violent rigors indicate the formation of abscess, confirmed later by profuse purulent expectoration, appearance of yellow elastic fibres under the microscope, and cavernous respiration. Gangrene is manifested by dark and horribly fetid sputa and the physical signs of a cavity.

In malarious regions periodic exacerbations are often strongly marked, and the majority of cases show the influence of the peculiar miasm. At regular intervals the fever, pain, dyspnœa, and cough are aggravated and in turn mitigated with the regularity of intermittent fever. In such cases spontaneous resolution must not be expected.

Physical Signs.—Ocular inspection shows diminished respiratory movement on the ailing side. Palpation manifests increased vocal fremitus in the affected tract. Both these symptoms become more marked in the course of the malady, and disappear as resolution progresses. The percussion sounds in the first stage are almost normal, but become dull and flat as consolidation progresses, and regain their normal character as resolution advances. Pleuritic effusion gives a more flat percussion sound than the consolidation of pneumonia, but always in the dependent portion of the chest, and consequently the point of greatest dulness varies with the position of the patient. The flat sound remains after resolution of the pneumonia has taken place.

Auscultation in the first stage discloses the crepitant râle, which is the best diagnostic sign of croupous pneumonia. This is compared to the crackling of salt thrown on the fire, but more closely resembles the sound of a lock of hair rubbed between thumb and finger close to the ear. In the first stage the air-vesicles are partially filled with the same viscid exudation which characterizes the sputa, and the crepitation, heard only in inspiration, is produced by the opening of the alveolar walls, which are agglutinated together in expiration. In the second stage this disappears, as the vesicles become filled up with the exudation, and loud bronchial or tubular breathing succeeds. When resolution takes place, the crepitant râle reappears and is soon followed by the subcrepitant râle, a moist to-and-fro sound. In pleuritic complications the to-and-fro friction-sound may generally be distinguished, until it is drowned in the effusion.

Diagnosis.—In the very young and old, and in subjects weakened by intemperance or previous bad health, the symptoms of croupous pneumonia are obscure. Young children may have convulsions at the outset ; they do not expectorate and cannot locate pain. In all these cases careful physical examination is needed. From pneumonia simple pleurisy is distinguished by the friction-sound, absence of initial rigor, sharper pain, less cough and fever, jerky and less rapid respiration, absence of vocal fremitus, and the anxious countenance—all of which belong to pleurisy.

Prognosis.—This depends greatly on the extent of lung-substance involved, double pneumonia being especially dangerous ; on the body-temperature ; on age, its gravity being greatly increased in old age ; on habits with alcoholic liquors ; on previous health. Complications with pulmonary tuberculosis, Bright's disease, and inflammatory cardiac affections are especially grave. Absence of sputa at the beginning and very dark sputa are unfavorable. An excessive amount of liquid or frothy expectoration indicates pulmonary œdema ; while a gurgling sound in the chest, with absence of expectoration, threatens speedy death from œdema and suffocation. Delirium at an early stage is attributable to high temperature, and is not especially dangerous ; in a later stage it signifies exhaustion. Stupor, subsultus, and paralysis are highly dangerous symptoms. Purulent infiltration in the third stage is unfavorable ; abscesses and gangrene are grave symptoms. The condition of pregnancy is unfavorable to recovery, and apart from this the fatality of adult cases is greater in the female sex.

Treatment.—Venesection and tartarized antimony were formerly in general use in the earlier stage of croupous pneumonia, but are now nearly obsolete. In pulmonary œdema venesection or free cupping with scarifications certainly affords relief to dyspnœa, and should not be neglected. In the active febrile stage, veratrum viride and aconite still have advocates, especially the former among country practitioners in the Southern and Western States of the Union. At the present time American physicians are partial to the free use of quinine, (℈j. to ℈ij. in twenty-four hours), believing that it has a controlling effect on the fever ; but they do not claim that it abridges the natural course of the disease. The same may be said of the German practice of using cold water externally by compresses to the chest, frequently repeated, or the wet pack. In malarious localities the paludal miasm habitually operates to complicate pneumonia, and must be met by the free use of quinine until periodicity of symptoms is arrested, and smaller doses should then be continued two or three times daily.

Blisters are mentioned by most systematic writers on medical practice only to condemn them in an early stage, and tolerate them after consolidation has taken place. The present writer's experience for more than twenty years has been totally at variance with such teaching, but it is confirmed by the practice of many private physicians, most of whom seem to have adopted it on their own motion. There are many other inflammatory affections, which high authorities have directed to be treated by early blistering, among which may be named boils, whitlows and carbuncles, congestion of the brain, ophthalmia and deeper inflammations of the eye, phlebitis in general and phlegmasia dolens in particular, acute dysentery, acute rheumatism. Why pneumonia and pleurisy should have been made exceptions to the revulsive or derivative effect of blisters in inflammatory affections has not been satisfactorily explained. The writer's practice is to apply the blister in any stage ; but, in his opinion, the earlier this can be done the better. The relief of the pain, fever, and cough immediately follows the action of the fly-blister ; and, if this can be ap-

plied within six hours after the rigor, the sub-crepitant râle may confidently be expected in place of the crepitant within twenty-four hours more. If the blister can be applied within twenty-four hours of the rigor, there will be no consolidation; in other words, the disease will be arrested in the first stage, and convalescence will begin at once.

The plaster should be large enough to cover the affected tract, and be placed directly over it. Its effect should be closely observed, and it should be removed as soon as the slightest appearance of vesication is noticed. With young children it is sufficient to redden the skin thoroughly, which will sometimes occur in half an hour. Carbolized zinc ointment is a good dressing, under which vesication is completed. The cuticle should never be torn from the skin. The relief to the pain and cough is so prompt and decisive that the blister is not complained of, unless allowed to become unnecessarily severe.

In ordinary cases, if the blister can be used within a few hours of the rigor, no internal medication will be needed, save such tonics as may be appropriate to convalescence. In neglected cases, already in the second or third stage, with high temperature (above 103°), it would be proper to resort to antipyrin. Sponging with cold water would not be objectionable, if agreeable to the patient; but a chilly sensation would be sufficient warning to desist.

Early blistering is equally applicable to pleuro-pneumonia, and in case of effusion repeated blisters greatly favor absorption of the serum.

The old plan of starvation survived venesection, but has become historical. Patients are now properly encouraged to take such food, and in such quantities, as they can assimilate. The aged and feeble need alcohol in some acceptable form from the beginning, and all cases neglected in the early stage are benefited by it, taken preferably with food, at short intervals and considerably diluted.

2. Catarrhal Pneumonia.—*Etiology.*—This is rarely or never a primary affection, but an extension of the inflammatory process from the mucous surface of the bronchioles to the alveoli. In most cases it follows measles, whooping-cough, or diphtheria, and is, therefore, much more common in childhood than in later life, but may follow influenza at any age. The condition of pulmonary collapse resulting from whooping-cough very naturally runs into catarrhal pneumonia, as also does the capillary bronchitis associated with measles.

Morbid Anatomy.—Unlike croupous pneumonia, in this malady a whole lobe is rarely involved, but circumscribed tracts of both lungs are affected, most frequently along the spine and in front of the chest. The cut surface of a nodule is smooth rather than granular, and yields a reddish or grayish fluid. There are three stages, corresponding to those of croupous pneumonia. That of gray hepatization terminates in resolution, purulent infiltration, or cheesy degeneration. The last condition is quite apt to result in pulmonary phthisis. The morbid process in this form of pneumonia is less regular than in the croupous form, and lobules may be found in the same lung in the three different stages. In the first stage the effusion is less fibrinous than in croupous pneumonia, and the sputa are less tenacious. In the second the alveoli are filled with an exudation composed chiefly of changed epithelial cells, with fewer lymphoid cells and blood-globules, than in croupous pneumonia, and with no fibrin. In proportion to the abundance of cell-deposits we find indisposition to resolution with tendency to fatty or cheesy transformation and to a chronic or permanent character of the disease. In this condition hyperplasia of the connective-tissue ensues, with fibrous induration, constituting a complication with interstitial pneumonia. In previous collapse of a lobule, from obstruction of a bronchial tube, the capillaries of vesicles beyond are distended, and exudation into the empty vesicles is favored. Such obstruction is most liable to occur in the very young, the very old, and those too feeble to clear the bronchial tubes by coughing; also in those long confined to the supine position (hypostatic pneumonia). When superficial lobules are attacked, the contiguous pleura is involved, constituting pleuro-pneumonia.

Symptoms and Course.—This form of pneumonia is not generally ushered in by a rigor, and never by one of marked severity. The temperature rises rapidly to 102° or 104°, or sometimes even higher. The pulse and respiration are hurried, particularly the latter. The cough, which was previously bronchial and moist, becomes dryer and painful; the expectoration is scanty, not tenacious, and rarely becomes rusty. In acute cases in feeble children this disease may rapidly extend, so as to produce dyspnœa, cyanosis, stupor or convulsions, and exhaustion, with death in a few days. The subacute form is a frequent sequela of measles and whooping-cough, is often protracted, and may terminate in gradual resolution or exhaustion from fever and arrest of nutrition. Resolution is by lysis rather than crisis, or, this failing, the disease becomes chronic, no absorption of the effusion taking place.

Physical Signs.—When the affected tracts are small and deep-seated, auscultation and percussion disclose no signs. Otherwise a limited dulness may be observed on the anterior and posterior aspects, but rarely on the lateral, and generally of both lungs. In the early stage, in the quick inspiration of coughing or crying, the crepitant râle may sometimes be discovered; and, after consolidation has taken place, bronchial breathing is heard. In the few cases where a large tract is involved, the sounds can not be positively distinguished from those of croupous pneumonia.

Diagnosis.—Catarrhal pneumonia may be distinguished from pulmonary collapse and capillary bronchitis, of which it is the successor, by rapid rise of temperature and by a dryer and more restrained cough, on account of the pain of the act; from croupous pneumonia by the antecedent bronchitis, by the usual absence of rigors, by its existence in small tracts of both lungs, by its gradual subsidence; from acute tuberculosis by bronchitis preceding instead of succeeding the febrile symptoms.

Prognosis.—In general the prognosis in this form of pneumonia is much more unfavorable than in the preceding, the mortality being nearly fifty per cent.; but this is largely due to previous lowering of the vital powers. The danger is in direct ratio to the extent of lung-substance involved, and is greatest at the extremes of life. Much depends on natural vigor of constitution and previous health, as well as on the hygienic surroundings. As a sequela of measles it is less serious than it is after whooping-cough; and following scarlatina with a renal complication it is particularly grave.

Treatment.—When it is considered that this malady is consequent on one or more previous ones, whereby the natural powers have been already reduced, the impropriety of any lowering treatment is at once apparent. On the contrary, the best alimentation permitted by the febrile condition should be maintained, and in most cases some alcoholic preparation will be advantageous. Since collapse of lobules from catarrhal accumulations is the most frequent forerunner of this form of pneumonia, collapse should be prevented, in order to avert the inflammatory process. This can be effected by forced inflation of the lungs. It is recommended by Jürgensen in Ziemssen's "Cyclopædia," to pour a small stream of cold water upon the occipital region over the medulla oblongata, which induces violent respiratory efforts. This should be practised during the course of the bronchitis which precedes pulmonary collapse, whenever diminished respiratory action seems to threaten obstruction of the bronchioles. As further prophylactic measures, the air of the room should be charged with warm vapor, and an expectorant of senega with muriate of ammonia be exhibited. Oil of turpentine is believed to diminish the bronchial secretion, and a few drops, according to age of the patient, may be given every two or three hours. The best vehicle is milk. The same measures have been found effectual even after collapse of the lung had ensued and the inflammatory process had been established.

In case of urgent dyspnœa with abundant mucous râles, threatening extensive pulmonary œdema, rapid eme-

sis is called for, and the most efficient agent is apomorphine administered hypodermically. Two or three minims of a one per cent. solution would be a suitable dose for a young child, and it would be prudent to precede this by an alcoholic stimulant. As to blisters, the writer's opinion is that they are less efficient than in croupous pneumonia, but that their results are favorable. Still greater care is needed, so as not to produce unnecessarily severe effects upon the skin, owing to the previous enfeebled condition of the patient. Convalescence is apt to be tedious, and may often be hastened by change of air or removal to a more genial climate.

3. Interstitial Pneumonia.—By many writers this has been called chronic pneumonia, and by some regarded as only a stage of various pulmonary disorders.

Etiology.—It is never a primary affection, but is commonly secondary to croupous and catarrhal pneumonia, from failure of resolution. It may also result from hæmorrhagic infarctions and abscess of the lungs, and is sometimes associated with tubercular deposit. Chronic bronchitis may run into this disorder, especially that form which is contracted by coal-miners and artificers in various metals through inhalation of irritating dust and powders.

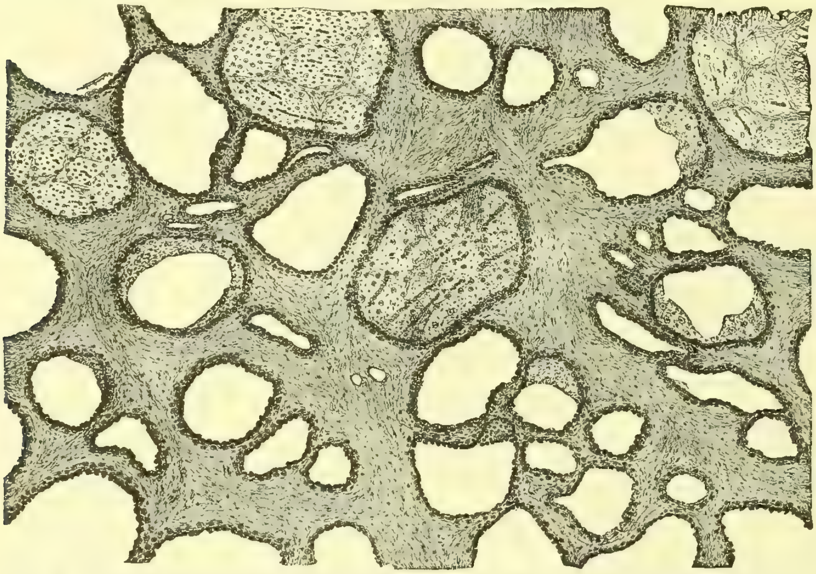

Fig. 2186.—Interstitial Pneumonia of Chronic Phthisis. (× 90, and reduced.) (Delafield and Prudden.)

Morbid Anatomy.—The changes consist in hyperæmia of the intercellular and interlobular tissue, proliferation of the epithelium of the air-cells and hyperplasia of the connective tissue. The result is a thickening of these structures, with occlusion of the alveoli and bronchioles of the affected tract, followed by contraction. At the same time the larger bronchial tubes undergo expansion, for reasons not well understood and variously explained. In cases resulting from inhalation of pulverized coal and metals, the lung-tissue is found discolored. When the contraction is extensive and permanent, the heart is pushed toward the affected tract; and, in proportion to the extent of obstruction, the right heart is dilated and hypertrophied.

Symptoms and Course.—As this is not an original malady, but consequent on one of several others, its features are not definite nor is its nature at first apparent from the signs actually present. When resolution fails to take place in croupous and catarrhal pneumonia, as shown by persistence of bronchial breathing and percussion-dulness, and want of vesicular breathing, this morbid process may be reasonably presumed.

There is no rise of temperature. Cough is a prominent feature, with profuse and sometimes fetid expectoration. Intervals of greater or less length take place between fits of coughing, during which the enlarged bronchial tubes become filled. If the accumulation is at the apex, little or no coughing is needed to expel it, but a violent and prolonged effort is needed to evacuate more distant collections. The decubitus is on the affected side, to afford relief to the dragging pain, cough, and dyspnœa. As contraction advances, retraction of the chest-walls takes place. In general we find want of appetite, loss of flesh and strength, anæmia, and sometimes night-sweats. Cyanosis and dropsy occur in prolonged and aggravated cases.

Physical Signs.—Simple inspection shows diminished respiratory expansion of the chest-walls, and subsequently retraction, with lessened capacity. Percussion shows greater dulness than is found in croupous and catarrhal pneumonia. Sometimes the "cracked pot" sound may be found over a large bronchial expansion. Auscultation reveals loud, bronchial breathing, sometimes cavernous, and total want of vesicular murmur in the tract involved. The cavernous sounds are heard after coughing and expectoration, previous to which there are moist râles, or gurgling sounds.

Diagnosis. — Interstitial pneumonia may be distinguished from pleurisy with effusion by the bulging of the intercostal spaces in the latter, and their retraction in the former. In pleurisy the percussion-sound is more flat and shifts its seat as the position of the patient is changed, being always flat at the most dependent spot. The exploring needle would demonstrate pleuritic effusion. The diagnosis from pleurisy with contraction of the chest-walls must be made by the history of the case; from pulmonary phthisis, by absence of fever and of the bacillus in the sputa, and by less diminution of appetite, flesh, and strength; from cancer, by absence of malignant growth elsewhere, for primary cancer of the lungs and pleura is rare, also by want of the peculiar cachectic expression of countenance and absence of glandular enlargement.

Prognosis. — This malady is rarely in itself fatal, but the consolidation is quite likely to remain permanent. The heart and kidneys are liable to become involved in trouble, on account of the pulmonary obstruction and disturbance, in which case the result is general dropsy and death from gradual exhaustion. Hæmorrhage or diarrhœa may also supervene, with a more speedily fatal result.

Treatment.—The indications are, to support the strength, favor expectoration, and limit effusion into the bronchiectasic cavities. The diet should be as generous as the digestive powers will admit, aided by suitable tonic remedies. Much may be expected from inhalations medicated with oil of turpentine, oil of eucalyptus, benzoic acid, boracic acid, tincture of iodine, or corrosive sublimate. For this purpose one to five drops of oil of turpentine or oil of eucalyptus may be dissolved in an ounce of water, with the aid of a little alcohol. Benzoic acid may be used in solution of ten to forty grains to the ounce of water, with four times as much phosphate of sodium. Tincture of benzoin may also be used, one-half to one drachm in an ounce of water. Boracic acid, ten to twenty grains in an ounce of water; corrosive sublimate, one grain to two ounces; or compound tincture of iodine, five to ten drops to the ounce, would be suitable for inhalation.

4. Hypostatic Pneumonia.—In this affection no inflammatory condition necessarily exists, but sometimes an infitration of the alveoli takes place, like that of catarrhal pneumonia, accompanied with febrile movement.

Etiology.—The necessary antecedents of a hypostatic

condition of the lungs are a lowering of the force of the heart and long continuance of the body in one position, and these are found in prolonged sickness or grave injury necessitating confinement to the horizontal position. Whenever a portion of the lung-space is thus disused, the antecedent causes become still more operative and the condition proportionally aggravated. Deformities of the chest, previous pleuritic adhesions, declining age and debility, and various cachectic conditions are predisposing causes.

Morbid Anatomy.—The appearances vary from simple engorgement, manifested by escape of a frothy liquid colored with blood from a section of the diseased lung, to complete solidification of a bluish or dark-brown color on the cut surface. The antecedent conditions are such that the back is almost invariably the most dependent portion of the body, and consequently both sides, posteriorly, are affected alike. Unless the engorgement is speedily overcome, the alveoli become filled with exudation of epithelial cells and extravasated blood, and the bronchi contain a purulent liquid colored with blood. By extension of the inflammatory process the pleura is involved, and effusion takes place into the pleural cavity.

Symptoms.—The first noticeable appearances are hurried respiration and pulse. Swelling of the superficial veins, cyanosis, and œdema of the extremities succeed, as the case becomes aggravated. There is sometimes cough, with muco-purulent expectoration. Elevation of temperature is not attributable to the hypostatic engorgement, but to the catarrhal pneumonia set up by the exudation into the alveoli, and this must be measured by its relative increase above the temperature in the antecedent disease, and not simply by its deviation from that of health.

Physical Signs.—At first there will be a diminution and later a suppression of the vesicular murmur over the affected tract. In some instances the crepitant râle of croupous pneumonia is heard. In a later stage loud bronchial breathing and pectoriloquy succeed, and the affected region extends its limits.

Diagnosis will be established by the antecedent history of the case rather than by signs actually present.

Prognosis.—When the infiltration of catarrhal pneumonia has not supervened, and recovery from the antecedent ailment has so far progressed as to allow change of posture, or the erect instead of the supine position, resolution may take place. All depends on the duration and severity of the injury or disease which first confined the patient to bed. The supervention of catarrhal pneumonia is an unfavorable event. According to the extent of lung-substance involved, there is danger of cardiac dilatation and hypertrophy.

Treatment.—The indications are : 1. To prevent hypostasis by frequent changes of posture, when practicable, precisely as we should aim to obviate bed-sores. 2. To sustain the heart's action, for which suitable food, supplemented by alcohol and digitalis, are the proper means. 3. To promote full respiratory efforts by voluntary deep inspirations, and by baths a little colder than the body. It is highly desirable for the patient to leave the bed as soon as the course of the antecedent complaint will allow.

5. Embolic Pneumonia.—Though the pathological conditions found in this malady were known by Laënnec, their connection with embolism was not then recognized, and the subject was treated under the head of pulmonary apoplexy. The following views are based upon the recent researches of German pathologists.

Etiology.—The determining cause of this form of pulmonary hypostasis is the migration of emboli through the pulmonary artery into some of its branches. These commonly originate in the right side of the heart, from obstruction due to valvular disease, by which the current is retarded and a roughened nucleus presented for the formation of a clot ; but they may arise in the systemic veins from various lesions which cause obstruction and produce coagula, such as open wounds, bed-sores, collapsed uterine sinuses of parturient women, etc. The embolus is arrested in some branch of the pulmonary artery, and the result is a hæmorrhagic infarction of such portion of lung-substance as is supplied by the obstructed arterial branch. In some instances, rupture of weakened pulmonary arterioles may contribute to the enlargement of the tract of consolidation.

When the embolus arises in the systemic veins from a lesion exposed to the air or to any source of contamination, the embolus may become infected and its poisonous property be communicated to the pulmonary tissues. In such case the result is metastatic abscess. It is evident that the infection might be conveyed by the same channel without the medium of a clot, in which event no infarction would precede the abscess.

Morbid Anatomy.—A hæmorrhagic infarction of pulmonary tissues is represented by a firm, solid mass in which all the arterial blood-vessels are filled with stagnated blood, which transudes their walls, and fills also the air-passages and alveoli, and infiltrates the whole structure. The cut surface presents larger granulations than those found in croupous pneumonia, and from it flows a sanious fluid. The bronchi of the affected tract are filled with a frothy liquid colored with blood, and an embolus may be found in the artery which supplies it. The surrounding parts are sometimes œdematous. When the infarction occurs near the surface of the lung, the pleura may become involved, and effusion take place into the pleural cavity. Observation shows that infarction is more liable to occur in the right lung than in the left.

Symptoms.—Unless the plug be large enough to obstruct a considerable arterial branch, the effect is masked by the antecedent condition, particularly when this is valvular trouble. The attack is announced abruptly by hurried respiration, and sometimes urgent dyspnœa, according to the extent of lung involved. Rise of temperature does not immediately follow, is never great, and may not be apparent. Rigors sometimes occur, but not uniformly. Cough soon ensues, with expectoration of tenacious mucus mixed with dark-red blood, moderate in quantity, lasting sometimes eight or ten days. The accompanying pain resembles that of pleurisy.

Physical signs are not marked, unless the infarction be of considerable extent and near the surface, when bronchial breathing, percusssion dulness, increased vocal fremitus, and prolonged expiration are manifested.

Diagnosis.—From the symptoms and physical signs it is apparent that pulmonary infarction can be inferred only from the presence of conditions which are liable to lead to embolism. With regard to metatastic abscess, the case is still more indefinite and conjectural during the life of the patient.

Prognosis.—Autopsies show that hæmorrhagic infarction may be absorbed, in which event there will be contraction of the parenchyma. Recovery may even follow embolic abscess. The conditions antecedent to the disease in question are quite unfavorable in themselves, and this complication makes the case one of extreme gravity.

Treatment.—The indications are, to keep the patient alive long enough to allow time for absorption of the infarction or discharge of the abscess. The heart's action should be sustained by digitalis and alcohol, and the strength be supported by the best possible alimentation.

S. S. Herrick.

LUNGS, MINUTE ANATOMY OF. Like other organs of the body, the lungs have a connective-tissue framework, consisting of its covering, the pleura, and the trabeculæ sent down between the lobes and lobules.

The pleura consists of two layers, a superficial and a deep one ; the former is of a thin, fibro-membranous character, covered by a layer of transparent, large, flat, endothelial cells. The deep or subserous layer is of loose areolar tissue, with many elastic fibres, and is said to contain in the lower animals some non-striated muscular fibres. Like all serous sacs, the pleura has a lymph canalicular system, which communicates with that of the subpleural alveoli on one side, and, by means of stromata, with the pleural cavity on the other.

The bronchi, with their accompanying vessels, nerves,

and lymphatics, having been already described (see article Bronchi), there remains for consideration the minute anatomy of the alveolus.

The alveoli are the irregularly round or oval dilatations in which the alveolar passages terminate. They vary in diameter between 0.113 ($\frac{1}{225}$ inch) to 0.376 mm. ($\frac{1}{66}$ inch) (Frey), and increase in size with age, never collapsing perfectly during health, but remaining partly dilated with "residual air," until the thoracic cavity has been opened, allowing atmospheric pressure to exert its force upon the lungs. Their walls, continuations of the infundibula, consist of very thin connective-tissue membranes, within which elastic-tissue fibres in greater or smaller bundles are irregularly disposed. In them, as well as in the interlobular tissues, are to be seen the black masses known as lung-pigment. This is not melanin, but is made up of foreign particles of carbon, dust, etc., which find their entrance into the alveoli during respiration. This pigment is not found in the lungs of wild animals, but makes its appearance soon after their domestication in the smoky and dusty habitations of man.

The vascular supply of the lungs is in two systems: the bronchial and the pulmonary (for the former, consult article Bronchi). The larger pulmonary arteries and accompanying veins, situated in the interlobular connective tissue, rapidly subdivide into minute vessels, each of which encircles an alveolus, and there split up into an unusually fine capillary network, of from 0.0056 ($\frac{1}{5000}$ inch) to 0.0113 mm. ($\frac{1}{2000}$ inch) (Frey) in diameter, only separated from the air by the exceedingly thin alveolar lining membrane. When the alveolus is in a state of dilatation, the capillaries do not bulge into the alveolar cavity, but when the alveolar walls are relaxed they are then seen to project partly from them, thus giving them a somewhat corrugated appearance. But a single mesh of capillaries exists in an interalveolar septum, and they possess so tortuous a course that in one situation they near the cavity of one alveolus, then dipping back soon do the same for an adjacent one, so that each alveolus has not a separate special arteriole and vein.*

The pulmonary veins commence in the interalveolar septa, gradually uniting to form larger and larger branches; they accompany the bifurcations of the bronchi to the hilus of the lungs. In vascular area they are peculiar in being narrower than the corresponding artery, thus forming an exception to the usual rule.

The lungs are richly supplied with lymphatics, which may, for convenience of description, be subdivided (though freely communicating) into three systems: 1, Peribronchial; 2, perivascular; 3, subpleural. The first has been described (article Bronchi); the remaining two begin in the lymph canalicular system described by Arnold as connecting the various alveoli (forming the so-called "Saftcanälchen"). The subpleural spring from those existing in the subpleural alveoli, together with branches from the pleural system, terminating in part in the bronchial glands at the hilus, in part joining the peri-vascular lymphatics in the interlobular connective-tissue septa. The perivascular begin also in the lymph canalicular system of the alveoli, follow the course of the arteria pulmonalis, and terminate in the bronchial glands. All three systems are provided with valves, situated at the slight saccular dilatations found in their course, and are lined with a simple endothelial membrane.

The nerves of the lungs are derived from the anterior and posterior pulmonary plexuses, which consist of branches from the pneumogastric and sympathetic" (Landois). Entering the lungs with the bronchi they follow their divisions, lying close to the bronchial arteries. Medullated and non-medullated nerve-fibres, which also contain numerous small ganglia, exist in the bundles. They are distributed to the blood-vessels, walls of the bronchi and their branches, but the question of their ultimate terminations is not yet settled.

The writer wishes to acknowledge his indebtedness to Landois and Stirling, Quain and Klein, whose works he has freely consulted in preparing this article.

L. L. McArthur.

* Klein mentions a peculiarity of the muscular coat of the arteria pulmonalis, in that it is *not* continuous throughout, but formed of circular fibres separated by distinct intervals.

LUNGS, ŒDEMA OF. Œdema of the lungs is always secondary to some other pathological condition, and does not naturally deserve consideration by itself. It is, however, of such frequent occurrence and of such importance, on account of interference with the respiration and of its frequently being the direct cause of death, that it is worthy of separate notice.

Pathological Anatomy.—In œdema a serous or sero-sanguineous fluid—according as the œdema is or is not accompanied by hyperæmia—is poured into the air-sacs and infiltrates the interstitial tissue of the lungs. The essential seat of the œdema is the air-sacs. Unless hyperæmia be present, the color of the lung is lighter than normal. On opening the cavity of the chest the lung does not collapse, and after pressure with the finger a marked depression remains. The lung is increased in weight. On section a light-colored or reddish fluid will exude, either at once or upon pressure, and if the air-sacs have not been completely filled it will be frothy. The pleural surfaces are moist and may be covered with a plastic exudation, and the cavity of the pleura may contain fluid. It is found with greatest frequency at the most dependent portion of the lungs, but may invade the whole or any part. It not uncommonly occurs after death, and is found posteriorly in one or both lungs, and in these cases it is not possible to say, without a previous knowledge of the physical signs, whether it occurred post-mortem or not.

Causes.—Œdema is secondary, and has a passive or mechanical origin. It usually accompanies either hyperæmia of the lungs, whether active or passive, or one of those conditions which cause general dropsy. It is frequent with the pulmonary hyperæmia caused by cardiac lesions, more especially with obstruction or incompetency of the mitral valve. It accompanies the general dropsy resulting from the various forms of Bright's disease of the kidneys. It is sometimes a consequence of anæmia, scurvy or purpura, or disease of the liver. It may occur in one part of the lung when there is some obstruction to the circulation in another part, as in pneumonia, or the obstruction may be without the lung, as when an aneurism presses upon the pulmonary veins. It may occur in the neighborhood of inflammation or irritation caused by the presence of a foreign body. A relaxed condition of the vessels from pressure on a nerve may produce it. It is observed in cases of emphysema with a dilated and weakened condition of the right ventricle. It is a consequence of acute general diseases in which there is an impaired condition of the blood and a weakly acting heart, as in typhoid and scarlet fevers.

Symptoms.—The rational symptoms will vary with the extent of the lung involved, and with the amount of the effusion. Rapid respiration and dyspnœa are present. The dyspnœa may be marked and cause much distress, or it may be slight. It comes on suddenly if the serous effusion into the lungs takes place rapidly, but increases gradually when the œdema is more slowly produced. If the œdema be extensive, signs of carbonic-acid poisoning make their appearance—headache, blueness of the lips and extremities, coldness of the hands and feet. More or less cough, with serous or sero-sanguineous expectoration, is always present. In percussion there is dulness over one or both sides, corresponding to the extent of the œdema. It is usually most marked at the bases of the lungs posteriorly, and, as a general rule, the pitch is higher on one side than on the other. On auscultation the respiratory murmur is feeble or absent, or there may be harsh respiration, the bronchial element of the respiratory murmur predominating, while the vesicular element is feeble or absent. Coarse bronchial râles may be heard. If there be exudation upon the pleura, coarse râles of pleuritic origin, resembling those produced within the bronchi, and crepitant and subcrepitant crackling may be heard. Vocal fremitus and resonance may be increased or diminished.

The PROGNOSIS depends upon the condition of the patient at the time, and the cause which gave rise to the œdema. In cases with general dropsy from kidney or cardiac lesions it is apt to be fatal. If a large amount of fluid is effused rapidly, death may occur quite suddenly. Not infrequently in cases of pneumonia, or of continued and exhausting diseases, œdema is the cause of death.

TREATMENT.—The treatment of œdema of the lungs will depend upon the conditions with which it is associated. If it occur with active hyperæmia in a plethoric subject, a large number of cups may be applied over the back or whole chest. Counter-irritation may be used over the chest, in the form of a mustard-plaster, and the feet may be placed in mustard-water. An active emetic should be prescribed, such as the subsulphate of mercury or apomorphine hypodermatically. If it be due to kidney disease, diuretics, diaphoretics, and cathartics should be actively employed; also dry cups over the back of the chest, in number from twenty to thirty. If it be due to cardiac disease, cups on the chest or a large mustard-plaster should be applied, in addition to the remedies which the condition of the heart calls for. If the heart is weak it should be strengthened by the use of digitalis, convallaria, etc. If it be due to an impoverished condition of the blood, tonic and sustaining measures are appropriate. Iron and especially the iodide of iron are indicated in such cases. If it occurs with hypostatic congestion, in addition to the means already indicated frequent change of position should be resorted to, in order to prevent the gravitation of blood to the most dependent portions. *Donald M. Cammann.*

LUNGS: PNEUMONOKONIOSIS. DEFINITION.—Etymologically, pneumonokoniosis is a general term indicating deposit of dust within the pulmonary parenchyma. Owing, however, to the intimate etiological relations which such deposit bears to subsequent pathological changes, the term is commonly used as including the earlier stages of the diseases thus arising.

SYNONYM.—The specific term anthracosis is often and, indeed, usually employed for the generic and more cumbersome one originally proposed by Zenker.

CLASSIFICATION.—As the pathological processes and anatomical changes do not differ in character, whatever the nature of the foreign matters, the classification is based upon the form of the inspired dust, and may be extended almost indefinitely.

The more common forms are anthracosis (ἄνθραξ, coal), deposit of coal or other carbonaceous dust; siderosis (σίδηρος, iron), applied to all metallic dusts as well as iron; chalicosis (χάλιξ, gravel), including the various forms of mineral dust; byssinosis (βίσσος, cotton), due to cotton or other vegetable fibre; tabacosis, inhalation of snuff or tobacco-dust. Deposits of any other form of dust may receive a similarly appropriate name. It remains, however, to compound a term which shall adequately describe the complex products of city pavements.

On account of the evident relations which certain diseases bear to dusty occupations they have received such characteristically descriptive names as miners' or stonecutters' phthisis, masons' or millers' lung, potters' asthma, buffers' consumption (among metal-polishers), Sheffield grinders' rot, and elevator disease, or "scoopers'" pneumonia.

HISTORY.—Both physiological experiment and post-mortem examinations have conclusively proven that foreign matters inhaled in fine subdivision, not only pass to the bronchial surfaces, but also reach the alveolar cavities, enter the pulmonary parenchyma, and are finally lodged in the bronchial glands. The relations of such dust deposits to various forms of chronic lung disease have long been recognized. Hilaire (Paris, 1845) and Vernois (Paris, 1858), among earlier writers, and more recently Hirt (Breslau, 1871), Michel (Bonn, 1872), Kuntzen (Berlin, 1873), Merkel (*Deutches Arch. f. Klin. Med.*, Leipzig, 1871; "Handb. d. Spec. Path.," Ziemssen, Leipzig, 1874), and others have described both the pathological changes and clinical manifestations of pneumonokoniosis in its chronic form. We are indebted to Rochester (Buffalo, N. Y.) for much of our knowledge of the more severe acute conditions.

PATHOLOGY AND MORBID ANATOMY.—It is not possible to suppose that any dust can pass by direct inhalation beyond the second or third bifurcation of the bronchial tubes, or that it remains suspended in the residual air. The first point of deposition must be, then, upon the bronchial mucous membrane, at some considerable distance from the alveoli. The larger portion is here taken up by the mucous corpuscles, or becomes entangled in the bronchial secretion and is thrown off in the expectoration. More or less, however, makes its way along the bronchial tubes, notwithstanding the opposing action of the cilia, and although it is gradually lessened in amount by expectoration a small residue eventually reaches the alveolar cavity, where the particles may be found closely adherent to the epithelial surface.

Occasionally this distribution occurs quite evenly throughout the lung, but more commonly the apices receive the larger portion, which by gradual increase becomes in some cases sufficient to fill the smaller tubes and alveoli and cause consolidation.

Of those particles which are finally lodged on the alveolar walls some become incorporated with the epithelial cells, to remain there permanently or to be transferred to the subjacent lymph-spaces. Others reach the lymphatic channels by insinuating themselves between the epithelial cells, which are loosened and elevated by the rapid growth of new cells that is excited by the irritating presence of the foreign bodies, or they are carried in by cellular elements which are probably migrated white blood-corpuscles.

From this point the distribution follows the course of the lymph-channels, more especially in the sheaths of the bronchial tubes and smaller branches of the pulmonary artery, and in the interlobular septa. Many of the pigment-granules are arrested along the course of the lymphatic vessels. They either become clogged in the lumen of the vessel or some sharp point pierces the thin wall and they are then imbedded there or pass into the connective-tissue spaces. At many points they become aggregated in minute nodules which completely block the vessels and arrest the lymph-current. When this condition is very extensive, nutrition of the pulmonary tissue may be seriously affected.

Notwithstanding the continual permanent deposition of the dust-particles along the lymphatics, proportionately large amounts pass through these vessels and finally become deposited in the bronchial glands. Only in rare instances do particles find their way to the cervical or abdominal lymphatics.

All the pulmonary tissues thus become infiltrated and stained by processes which are physiological, or at least conservative rather than pathological, since they are directed to the removal of the irritating foreign particles from the delicate alveolar walls, where even small amounts are productive of serious inflammatory changes, to the lymphatic glands, in which considerable quantities can be stored without special detriment to the system.

The above are the pathological processes present in all grades of pneumonokoniosis. The morbid anatomical appearances will vary with the amount and nature of the material deposited.

Post-mortem examinations show a moderate amount of carbonaceous and other extraneous pigment deposits in the lungs of all adults, more especially of such as have resided in cities. In the lighter grades the surface of the lung is uniformly mottled and striated in black or deep brown, the striæ marking out the interlobular septa and the pigmented spots indicating concretions in the lymph-vessels or areas of lymphatic plexuses.

As the pigment deposits increase the color deepens, until in the higher grades of anthracosis the lung is of an uniform coal-black color, while the pleura presents a bluish-black and semi-transparent appearance, owing to the implication of only the deeper layers in the pigmentation. On passing the fingers over the surface distinct hard nodules may be detected, either causing slight elevations or lying more deeply imbedded in the substance of the lung. The lungs are increased in size, often mark-

edly so; they have everywhere a firm resistance, which in some portions amounts to an almost stony hardness. They crepitate but little, and their specific gravity is in many cases raised above 1.000.

On section the cut surface presents the same variations in color, from a fine outlining of the lymph-courses to a uniform black. Here the nodules and concretions become more apparent, varying in size from the most minute appreciable point to others the size of a pea. On pressing the lung a more or less deeply stained fluid exudes, from which the pigment matter may be obtained and its nature determined. The concretions when isolated resemble minute bits of coal.

Upon microscopic examination, in the earlier stages, the lines of pigmentation are seen to follow very closely the distribution of the lymphatic vessels. Later the pigment-granules may be detected in the alveolar epithelium and free among the connective-tissue fibres. In many instances the nature of the pigment-matter can thus be recognized.

The changes in the bronchial glands are equally varied in extent. As increasing amounts of inorganic matter become arrested in their meshes, gradual absorption of the glandular substance takes place, while the glands themselves become enlarged and indurated, until in extreme cases they may reach the size of walnuts, and on section present the appearance of encapsulated, compact masses of fine coal. When other pigments than carbon are deposited within the lung, the only variation in the anatomical appearances will be in the color. The oxide of iron gives a brown or reddish color, and the metals generally give a lighter tint. Silica and the various clays cause gray tints, which are often darkened, however, by admixture with carbon elements. The ease with which the various forms of dust penetrate the tissues will determine largely the proportionate distribution of the pigmentation. In anthracosis the bronchial glands are quickly affected. The same is true of some of the metallic dusts and silica in some forms. The various clays pass but slowly into the tissues, and the pigmentation will therefore be more strongly marked in the interlobular septa near the alveoli.

It is to be remembered in this connection that high grades of pulmonary pigmentation, with quite decided enlargement, induration, and staining of the bronchial glands, may be due to processes entirely independent of inhaled matters, and that in some instances it is not possible to distinguish anthracotic from melanotic pigment derived from the blood.

An exception must be made to the above description as applied to byssinosis and allied forms of dust. When inorganic matters are mixed with the inhaled organic fibres, as happens with dirty cotton, they become separated by mixture with the bronchial secretions and afterward pass into the lung-tissue as already described.

The organic fibres, however, cannot pass through the alveolar wall, and, indeed, they seldom are carried thus deeply in the lung, but are gradually softened in the mucous secretions, become rolled into slate-colored gelatinous masses, and are thrown off in the expectoration.

The above constitute those changes which can strictly be called pneumonokoniosis. They are seldom present alone, however, and in the higher grades always induce secondary diseases, which cover a wide range of pathological processes.

Although pneumonokoniosis is only an etiological factor, and will be so considered in describing the resulting diseases, the relations are nevertheless so intimate that they require consideration as pathological complications.

Whatever the nature of the dust inhaled, the secondary processes excited by reason of its chemical or mechanical irritating qualities are identical in character; they vary only in intensity and in the order and proportion of their development.

Dust deposits occur in the lung in a large proportion of cases intermittently and with extreme slowness, few artisans working over ten, and miners only eight, hours out of the twenty-four. The consequent diseases are, with equal frequency, chronic inflammations and degenerations.

The one most constantly and earliest developed is bronchitis. It presents no pathological peculiarities beyond a tendency to the production of an exceedingly viscid mucus. The mucous membrane at first is thickened; later it is atrophied, and may be ulcerated or contain ecchymoses.

Closely following the bronchial changes, and coincident with the passage of the dust elements into the interlobular tissue, there occurs a low grade of productive inflammation, characterized by cellular infiltration and connective-tissue hyperplasia.

These fibroid changes at first produce thickening of the interlobular and alveolar septa, but as the new tissue becomes organized and begins to contract, pulmonary nutrition is decreased, the septa atrophy and finally are absorbed, and the lung-tissue gives place at various points to firm, tough bands and masses of the new-growth. Adjacent lobules, which have escaped, in part, the fibroid processes, become distended, thus developing a compensatory emphysema. Similar fibroid changes about the tubes exert traction, which, in connection with softening and ulceration of the tubes, causes bronchial dilatations or bronchiectasic cavities. These bands of new tissue may be several inches in length, and are at times an inch or more in thickness. They have no definite outline, but merge gradually into the surrounding tissues. Small fibrous bands pass from the pulmonary tissue to the deeper layers of the pleura, where a similar fibroid condition exists. Such changes are best marked along the anterior borders of the lungs, and over such areas the pleura may be thickened by organization of surface exudation as well as by the subpleural changes.

The contracting fibroid growth not only induces atrophy and absorption by compressing the capillaries, but causes similar obstruction to the circulation in the larger pulmonary vessels and lymphatics, a condition which in the lymph-vessels is augmented by pigment concretions and glandular infiltration.

As a result, local congestion, exudation, œdema, or even extravasation may occur, and in extreme cases infarctions, abscess, and gangrene are present. These, by rupture or sloughing, form large ragged cavities, whose walls continue to secrete offensive pus, which appears in the expectoration mingled with gangrenous shreds of pulmonary tissue.

Chronic bronchitis and fibroid phthisis are thus seen to be the necessary complications of chronic pneumonokoniosis, but to which lobular pneumonia and compensatory or atrophic emphysema are often added. Such a lung would seem to furnish a fertile soil for the growth of tubercle bacilli, and it is a noteworthy fact that tubercular processes are developed late if at all.

It has been questioned whether acute inflammatory processes, with exudation and cellular proliferation, are ever excited within the alveolar cavities by the inhalation of dust. Recently such a condition has been described as affecting grain-shovellers, in which the etiological element was unquestionable. The lungs are never seen until the process is well advanced. Then the pleura is found to be adherent, deeply congested, red, thickened, and covered with a false membrane of plastic exudation. Serous effusion into the pleural cavity is rare. The lung itself is dark red, with occasional points of extravasation just beneath the pleura.

Consolidation is most marked posteriorly, and is due to both vascular engorgement with serous exudation, and inflammatory products within the alveoli and smaller bronchioles. The consolidated portion is soft and pulpy, breaking down easily under pressure. On section it presents a deep-red or gray color, according to the stage, and from the cut surface there flows a frothy, bloody, or purulent fluid. Small infarctions and abscesses may be present in the later stages.

Under the microscope the alveoli are seen to be filled with exudative products and granular or broken-down cellular elements. Rarely a bit of the beard from the grain may be recognized.

The pathological processes, which affect both lungs,

appear to be a mixture, in varying proportions, of hypostatic and broncho-pneumonia, accompanied by circumscribed areas of plastic pleurisy. Changes in the liver and kidney are functional rather than organic.

ETIOLOGY.—Predisposing conditions : There is no condition which strictly can be considered as predisposing to inhalation of dust, beyond the anatomical conformation of the nasal and respiratory passages, except the habit of mouth-breathing.

Workmen who habitually inhale through the mouth, or whose occupation compels them to take sudden, deep inspirations often suffer more in a dusty atmosphere than those who, though working under the same conditions, breathe through the nostrils and inhale more gently.

Very many conditions, however, under which artisans labor exert a strong influence in increasing the extent and severity of the diseases consequent upon dust inhalations.

Imperfect ventilation of mines or workshops and overcrowding of operatives result in a vitiated air which of itself tends to pulmonary congestion and inflammation. Under such circumstances not only is the bronchial mucous membrane more susceptible to irritation, but the amount of dust deposited is relatively larger.

Again, constrained positions, as in mining, or occupations requiring but little muscular effort, as in metal-polishing, not only tend to favor the rapid accumulation of inhaled matters and lessen the ease with which they are expectorated, but they seriously interfere with pulmonary nutrition, and so decrease the power of resisting deleterious influences.

All inherited vices of constitution, more especially the lymphatic diathesis, enervating habits of life, the use of alcohol, and excesses of all kinds, lower vitality and predispose to pulmonary disease when pneumonokoniosis or any other irritant is the exciting cause.

EXCITING CAUSES.—Any form of inorganic dust, and very many organic products, when persistently inhaled will produce various degrees of pneumonokoniosis, that may be the direct cause of any of the secondary diseases.

It were superfluous, then, to attempt to mention all the exciting causes. Among the more common avocations, however, in which laborers are exposed for prolonged periods to a dusty atmosphere, are mining of the various minerals, and the handling of anthracite or bituminous coal in transit to its point of consumption ; charcoal-grinders and -carriers, moulders and those who clean castings, metal- and glass-polishers, stone-masons and plasterers, chimney-sweeps and laborers who tear down old buildings, potters and grinders on various forms of stone, bakers and pastry-cooks, gilders and gold- or tin-foil beaters, workers in mother-of-pearl and lead, jewel and glass-cutters, file-cutters, millers, tobacco-workers, factory-operatives, grain-shovellers, etc., through a still longer list, all suffer from inhaling the peculiar dust produced by the nature of their avocations, and develop varying grades of pneumonokoniosis.

The extent and character of the ensuing inflammatory changes, however, together with the order and rapidity of their development, will depend upon several complex factors.

1. The amount and character of the exposure. Other things being equal, the secondary conditions will stand in a direct ratio as to their extent with the amount of dust deposited. The rapidity with which this deposition takes place affects very decidedly the nature and severity of the subsequent disease. When artisans breathe a dusty air for only a few hours each day, as is almost invariably the case, the lungs soon accommodate themselves to the new conditions, and the usual processes of absorption are sufficient to practically clear the alveoli of foreign matters during the hours of non-exposure. There will be an acute bronchitis for a short time, but it soon subsides and passes into a chronic form, which is unimportant and causes little trouble to the patient. In such cases the principal changes will be fibroid in character and may not become prominent for years, the rapidity of their development depending upon conditions yet to be considered.

The results are very different when dust is inhaled continuously for a long period.

In handling grain the shovellers not only labor in confined places, as the holds of canal-boats, where there is absolutely no ventilation, but they work without intermission for days. The gang bosses admit that the labor is sometimes continuous for thirty-six hours, while the workmen claim that they are often employed for five and six days, with intermissions of only a few moments for food and rest. Taking an average as the truth, it gives three and four days as the probable length of time during which every respiration bears to the lung large quantities of an exceedingly irritating dust. Under such conditions the absorptive processes are inadequate for its removal, and the tubes become filled with the irritant. The resulting inflammations are acute exudative processes. As before, bronchitis appears first, usually following the first exposure, but later, similar exposure induces the pseudo-pneumonic changes already described.

2. The nature of the inhaled dust, as regards its penetrating power and chemical qualities.

The most penetrating, as well as the most irritating, forms of dust are the siliceous, as the particles have exceedingly sharp edges and fine points. Similarly, mineral coal passes into the tissues more easily than charcoal, but both are only slightly irritating, owing to their chemical properties, as compared with other forms of dust. True anthracosis often reaches a condition of almost complete solidification without inducing any extensive fibroid change. Although pulmonary diseases are much more frequent among miners than in the community at large, the percentage of phthisis cases to the total number of sick, among this class, is lower than in any other class of dust workers (Hirt's statistics).

Various clay dusts pass into the lung but slowly, being deposited more thickly about the alveoli ; yet they possess specially irritating properties and speedily cause severe disease. Metallic dusts also stand high in the list of irritating matters.

Tobacco dust passes into the lungs quite freely, but the resulting diseases are due to its constitutional effects rather than its locally irritant properties.

The frequency with which pneumonokoniosis is the etiological factor in pulmonary phthisis among the laboring classes in large cities, may be fairly determined from the following list of one thousand consecutive cases, taken from the dispensary records of the University Medical College and Bellevue Hospital, only those being given here in which dust inhalation was a possible factor. It is but fair to state, however, that probably a small percentage of the 311 cases classed as laborers, were engaged in handling coal. The list includes only males.

Printers	48	Machinists	14
Carpenters	45	Bakers	12
Masons	39	Moulders	10
Painters	28	Hatters	7
Tobacco-workers	24	Wood-turners	6
Factory-hands	23	Glass-workers	4
Stonecutters	23	Millers	4
Iron-workers	20	Weavers	3
Blacksmiths	18	Gold-beater	1
Brass-workers	15	Dyer	1
Total			345

The above cases, together with those which should be taken from the class of laborers, form nearly forty per cent. in which inhalation of dust can fairly be considered as having started or hastened the phthisical processes.

SYMPTOMS.—Chronic pneumonokoniosis presents but few symptoms. So long as the patient continues his occupation the bronchial secretions will contain pigment matters. Cough is an early and persistent symptom. It may be due to either bronchitis or pressure of an enlarged bronchial gland. Dyspnœa is often a prominent symptom even when no appreciable inflammatory conditions are present, and appears to depend upon deficient oxygenation caused by abundant pigment deposit. Other symptoms will depend upon the secondary diseases. Subacute and chronic bronchitis will afford the usual subjective and physical signs. In some cases the prominent

symptoms will be those of fibroid phthisis, with compensatory or atrophic emphysema. In others the asthmatic element is prominent, and in all the physical signs of pleurisy will be present at an early stage of the disease. Inflammation or enlargement of the bronchial glands (*q. v.*) will cause characteristic pressure symptoms. If tubercular infection occurs it will soon be indicated by rise in temperature, hectic, rapid exhaustion, and hæmoptysis.

The phthisis of anthracosis, however, is seldom tubercular or rapidly progressive, but tends to abatement or even recovery when the exciting cause is removed.

The acute processes which ensue upon the prolonged inhalation of specially irritating dusts are the most severe in the so-called elevator disease.[1]

The earliest attacks are in the form of acute bronchitis with profuse muco-purulent expectoration, unattended by fever or other constitutional symptoms. Within a year or two, however, when from repeated attacks of bronchitis the lungs are more susceptible to irritation, some specially prolonged period of exposure excites an inflammatory process resembling acute broncho-pneumonia.

The more decided symptoms are preceded for a day or two by some bronchial irritation, cough, and expectoration. Distinct onset of the disease is marked by a light chill, and a rapid rise of temperature to 101° F. in mild, or 105° to 106° F. in severe cases, with an average of 103° F. The pulse is frequent and feeble, and the heart's action tumultuous. The face is flushed, but the skin remains moist. Delirium is frequent in both sthenic and asthenic cases. The cough is increased, and the sputa become thick, tenacious, rusty, or hæmorrhagic ; later they are purulent, with an exceedingly offensive odor.

On physical examination both lungs are found to be affected. There is partial consolidation in the posterior and lower portions of the lungs, with evidences of alveolar and bronchial exudation such as are usually present in hypostatic pneumonia. The physical signs of a plastic pleurisy are often present over the consolidated portion.

The disease runs a prolonged course of from ten days to two weeks with sthenic symptoms, and convalescence may not be complete for two or three months.

Many cases pass into a condition presenting all the rational signs of phthisis, with hectic, night-sweats, and rapid emaciation, but without the physical evidences of tubercular infection.

In connection with the pulmonary processes there may be renal and hepatic complications, and general disturbances in the digestive functions.

Diagnosis.— The recognition of pneumonokoniosis, either as a condition *per se*, or as the etiological element in other pulmonary diseases, depends entirely upon the history of the case and the detection of pigment deposits in the sputa.

Prognosis.—The prognosis depends primarily upon the possibility of removing the exciting cause, and the extent and character of the secondary changes.

When the subject cannot or will not give up his occupation, the duration of the disease will depend upon the general habits and constitution of the patient, and upon those factors more fully discussed under Etiology.

Treatment.—Prophylaxis is the only practical line of treatment. Since men must work at dusty avocations, means must be devised for preventing the inhalation of the dust-particles. In those trades where dust is formed at a single point, as in polishing, glass cutting, wood turning, etc., some form of blower or aspirator which will entirely remove the dust is the most effective protection. When, however, the dust is evenly diffused, as in tobacco factories and iron foundries, any amount of ventilation which would successfully remove the dust will become a source of danger from cold and draughts. In such cases respirators, although more or less clumsy and disagreeable, are exceedingly valuable. In all cases they possess the advantages of being under the control of the operative and always available, while ventilators, blowers, and aspirators must often be wrung from soulless corporations. A cheap respirator, and one which not only has the advantage of being easily cleaned, but is also very efficacious, may be made from a fine flat sponge.

Treatment of the secondary complicating chronic diseases presents no peculiarities.

For the acute broncho-pneumonia it is generally tonic, stimulant, and symptomatic. *Charles E. Quimby.*

[1] Rochester: Buffalo Medical and Surgical Journal, 1879.

LUNGS, SURGERY OF. This subject may be conveniently divided into the two divisions of wounds and of operations upon the lungs.

Wounds of the Lungs.—The thoracic viscera are so well protected from injury by their position and natural resilience, by their bone and muscle armor, and by the guard of hands and arms, that wounds of the lung are not of very frequent occurrence. Such wounds do occur, however, and of all varieties ;—punctured, incised, lacerated, contused, and complicated. They may be open or subcutaneous. In all lung wounds the air must have more or less free access, though in the term subcutaneous we commonly imply the absence of air from the wound.

Simple punctured and incised wounds of the lung are comparatively of quite frequent occurrence. Such wounds are inflicted in fights, or by the careless handling of sharp and pointed tools—knives, chisels, hay-forks—which may be thrown. An accident of no great rarity is the penetration of the lung by the end of a broken rib. This is especially apt to occur when the lung adheres to the chest-wall by reason of an old pleurisy. Such an injury is not apt to occur except as a result of direct violence (Holmes), because the shape of the chest renders it probable that the ends of ribs fractured by indirect violence will project outward rather than inward toward the lung.

Large bodies passing through the lung cause a very different wound. A rock-drill or shaft of a wagon must contuse and lacerate the lung if it perforates the organ. Accidents involving great mechanical force, as falls from high places, "buffer" and machinery injuries, and the like, may cause wounds of the lungs ; but their very violence commonly makes the pulmonary lesion only one of a series of fatal complications.

Blows upon the chest-wall which have not caused a wound of the parietes nor fractured a rib, have been known to cause rupture of the lung in some instances. While this is difficult to explain, it is supposed that occlusion of the glottis takes place just as sudden pressure, brought to bear on the air in the distended lung, causes the air to force its way through the weakest place. The same interpretation explains a phenomenon of rare occurrence—the rupture of the lung by severe exertion of bodily strength. This may occur from a strong expiratory effort while the upper air-passages are occluded. Such an accident is related in the records of the New York Hospital. In a case of bronchotomy, for tracheal diphtheria, the tube became suddenly plugged by false membrane. The consequent violent expulsive effort caused rupture of the lung and almost instant death.

Another class of injuries met by the surgeon is made up of wounds complicated by foreign bodies, as gunshot and arrow-wounds.

Position.—The most usual site of incised and punctured wounds of the thorax is the lower portion of its anterior aspect. Hence it is the anterior portion of the inferior lobes of the lungs which are most often wounded. The action of the arms in fending blows tends to throw them down, and the presence of a thicker layer of bone and muscle in the upper part of the chest, in some degree explains the immunity enjoyed by the superior portion of the lungs.

Symptoms.—Seldom are all characteristic symptoms present ; and it is by noting the position and direction of a wound of the chest, with whatever distinctive signs may be present, that a diagnosis is reached ; no one symptom is pathognomonic. Often much help can be derived, in case of stabs, by examination of the weapon and consideration of the way in which it has been used. The appearance of the external wound may help us in judging how much the deep tissue has been lacerated, for it may

itself show signs of laceration caused by a twisting or moving of the handle of the weapon to and fro. The more certain diagnostic symptoms of lung-wound are escape of air and bloody froth from a chest-wound and bloody expectoration. Besides these we may have the presence of air and blood in the chest-cavity, dyspnœa, cough, collapse of the lung, and subcutaneous emphysema. When a wound of the lung is received there is usually very marked shock and prostration. Patients have been remarked as wearing an anxious expression, and inquiring constantly about their danger. The wound, particularly if large and open, bleeds profusely; the blood with each expiration is forced out in a froth by the air from the sound lung, and is drawn in at each inspiration. This symptom is known as traumatopnœa. Hæmorrhage is sharp, and often fatal. The blood may come from the wound in the lung, and in large quantities if large vessels be divided; or from arteries and veins in the chest-wall, as the intercostal or internal mammary. From either source the active bleeding is apt to be alarming. Hæmoptysis is an infrequent symptom, and when present affords strong evidence of a wound of the lung; and particularly so if a frothy appearance of the sputa is noticed. When the bleeding is internal, cough is present and blood is expectorated; otherwise it is not a common symptom. Air in the pleural cavity may enter through the chest-wound or from the wounded lung. Severe dyspnœa may arise from this pneumothorax, by pressure on the heart and uninjured lung, when the wound of the thorax is closed. Dyspnœa may arise independently of pneumothorax, from the inability of the one lung to aërate the blood, or from its inefficient action brought about by the general injury. Should free exit be denied the air contained within the chest, by sealing of the skin-wound, the air may find its way beneath the skin and cause subcutaneous emphysema. With puncture of the lung by a fractured rib we may have troublesome emphysema. The interpretation of this condition is mechanical. A wound of the lung occurs, and the next inspiration naturally fills the chest with air from the lung. Then the subsequent expiration drives the air into the subcutaneous tissue through the wound in the parietal pleura. Hæmothorax is a symptom which may give rise to great anxiety, for the hæmorrhage may be considerable in amount. It may cause dyspnœa by pressure, and with it sudden anæmia and its attendant symptoms. Air and blood are commonly both present in the chest-cavity after such an injury, and the physical signs of fluid and air may be obtained. Collapse of the lung is to be expected, but its occurrence may be prevented by old pleuritic adhesions, or it may occur without wound of the lung.

Complications.—The presence of blood and air in the pleural cavity, and of air beneath the skin, are symptoms which are apt to remain as complications. Added to them we have fractures of surrounding bones, and the presence of foreign bodies in the lung or pleural space. We may have hæmorrhage from the lung at a subsequent time. Pleurisy, pneumonia, empyema, abscess or gangrene of the lung, and pneumatocele, are all special complications of pulmonary wounds which may arise during convalescence.

Prognosis.—This is always grave. A wound of the lung is a severe injury, but by no means hopeless. The commoner punctured wounds are recovered from in the majority of cases. Hæmorrhage is a very good guide in prognosis. With severe hæmorrhage the indication is that the lesion involves a considerable portion of the lung or a large vessel, and the outlook is, of course, much more serious than in cases where the wound is small and the bleeding slight. The age and physical condition of the patient must be considered more in such an injury than when no vital organ is involved. In *The Lancet* for October, 1881, is reported a case which will illustrate some of the possibilities of recovery from a severe pulmonary injury. A miner, at the bottom of a shaft, was struck by a drill, which fell a distance of two hundred and twenty-five feet. The drill was three feet long, and weighed eight and a half pounds. Its point struck the man near the superior angle of the left scapula, and in its exit fractured the sixth rib in the mammary line. The wound was eight inches in length from entrance to exit. The drill was buried almost to its head, and was extracted with difficulty by two companions. The laceration of the lung was great, and the symptoms, especially traumatopnœa, well marked. At the end of sixteen days the man was able to walk out, and patriotically attend an Independence-Day celebration.

Wounds of both lungs are almost certainly fatal. Seven cases, however, of bullet-wounds of both lungs are reported in the third surgical volume of the "Medical and Surgical History of the War of the Rebellion," and of these six recovered. The diagnosis was confirmed in one case after death from hæmorrhage on the ninth day, but in the six cases of recovery doubt is expressed as to correctness of diagnosis. Death occurs primarily from hæmorrhage, shock, or heart-failure; subsequently from exhaustion resulting from septic processes set up by foreign bodies, or by hæmothorax or pleurisy resulting in empyema. Pneumonia is a cause of death in a considerable number of cases. Fatal secondary hæmorrhage from the lung at about the tenth day is not unusual. If the laceration of the thoracic wall be at all extensive, or if the lung be left contracted, the healing process is apt to leave the chest drawn in on the injured side, and considerable deformity may result. In the same way loss of a portion of a rib, in operations for abscess in the pleura (empyema) or in the lung, or a long-continued thoracic fistula, permits the lung to recede, and with it the chest-wall is retracted. Subsequently to, or accompanying, this change, a curvature of the vertebral column may develop, the convexity being backward and to the opposite side.

Treatment.—In the treatment of all wounds of the great cavities the cardinal rule of cleanliness holds to its maximum degree. The wound should be touched by no surgically unclean hand, instrument, or dressing. Should such an accident occur, prompt effort should be made to cleanse the wound. Air cannot, from the nature of the wound, be excluded, but dirt need not enter through the surgeon's neglect. Do not use strong solutions for irrigation, lest they act as irritants within the pleural cavity, and use the solutions warm. Any antiseptic solution may be used, but, as examples of the strength, corrosive sublimate 1–5,000 to 1–10,000, or carbolic acid 1–40, may be mentioned. Lung wounds must be treated on general principles, and no fixed rules can be followed. The shock is often extreme; but it is advised not to be in too great haste to relieve the collapse, because a vigorous heart-action will tend to engorge the vessels of the lungs and promote hæmorrhage. The aim of the surgeon should be to maintain perfect rest, and to keep the heart in action by just enough stimulation to retain a balance in the patient's favor.

In case of wounds of the thorax the physical examination should be more than commonly critical. A neglected foreign body, a bleeding intercostal vessel, an undetected fracture, may give rise to much subsequent mischief. The finger is the best probe. Cleanse it thoroughly and examine freely, but cautiously. Extract all foreign bodies—pieces of clothing, or of bone, or of any other material which may have found its way into the wound. Hæmorrhage is to be checked by hæmostatic clamps and by ligature, if examination shows it to come from divided vessels in the chest-wall. There can be no objection in most cases to enlarging the wound, if it be necessary for this purpose. At times it is more expedient to tampon the wound. A very efficient extemporized plug may be made by pushing a tent of cloth through the wound, and crowding into the cavity of it sponge or other elastic substance, so as to make a knob on the inner side. Then, by traction on the loose ends of the cloth, sufficient pressure may be made to check bleeding.

When the hæmorrhage comes from the wounded lung immediate action is necessary, particularly if the bleeding be of considerable amount. Obtain rest as quickly and as perfectly as possible. Give morphine hypodermatically in small doses, always bearing in mind the defi-

cient lung-space and the action of the drug on the respiration. Opium should be used cautiously, and may be combined with small doses of atropine. If the hypodermic method is used, morphine, gr. $\frac{1}{10}-\frac{1}{6}$, with or without atropine, gr. $\frac{1}{200}-\frac{1}{100}$, may be administered hourly until symptoms of its action are obtained. Ergot, tannic acid, and other internal hæmostatics have been used, but the benefit resulting from their use is questionable. Still, it would seem desirable to try such drugs. Cold applied locally has been found of value in checking this bleeding. Ice-packs to the chest are the best and easiest mode of applying cold. Cloths wrung out in hot water—110° - 140° F.—might be used in the same way, and in case of intense collapse they would be safer. If the chest-wound be open, the heat or cold should be applied to the bleeding-spot. Styptics locally offer the best promise, so far as immediate results are concerned; and of them the actual cautery, at a dull cherry-heat, is the best. In its absence chemical styptics might be used, though their application is followed by a much more dangerous slough. How far the surgeon may go in enlarging the chest-wound to reach the actual site of the lung-hæmorrhage must be left to the individual judgment in each case. Stimulation must often be used to sustain the heart; but with a sparing hand, for the surgeon must always recollect the danger from a forcible heart in pulmonary hæmorrhage. Alcohol (whiskey or brandy) is best for the purpose, and acts most quickly and certainly when given under the skin. Ether may be used in the same way. Ammonia by inhalation, or in small doses by the mouth, may be used. Digitalis should not be used until other remedies have been found insufficient, for the propriety of using it in hæmorrhage from the lung is questionable. As soon as local measures for stopping the bleeding and cleansing the wound are completed, the question of wound treatment will arise. The experience of the surgeons in the civil war was not favorable to sealing chest-wounds in which there was much contusion or loss of substance. In the case of a punctured wound with slight hæmorrhage, the wound should be promptly closed. This may be done by forming an artificial scab of iodoform or by the use of collodion, but the more scientific method will be to take a deep suture with silver wire or catgut. If this suture be passed deep into the tissues, it will thoroughly close the wound and prevent subcutaneous emphysema. In punctured and incised wounds with very slight symptoms, the treatment need not be exhaustive. Seal the wound, insure perfect quiet, and do not overstimulate. Remember that the prognosis in such cases is good, and the chief danger is past when hæmorrhage is no longer to be feared. If the wound be contused or lacerated extensively, pack with iodoformized or other antiseptic gauze. A free exit should be allowed to air and blood in the pleura by a drainage-tube, particularly if the wound be large and hæmorrhage free. It is important not to allow the patient to become too much exhausted. If he recovers from the first shock and hæmorrhage, much may be done at a later period in treating the complications as they arise.

Over the wound a firm compress of an antiseptic dressing should be applied, to prevent oozing and to make even pressure over the wounded parts. Usually it will tend to render the patient comfortable to limit the movements of the ribs. This may be done by a stout binder of muslin, or of some unirritating sticking-plaster. The "moleskin" plaster is very good for the purpose. Later a more permanent dressing of crinoline bandages, applied wet, or of plaster-of-Paris in the form of a light jacket, may be substituted. These may be fenestrated, to allow approach to the wound without removal of the supporting dressing. Care should be exercised, in the case of fractured ribs, that the compression of the dressing does not drive the broken end of the bone inward.

Treatment of complications, as they arise, must follow the usual medical and surgical principles. Emphysema, pneumothorax, and hæmothorax are, perhaps, the first which demand attention. Emphysema of the areolar tissues will usually disappear without treatment; but no harm will arise if the skin is cut or punctured to allow the escape of the air, if it passes the compressing dressing and proves troublesome. Hæmothorax may be left to be absorbed, or may be aspirated. There should be no hesitation about resorting to the use of the aspirator if need for it arise. The air in the pleura may demand attention by reason of the severe dyspnœa caused by its pressure. A case is recorded (*Lancet*, 1882) in which the lung was ruptured in a runover accident. The patient suffered from severe dyspnœa and orthopnœa; the respirations were sixty-four to the minute. The introduction of a trocar and the resulting relief of the pneumothorax enabled the boy to sleep reclining, and reduced the respirations eighteen per minute. Pleurisy and pneumonia furnish indications for their own treatment. Empyema should be treated by free opening of the pleural cavity and search for a foreign body which may excite it. After this the usual thorough drainage is easy. Abscess and gangrene, and hernia of the lung, will be mentioned more at length.

Gunshot wounds involving the lung follow the usual rule of such wounds. Comparatively, slow round bullets do more harm than the conical balls from rifles. Small bullets from revolvers are apt to lodge in the track of the wound. "Girdle-wounds," caused by bullets reflected by the ribs, simulate in appearance closely the wounds of perforating bullets. Spent balls may cause "contusion pneumonia." When a bullet passes through the lung there is an area of consolidated lung for two or three inches about the track of the missile (Erichsen). This traumatic pneumonia is due to interstitial hæmorrhage caused by contusion.

The prognosis is bad, but depends in a great degree upon the course of the bullet after entering the lung. Small bullets do much less mischief than large ones. The smaller bullets may become encysted, but, as a rule, none weighing as much as an ounce will remain without serious results.

Treatment is the same as in other lung-wounds. Search for foreign bodies in the wound of entrance. If the bullet can be felt beneath the skin, wait until the wound behind it is healed before removing it. Wait for trouble before exploring too much for the lost bullet.

Contusion Pneumonia.—A traumatic lung-lesion of rare appearance is known as "contusion pneumonia." The impact of a blow insufficient to produce a rupture of the lung may cause a consolidation of the subjacent lung-tissue. The physical signs of carnified lung are present without the constitutional symptoms of pneumonia. The condition is one of interstitial hæmorrhage in the contused area—a sort of lung-apoplexy. As a rule, all the indications of consolidation clear up in a short time without severe constitutional symptoms. Gangrene of the lung has, however, been known to result from contusion pneumonia.

Hernia of the Lung.—Penetrating wounds of the chest are occasionally complicated by the escape of a portion of the lung-substance through the wound, forming a hernia or pneumatocele. Such a hernia may be primary or secondary; that is, it may escape immediately upon the receipt of the wound, or may push the cicatrix of a healed lesion before it. The primary form is the more common. In the late civil war seven cases of pneumatocele were recorded, of which six were primary. These protrusions may occur wherever the weakening of the containing wall exists. Wounds being more common, and the parietes being thinner, in the lower half, herniæ are more common in this portion of the thorax. A few cases are reported of such an escape of lung at the root of the neck, simulating in position and outline an aneurism of one of the great vessels. It may also transmit an impulse and murmurs which are sufficient to embarrass diagnosis. A unique case is reported (*Lancet*, 1882, p. 139) of hernia of the lung through the diaphragm, caused by indirect violence. The intestines are apt to be subjected to stronger pressure, and are much more liable to become prolapsed, through the diaphragm than are the lungs.

Primary pneumatocele is explained by spasmodic and involuntary closure of the vocal cords on the receipt of a blow upon the chest, and the simultaneous contraction of the respiratory muscles of the chest and abdomen.

The air, thus compressed within the lung, forces a portion of the lung through the wound. Secondary hernia is probably due to repeated acts of the same character, forcing the weakest spot.

The results of such injuries are frequently serious. The hernia may become irreducible or strangulated, or it may attain very considerable dimensions. The appearance presented is that of a swelling at the site of a wound, usually irreducible, resonant at first, and capable of some diminution in size by moderate pressure. The tumor may expand and retract with the respiration; and may give an impulse, like abdominal herniæ, when the patient coughs. There is often an exaggerated vesicular murmur to be heard on auscultation over the mass. The pneumatocele is apt to cause considerable disability from pain and dyspnœa, although this is not invariably the case.

Treatment.—If the hernia be open, cleanse thoroughly and immediately reduce the mass by gentle taxis. Reduction is, however, not always possible. Pleuritic adhesions are very rapidly formed and may prevent reposition. Perhaps impaired circulation will have set up such changes as to render reduction very undesirable. Extirpation of the gangrenous mass has been attended by good results in a number of cases. This may be done gradually by ligature of the base of the hernia; or a galvano-cautery wire may be used; or the écraseur wire may be employed and hæmorrhage, should any follow, be checked by the thermo-cautery. A case reported by Demons in *L'Union Médicale*, June, 1886, and generally reprinted in the journals, may be referred to. Hernia one-half the size of the fist, followed a stab-wound of the left side, between the ninth and tenth ribs. The prolapsed lung became gangrenous and was extirpated by the écraseur and cautery on the eighth day. The left kidney was exsected on the twenty-seventh day for urinary fistula. Recovery followed. Should the lung protrusion be irreducible and healthy, the question of resection is an open one. It would seem preferable, ordinarily, to protect the hernia by a suitable dressing, so that the wound may close over it by granulation, and so prevent further prolapse of the viscus. In secondary hernia the process is usually a gradual one, and strangulation does not occur as a rule. Some form of apparatus is usually efficient in retaining and protecting the hernia; and the pad of the truss may be cupped, so as to fit more accurately. Operations for the reduction of irreducible pneumatocele are not advised, and such cases have, heretofore, been treated on a strictly expectant plan.

Foreign Bodies in the Air-passages and Lungs.—Foreign bodies in the lungs may enter from the air-passages, by ulceration through the bronchial tubes, or directly from the outside by perforation of the chest-wall. While foreign bodies in the air-passages do not, strictly speaking, belong to lung surgery, the relation is so close that a brief consideration of them may be pardoned. Foreign bodies which enter the air-passages from the pharynx have been classified as smooth and rough. The latter may be pointed, or furnished with sharp angles or edges; as examples, bones, fragments of teeth broken in extraction, or whole teeth, pins, needles, fish-bones, coins, etc. The smooth may be hard or soft, *e.g.*, food, vomited matters, pebbles, beans, buttons, and the like. Vomited material is dangerous, particularly during unconsciousness from anæsthesia or in epileptic, alcoholic, or other conditions accompanied by coma. Foreign substances may enter by ulceration of the œsophagus, by wounds involving the larynx or the trachea, or by abscesses which open through the lung or bronchi, such as degenerated bronchial glands, empyema or abscess of the liver.*

Foreign bodies entering the lungs through the parietes may be of any kind. Bullets, and the bits of clothing and other fragments which accompany them, are foremost in this category. Besides these we may have any substance which can perforate the chest-wall and break off, or leave pieces after the extraction of the major portion.

When impacted in a bronchus, the foreign body is usually on the right side, because the bronchus is wider on this side, and its direction more vertical, and the septum between the bronchi is somewhat to the left. If the body be small, it may enter one of the smaller bronchi.

A consideration of foreign bodies in the larynx or upper air-passages need not detain us.

Symptoms.—When the trachea and bronchi are invaded by a foreign body the prominent symptoms are cough, more or less intermittent, and dyspnœa, which is apt to be spasmodic. If the body is light and smooth it will probably be moved up and down in the trachea in the efforts at its expulsion by coughing. Auscultation will detect the rattling of the body in its journeys, and its impact against the larynx. Seldom does the offending mass escape by the rima glottidis, because of the reflex spasm excited by the presence of a foreign body in the larynx. Dyspnœa arising from this cause may be very alarming.

With a foreign body impacted in the bronchus the symptoms are intermitting cough, more or less respiratory distress, and sometimes local pain. Auscultation shows diminution or absence of pulmonary sounds in the whole or part of one lung. Wide variations may occur in the murmurs, depending upon the fact that the foreign body may move in the bronchus, and also depending upon the completeness of the occlusion and upon the size of the bronchus blocked. There may be curious and unusual sounds caused by air passing the obstruction. The percussion-note will be somewhat dull over the lung supplied by the plugged bronchus. These physical signs may be increased by swelling of the mucous membrane or of some kinds of foreign bodies, as for example, a bean. Expectoration will accompany the cough, and an increased amount of pus will be present in the sputum; blood in varying quantities may present itself. This bronchitis will soon become putrid, if the cause remains.

The *prognosis* varies with the location, shape, and size of the foreign body. Such bodies rarely become encysted, but may remain for a long time before giving rise to much trouble. Sooner or later they will excite dangerous symptoms. As exceptions, many authors mention cases in which foreign bodies have lain quiet in the air-passages, and have been expectorated at the end of ten or more years (Erichsen, Ziemssen); these cases are, however, to be classed among the possible rather than the probable. If the foreign body remains impacted in a bronchus its wall will ulcerate and the foreign body escape into the lung, or the lung will collapse if the occlusion be complete. From these occurrences we may have abscess or gangrene of the lung.

Treatment.—As soon as the diagnosis is established an immediate effort should be made to extract the foreign body. Previous to the use of cocaine as a local anæsthetic, it has been a rule to do tracheotomy before attempting the removal of the foreign substance. This is on account of the spasm of the glottis, which may prevent the exit of the body and will cause severe dyspnœa as soon as the larynx is touched. As an experiment, an effort to extract under cocaine would seem justifiable. Tracheotomy is almost always necessary, and is usually done by preference below the isthmus of the thyroid. As soon as the trachea is opened there will be a violent attack of coughing, and in it the foreign body will often present itself at the opening in the trachea. At all events, danger from spasm of the larynx is then past. Further efforts should be made, while the patient is still under an anæsthetic, to remove the foreign body by inverting the patient, or by artificial forced expiration. A laryngoscope may be used through the wound to locate the body. A bent probe may be pushed past the body and extraction secured in that way. Various forceps have been devised for the purpose. They are long and delicate, with slender jaws and a moderate bite, so that they may pass readily and grasp the foreign body within the bronchi. They are made with a curve sufficient to permit use of the handles away from the neck. Cohen's

* A very complete list of foreign bodies which have entered the air-passages may be found in the International Encyclopædia of Surgery, edited by Dr. John Ashhurst, vol. v., p. 667, 1884. Ziemssen's Cyclopædia of Medicine, American translation, vol. iv., p. 501, presents a valuable and exhaustive bibliographical list of such cases.

and Gross's trachea-forceps are, perhaps, the best known. If these procedures fail to relieve the obstruction (and the operation should not be of great duration), the patient should be kept quiet, and the tracheal wound kept open. Often the foreign body appears, as a result of natural efforts at expulsion, some time after the operation. Further consideration of the subject of foreign bodies in the lungs will be found below.

Operations on the Lungs.—An old law, which gave over to the care of the physician the diseases of the internal organs, has so often been violated by the surgeon, that its force is now gone. No organ has remained untouched. The lungs were among the last to receive systematic treatment by operations. It is true that, now and then, someone would amaze himself by a phenomenal bit of surgical daring in an attack upon the great cavities. But no well-formulated idea had found birth, until clean surgery and the theory of disease from demonstrable germs had led inquirers to seek topical treatment for certain lung disorders by the use of instruments.

Operations upon the lungs are not many. They have followed experiments upon animals, or have been undertaken as a last resort in incurable cases. They may be briefly summed up as: (1) Pneumotomy for cysts; and (2) for foreign bodies; (3) parenchymatous injections. In 1873 Professor Mosler, of Germany, incised and drained tubercular cavities in three patients. These operations were not fatal and, furthermore, in all the cases gave relief to the symptoms which indicated the operation. Success in this induced further experiments upon animals in resection of portions, and even the extirpation of an entire lung. In Europe, Gluck, Biondi, and others, have demonstrated that partial excision of lung, including both apices, is well borne in nearly all cases. Extirpation of a whole lung is fatal in about half the animals —dogs and rabbits—subjected to the operation.

Resection of lung in the human subject has not been accepted as a safe means of treatment, except in pneumatocele. Tumors, which are so eagerly attacked everywhere else, are respected when they involve the lung, save only those with fluid contents.

Incision and Drainage of Cysts of the Lung have been performed a number of times since Mosler's cases. Nearly every time the operation has been done for the relief of septic symptoms. Abscess (and gangrene) of the lung, and occasionally well-demonstrated tubercular cavities, which give rise to alarming symptoms, have been treated by drainage. The sole indications in all these cases are the removal of the cause, when possible, and local treatment when drugs fail. Besides this we may have hydatid cysts, which by their size cause sufficient distress to warrant operation; or they may go on to suppuration and demand treatment as foreign bodies. In considering the subject at present we shall not separate abscess and gangrene. Their symptoms and treatment are closely identical, and they may arise from the same causes, although their pathological histories may be different. Inefficient exit for putrid necrosed lung-tissue permits absorption of septic matter and the characteristic symptoms follow. The usual course of an unoperated case is well illustrated by a case reported in *The Lancet*, 1880, p. 89. A boy, seven years of age, drew into his lungs with the inspired air a head of grass. The immediate symptoms, those of acute bronchitis, soon subsided. At the end of a month the patient began to complain of cough, with some expectoration, and had a little hectic fever; the sputum was purulent and offensive in odor; and there were signs of consolidation in the right lower lobe. At the tenth week the septic symptoms were marked, the patient was much emaciated; temperature high and irregular; pulse and respiration rapid and feeble. The expectoration was now very abundant, profusely purulent, and dark in color. It was intensely putrid to the smell. The stench of the breath was almost intolerable. Death occurred two weeks later. The whole lower lobe of the right lung was found to be gangrenous; some of the dorsal vertebræ were eroded, and the diaphragm was perforated, so that there was a purulent collection above the liver. As a focus of all this the bit of grass was found in the gangrenous lung. It is useless to pursue the symptomatology of these cases further. The chief indications for surgical interference are shown—septic exhaustion, a foreign body which is exciting pernicious inflammation, and large cysts which cause distress by pressure.

It is well urged by Fenger and Hollister (*Jour. Am. Med. Assn.*, July 19, 1884; also, *Am. Jour. Med. Sci.*), that pneumotomy should be more often done. The operation is not necessarily fatal. Of some forty cases reported in the medical literature of the past four or five years, about one-fourth have resulted fatally. The operation is resorted to for a disease which is not necessarily fatal, but which does not often cure itself. It arrests the septic exhaustion and the loss of lung-tissue, and prevents the invasion of other parts by the inflammatory process.

Treatment of Lung Cysts.—Pleuritic adhesions are to be expected in the case of any severe lung lesion, and, in most cases of abscess, one may wait safely until such adhesions form before making an opening. It has been suggested (Fenger and Hollister) that the motion of an aspirator-needle thrust into the lung would determine the presence or absence of adhesions. In case adhesions are present, make an opening at the point at which the cyst seems most superficial, following an aspirator-needle as a guide, and check all hæmorrhage before attacking the pleura or lung. If the intercostal spaces are too narrow, exsect an inch or more of a rib as in empyema. In penetrating the lung, Mosler advises the use of the thermo-cautery, at a dull cherry heat, to prevent hæmorrhage. Another and older method is to pass a large trocar and cannula, and to insert a drain through the cannula after withdrawal of the trocar. This device is especially valuable when the cyst is rather deep.

Should there be no pleural adhesions, the case must be treated as an empyema. Make a free opening, and, if necessary, a counter-opening, in the chest-wall. Be sure the products of inflammation have free exit. Pass the finger into the wound and break down septa freely but gently. If the pus be very fetid, do not hesitate to wash out the cavity with a weak antiseptic solution—sublimate, 1–10,000 to 1–5,000; thymol, 1–1,000 to 1–500. Put one or two big rubber drainage-tubes in the cavity; two are better than one, for one may become plugged. Fasten the ends of the tubes, lest one slip into the cavity. If the foreign body can be found extract it, if possible. If not, perhaps you will obtain a good result, notwithstanding. One of the earlier cases resulted in a a cure, though the foreign body was not found (Fowler, *Brit. Med. Jour.*, 1884, p. 1045).

Apply a large antiseptic absorbent dressing. Bags of wood-wool, wood-pulp, peat, or saw-dust, moistened with a solution of corrosive sublimate (1 to 1,000), answer this purpose well. Cover this dressing with a layer of cotton, and hold the whole in place by a binder. As soon as the discharge comes through the dressing, or the symptoms demand it, wash out the cavity and apply a fresh dressing. As long as the discharge remains foul wash out the cavity at least once daily. The after-care must be very constant. Push nutrition to its highest point, and watch every item in the nursing.

Parenchymatous injections into diseased lung and the treatment of phthisical cavities by remedial injections.—In 1867 Dr. Pepper, of Philadelphia, suggested that, as tubercular lung-cavities had many points in common with other abscesses, local treatment might be of value. He hoped to be able to treat these ulcerating surfaces by such local treatment as would check the tendency to disintegration and at the same time promote the healing of the cavity. The experiment of Kock, Fraenkel, and others, showed that animals bore almost any injection into the lung-substance with only slight constitutional disturbance and almost no local irritation.*

* Fraenkel, for example, used rabbits in his researches. He gave daily one to six injections of one gramme each, using the following solutions: Solution of carbolic acid, 1, 2½, 4, and 5 per cent.; solution of boracic acid (aqueous), 4 per cent.; solution of iodoform, in oil, 5 per cent.; solution of acetate of alumina, 2, 4, and 5 per cent. (*Deutsche Med. Wochenschrift*, 1882).

In 1880 Pepper published twelve cases which he had treated by over two hundred injections of an iodine solution, or sometimes of carbolic acid in weak solution. No harm seemed to be done by the injections in any of the cases; and there seemed to be a tendency to repair in some of the cavities treated, as well as relief of some symptoms (*Am. Jour. Med. Sci.*, October, 1874; and *Trans. Am. Med. Assn.*, vol. xxxi., 1880).

On the whole, Pepper's results were very hopeful, but others do not appear to have secured like benefits from his methods. A number of cases treated by parenchymatous injection have been reported. In the hands of some, the operation would seem a success; with others, no benefit results. It appears that the value of the operation must remain *sub judice* until further results are known. The following are ideas of two observers in brief.

Skolowsky reports that he was unable to see any advantage from injections of carbolic acid solution (one per cent.) or iodine solution (five per cent. of the tincture). The injections were well enough endured, especially those of iodine. Instead of improving the patients' condition, the fever increased for a short time after the injections, and in some instances an alarming attack of dyspnœa followed the operation (*Centralblatt f. die Med. Wissensch.*, 1882) Dr. Beverley Robinson, of New York, has treated eighteen cases, by twenty-nine injections. "In six instances the patients were benefited with respect to their cough and breathing. . . . In one case localized pain . . . was diminished. In three cases expectoration was considerably less, and in one of these the sputa were favorably modified in appearance. In one case the pain was apparently increased by the injections" (*N. Y. Med. Record*, 1885).

On the whole, there seems to be little, if any, advantage to be gained from the treatment unless the tubercular process is surely circumscribed, and the remaining lung-tissue unaffected. Even if the process be localized, the injection is still likely to be futile until a specific for the bacillus of tuberculosis is found.

Method of Injecting.—A syringe holding about twenty-five minims is used. The needle is about three inches long, and rather slender, though strong enough to avoid the danger of breaking easily. The puncture is made in the mammary line, at the lower margin of the first, second, or third intercostal space, and usually to a depth of one and a half or two inches, depending upon the thickness of the chest-wall. The fluid used by Pepper was usually a dilution of the compound solution of iodine, 1 to 15, later, 1 to 5, and of this four to twenty-five minims were injected. The patient sits and holds his breath for a few seconds while the injection lasts. The pain of the puncture may be avoided by local anæsthesia. Slight pain and coughing follow the injection.

In pneumonia a French author, M. Lepine (*Lyon Médical*, May 30, 1886), claims to have obtained success by a novel mode of treatment by parenchymatous injections of solutions of the bichloride of mercury. He uses the sublimate in 1 to 40,000 solution, and claims that he has seen no bad results and has had no complications beyond some pain and slight hæmoptysis. By his method he claims to have had excellent recovery in all cases so treated. His mode of operating is to pierce the carnified lung to a depth of an inch or an inch and a half, and inject a small quantity; then, after partially withdrawing the instrument, he advances to a new spot and injects again. This process is repeated through three or four intercostal spaces. He has injected as much as three ounces at one sitting. *F. A. Manning.*

LUNGWORT (*Pulmonaire officinale*, Codex Med., leaf). *Pulmonaria officinalis* Linn.; Order, *Borraginaceæ*, one of the plants called Lungwort, was so named because its leaves were blotched and spotted with lighter color, in a way to remind one of the mottled look of the surface of lungs in some conditions. The leaves are from eight to fifteen centimetres long, and half as broad, heart-shaped, and hairy, of little taste, bland and mucilaginous, and of no medicinal value whatever—which may be said in general of the whole order (see BORAGE). They have been used as household herbs in colds and coughs.

ALLIED PLANTS.—See BORAGE.

ALLIED DRUGS.—A widely distributed lichen, *Sticta pulmonacea* (*Lichen pulmonaire*, Codex Med.). Acharius, growing on oaks and beeches, with a spreading, flat, branching, brown thallus, is also called lungwort, on account of the deeply rugose character of its surface, which gives it a reticulated look, and may remind the imaginative of a section of the lung with its open bronchi and vessels. For the same reason, probably, it is an old household herb for bronchitis, hæmoptysis, etc. See MOSS, ICELAND. *W. P. Bolles.*

LUPUS ERYTHEMATOSUS. A disease of the skin formerly included among the cellular neoplasmata, but of late by some dermatologists considered to be an inflammatory process. Veiel defines it as an inflammatory process beginning in the swollen capillaries of the corium and papillary layer of the skin and leading to cell-infiltration and to the formation of cell-foci. It is this formation of cell-centres or heaps which brings lupus erythematosus anatomically close to lupus vulgaris, although the clinical appearances of the two affections are dissimilar.

Clinically, lupus erythematosus is characterized by one or more circumscribed, roundish or irregularly shaped, variously sized reddish patches, either smooth or occasionally covered with grayish or yellowish adherent scales. The disease usually begins in the form of one or more roundish, erythematous patches, from the size of a pin-head to that of a small pea, which enlarge upon their periphery, and often coalesce to form large irregularly shaped patches. After a time the patches increase in thickness and show more infiltration, and when fully developed there may be a number of patches, varying in size from a split pea to a silver dollar or the palm of the hand, having usually a distinct and clear-cut marginal outline. In color they are reddish or violaceous, and are either smooth or covered with fine, dry, adherent scales, or, in other forms of the disease, covered with sebaceous-looking crusts, like those found in seborrhœa of the face. In the latter case the crusts are firmly attached to the openings of the sebaceous glands, which are often plugged up with inspissated sebum or are denuded and patulous. The patch spreads on its margin, which is usually higher than the centre, the latter being commonly paler and often showing atrophic depression. Occasionally the patch may heal at one point while spreading at another, giving rise to lesions of a gyrate form. After a variable time the patch attains a certain size, and may remain stationary. There is never any moisture or discharge in connection with the disease.

The affection may spread, either by an extension of the original patch or by the occurrence of new centres of disease, or both. In unfavorable cases a number of new centres may appear at once, and occasionally the disease, after remaining quiescent for a considerable time, may suddenly spread by the occurrence of a more or less erysipelas-like rash, leaving behind it a permanent erythematous eruption which soon takes on the characteristic appearance of L. erythematosus. This is particularly apt to occur upon the face. The course of the disease is usually exceedingly chronic, lasting months and years.

The most common seat of lupus erythematosus is upon the face. Not infrequently the bridge of the nose and a symmetrical patch on either cheek are affected simultaneously, and the disease assumes the appearance of a butterfly with outstretched wings, the body being on the nose. This is a highly characteristic appearance of the disease. In addition to the nose and cheeks the eyelids, ears, lips, and scalp are favorite seats of the disease; less frequently the fingers and toes. Hyde has recently published an interesting monograph on the occurrence of lupus erythematosus on the backs of the hands. When hairy parts are affected the hair is apt to fall out and disappear, through atrophy of the hair-bulbs. On the scalp, however, where the roots of the hairs are deeper, complete or nearly complete regeneration of the hair has been

observed by the writer after the eruption of lupus erythematosus had healed.

Occasionally lupus erythematosus may assume an almost malignant form, as has been observed by Kaposi and others. Here the disease not only appears in the localities of predilection mentioned above, but a large number of foci of disease may appear almost simultaneously in various parts of the body. General symptoms of fever, pain in the bones, headache, etc., accompany the outbreak of the eruption. Sometimes an eruption like erysipelas, only persistent, breaks out over the entire face, with swelling, œdema, high temperature and pulse, and typhoid symptoms, leading to a fatal termination, may supervene. At other times numerous hæmorrhagic, or clear, watery blebs, such as are seen occasionally in herpes iris, break out at different points and soon dry to a crust, which, falling off, leaves the characteristic lupus erythematosus patch, with its depressed centre and dusky red border behind.

Lupus erythematosus of the mucous membranes is very rare. It has been observed upon the eyelid, lip, mucous membrane of the hard palate, and buccal surface of the cheek. On the lip the surface is dry and looks as if strewn with fine, grayish, sand-like scales. Within the mouth the lesions occur as red or grayish excoriations, from the size of a pin-head to that of a pea, with bluish-white cicatrices.

Pathological Anatomy.—The earlier studies in the anatomy of lupus erythematosus seemed to indicate the sebaceous glands as the seat of the disease in the first instance. Later investigations, however, in localities, such as the palm of the hand, where no sebaceous glands exist, have shown that the part taken by these as well as by the sweat-glands is only secondary. The affection is now believed to originate in the epidermis and papillary bodies, and only rarely in the deeper layers of the skin. The morbid process begins by enlargement and distention of the capillary blood-vessels, involving later the capillary net-work around the glands. Along the course of these vessels a profuse cell-infiltration occurs, with the formation of cell-collections. Increased cell-formation also takes place in the glands themselves, together with hypersecretion. Along with this, connective-tissue new-growth and serous infiltration of the tissues occur. Fatty and hyaloid degeneration subsequently take place, leading to cicatricial atrophy, with shrinkage of the glands and obliteration of some of the included blood-vessels, and this gives rise to the central depression observed clinically.

In the epidermis a fissured horny layer, fatty degeneration, and cloudiness of the rete cells, with subsequent atrophy, are observed.

It results from the observations just noted that such designations of this affection as *lupus acnéique, seborrhœa congestiva*, etc., referring to an involvement of the sebaceous glands as an essential feature of the disease, are incorrect.

Etiology.—Lupus erythematosus is one of the rarer skin diseases. In this country, out of 81,953 cases of skin disease observed by members of the American Dermatological Association, only 324 cases of lupus erythematosus were reported—about 0.39 per cent. It is said that women are more frequently attacked than men, in my experience about three times as often. The disease usually shows itself between the ages of twenty and forty. The exact cause of the disease is unknown. Predisposing causes are other affections of the skin, such as acne rosacea, seborrhœa, erysipelas, etc., which give rise to congestion.

Diagnosis.—The diagnosis of well-developed lupus erythematosus is usually not difficult when the disease is found involving characteristic localities. When, however, it is found ill-developed, or in unusual places, the diagnosis may at times require very careful examination into the history and features of the suspected eruption.

From *lupus vulgaris* the disease under consideration is distinguished by appearing in small, superficial, red points with, occasionally, adherent crusts, which on removal show projections on the under side corresponding to patulous sebaceous ducts. L. vulgaris begins with deep-lying brownish or orange-red points in the cutis, not superficial. L. erythematosus never goes on to softening, suppuration, and crusting, and never forms tubercular enlargements, as does L. vulgaris. L. erythematosus is confined to the skin and subcutaneous cellular tissue, never attacking the deeper tissues, such as cartilage, as L. vulgaris does.

Lupus erythematosus may now and then, though rarely, be mistaken for acne rosacea. Both involve the nose and cheeks adjoining. But in acne rosacea there is no surrounding elevation with central depressed cicatrix or adherent crust, while the dilatation of the vessels is much more marked, and pustules not infrequently occur.

Psoriasis sometimes may be mistaken for L. erythematosus, but the scales of psoriasis are dry and silvery, and on raising them a moist, punctiform, bleeding surface is observed underneath instead of the processes dipping into the sebaceous ducts often observed in L. erythematosus.

Erythema multiforme may resemble L. erythematosus very closely when occurring in the characteristic localities of the latter, but the peculiar violaceous tint and the comparatively rapid course run by the disease will serve to distinguish the two.

The *circinate papular syphiloderm* may be mistaken for L. erythematosus, but the red coloration of lupus disappears under the pressure of the finger, while the red coloration of the syphilitic eruption remains and shows a hard, shining, infiltrated boundary. In addition the boundary wall, so to speak, of the syphiloderm is seen on close examination to be made up of aggregated round lesions.

Treatment.—Internal treatment is quite ineffectual for the cure of lupus erythematosus. There is no specific against this affection. Nevertheless, in cases where the general system is below par tonics are clearly indicated, more particularly where the patient has a history pointing to tubercle or when the disease tends to take on the disseminate form.

The local treatment is of great importance. Unfortunately, the fact that a very great number of remedies have been recommended seems to indicate that at times none is altogether satisfactory, and such will in practice occasionally be found to be the case.

In the milder and more superficial forms of the disease, especially where new patches are appearing or old ones spreading superficially but rapidly, the following formula will be found useful: ℞. Zinci sulphat., potasii sulphuret., āā 2 grm. (ʒ ss.); aquæ rosæ, 112 grm. (f ℥ iijss.); alcoholis, 12 grm. (f ʒ iij.). M. This mixture is to be well shaken and applied with a sponge morning and evening. If too strong it may be mixed with water, or if found not stimulating enough the solid ingredients may be increased somewhat in quantity. This preparation, however, should not be used when the process is very recent and acute, partaking of an erysipelatous character. Here the most soothing remedies alone are appropriate, *e.g.*, lead-water and laudanum. The sulphide of zinc wash just mentioned may be brought into use a few days later.

Among the more highly stimulating semi-caustic applications may be mentioned chloracetic acid and pyrogallic acid. The first is applied in a liquid form with a glass brush or a pointed stick. It quickly covers the surface with a thin white eschar, is not painful, gives rise to little inflammatory action in the neighborhood, and is followed by a smooth cicatrix. The operation should be repeated every day or two as necessity requires. Pyrogallic acid is applied in the form of ointment of the strength of ten per cent.

In chronic cases the most satisfactory treatment will be found to be that by linear scarification. This may be carried out by using a fine scalpel or tenotome, holding it in the hand like a pen, and making a series of parallel incisions about a sixteenth of an inch apart and extending entirely through the skin. Having covered the patch to be operated upon with a series of incisions running in one direction, a fresh series, perpendicular to the first, should follow, and even a third series may be practised

until the diseased skin is fairly hashed up by the knife. The multiple scarifier of Squire (pictured under Lupus Vulgaris) may be used when large areas are to be operated upon. Excepting in persons of particularly tough fibre, it will be necessary to freeze the skin with a little bag of ice and salt or by means of ether or rhigolene spray before operating. Bleeding may be checked at once by the application of absorbent cotton with pressure. Successive patches of a square inch, more or less, may be operated upon daily, until the entire surface has been covered. When the wounds are healed, which will be very soon, the operation can be repeated on any patches that may have escaped. Scarification thus accomplished leaves little scar, and, as has been said, gives a more satisfactory result than any other treatment.

Prognosis.—The prognosis of the milder forms of lupus erythematosus is in general favorable. Small patches in a stationary condition can always be removed and the superficial variety, when recent, can usually be cured by the milder applications above described. Indeed it is surprising how quickly large patches of lupus erythematosus will sometimes disappear. On the other hand, relapses often take place to a most discouraging extent, and when such inaccessible parts as the scalp, the inside of the ear, or the mucous membranes are attacked the disease may often be said to exhaust itself rather than yield to treatment.

The prognosis of the exceedingly rare disseminate form is said to be grave.

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LUPUS VULGARIS. A neoplasmic affection of the skin of a highly chronic character and course, characterized by the formation of small centres of infiltration in or under the surface, of sharply defined outlines, yellowish-red or reddish-brown in color, and disappearing only slightly under pressure. When further developed these patches of infiltration tend to rise above the surface and form papules and tubercles. The disease spreads by peripheral extension and the formation of new centres, while the older ones disappear by gradual resorption or by ulceration followed by the formation of disfiguring scars. The varying degree of involvement of the corium and papillary layers of the skin gives rise to certain clinical varieties of the disease. These are as follows:

1. Lupus Maculosus.—Here the primary efflorescence of lupus vulgaris shows itself in the form of a little patch, the size of a pin-head, situated in an otherwise normal skin and slightly sunken below the surrounding surface. Its color is yellowish brown, only slightly changed to a lighter shade under pressure. The epidermis covering the patch is smooth, rarely slightly scaly and shining. The most characteristic point about the patch is its consistency, which is much less firm than that of the surrounding skin, so that when a blunt probe is pressed upon it it gives way and the probe buries itself in the mass, while normal skin entirely resists such pressure.

The lupous tubercles are seated in the connective-tissue layer of the skin, whether they occur in unaltered skin or in old scars. In the latter their bright color sharply contrasts with the dead-white of the scar.

Lupus maculosus is always the first stage in the development of the disease. It is sometimes met with as the first sign of the original affection, or it occurs in the periphery of old patches of disease, or as the first sign of relapse in cicatrices, usually in the form of small groups of lesions distributed in a more or less circinate arrangement. There are no subjective symptoms accompanying the development of lupous tubercles.

2. Lupus Exfoliativus.—In the course of the affection, always, it must be remembered, a very chronic one, a number of the lesions above described not infrequently join to form a patch, usually of a roundish shape and two to three centimetres in diameter, of a brownish-red to brownish-yellow color. By the time such a patch is fully formed the centre has already begun to undergo retrogressive metamorphosis (fatty degeneration, caseous change, and scarring), and is seen to be of a darker color while the periphery is still bright red and forms a sort of wall-like elevation around the patch. In addition to these closely crowded conglomerations of lupous tubercles of irregular form, single, isolated, recent lesions can be seen.

The infiltration, which is pressing downward as well as spreading on the periphery, robs the surface of these flat lupous patches of their normal linear markings, by destruction of the papillary bodies and flattening of the processes of the rete-malpighii. At the same time the cohesiveness of the horny epidermic cells is impaired, so that the surface is scaly, rough, and fissured. The skin is also thinned, and thus easily becomes folded and wrinkled. It is this peculiarity which gives the name lupus exfoliativus to this form of the disease.

3. Lupus Exulcerans.—Now and then the lupous process ends by a sort of subcutaneous cicatrization (cicatricial atrophy). Usually, however, the intensity and acuity of the necrobiotic process is such that, in connection with the usual external sources of irritation, it is enough to cause solution of continuity in the normal epithelial covering, when the disintegrating lupous infiltration will be exposed.

Upon this a freer secretion is established—a suppuration—and we have an ulcer. This constitutes lupus exulcerans.

The surface of the lupous ulcer is covered with yellowish and brownish, rather thin crusts. On lifting these and wiping away the secretion, the surface is seen to be irregular and covered with granulations which are soft and "rotten." The border of such ulcers slopes gradually to the level of the skin, which for some distance around shows the brownish-yellow color and soft consistence of lupous skin. Sometimes a wall-like elevation is observed surrounding the ulcer, due to unusually active lupous infiltration.

4. Lupus Serpiginosus.—When the lupus process proceeds with rapidity, a very rare occurrence, the affection is sometimes called *lupus vorax* or *lupus exedens* (although it may be said in passing that most of the cases formerly called lupus exedens were in reality syphilis). When, however, as is usual, the granulations, the exposed corium, and the subcutaneous connective tissue gradually become disintegrated, and are replaced by persistent connective-tissue which subsequently becomes covered with epithelium proliferated from the neighboring parts, a further stage is reached. The lupus heals and is replaced by a thick, irregular, retractile scar. This healing, however, may take place only in the centre, or in a segment of the periphery, where the lupus virus is extinct, and therefore where cicatrization can take place, while at other points the morbid process continues and the lupus creeps on, followed by the scar and giving rise to circinate and gyrate forms. This is lupus serpiginosus.

5. Lupus Hypertrophicus (*Lupus frambœsioides*).—The inflammatory formative neoplasia of the connective tissue at the base of the lupous ulcer may overbalance the necrotic disintegrating tendency in some cases, and then exuberant granulations are found, which sometimes become covered with epithelium and remain as permanent warty growths, and at other times become soft and fungous, bleeding easily at a touch. This form of the disease has sometimes been called "frambœsia luposa," or "lupus frambœsioides." The firmer form, occurring

on the extremities, leads to considerable hypertrophy, even causing the limbs to look elephantiasic. The various names which have been given to this form of the disease give some idea of the aspects which it presents. It is called, in addition to the terms just mentioned, L. tuberculosus, L. tuberosus, L. nodosus, L. tumidus, L. papillaris, L. varicosus. However, the title L. hypertrophicus will cover all these.

These later forms of lupus are not, however, permanent in character ; sooner or later, sometimes only after the lapse of years, they break down and result in cicatrization.

As to the mode of propagation of lupus, one way, that of spreading by contiguity, has been mentioned, but the disease may, and frequently does, attack various and sometimes remote parts simultaneously. It may also extend along the lymph-spaces, the deep-lying sweat-glomerules, and the connective tissue until arrested by the deeper fascia and the bones. In fact, the periosteum itself is now and then attacked, and in this way superficial necrosis may be produced Cartilage is very readily attacked by the lupus virus, often with the result of a serious loss of substance.

In by far the greater number of cases of lupus the disease first shows itself upon the external skin, and proceeds from this to the mucous membranes (of the mouth, pharynx, conjunctiva, etc.). Primary lupus of the mucous membrane has been observed only in rare cases. In lupus of the mucous membranes the small, reddish-brown, sharply defined lesions above described as ushering in the disease in the skin are not usually observed. Instead, minute whitish exfoliations of the epidermis show themselves in the livid red, slightly thickened mucous membrane. Later, these are transformed into small warty prominences, which either continue covered with the whitish epithelial coating or show a red, easily bleeding surface.

Having now pointed out the various forms which lupus vulgaris may assume, we may examine the especial varieties of appearance induced by the difference in locality. The lupous process may occur in any part of the body, but is by far the most commonly found upon the face and extremities. Usually the disease is confined to one or more small-sized patches, rarely overpassing an area the size of the hand. Occasionally, however, very extensive surfaces may be involved in one sheet of disease, as the entire face or neck, or, as the writer has observed, the greater portion of one thigh and buttock.

Lupus of the face begins either in discrete patches of the macular variety, situated on one or both cheeks, which may exist a long time without attracting the patient's attention, or it may first show itself upon the nose in the form of lupus tumidus or tuberculosus, giving rise gradually to tumefaction and a bluish-red discoloration. While now the central portions heal up with the formation of scars, the disease may be spreading sometimes in a serpiginous manner, and at other times by the peripheral occurrence of new isolated patches of disease in the neighborhood, leading gradually to the involvement of the upper lip, brow, and eyelids. At a later stage these isolated patches may become confluent, and the formation of cicatricial tissue may lead to extreme disfigurement, not only from irregularity of cicatrization, but by the production of ectropion of the eyelids and lips, while the œdema and tumefaction of the latter, with the purplish discoloration of the disease, give the face a hideous aspect scarcely surpassed by the ravages of leprosy or syphilis. Lupus of the forehead may give rise to exfoliation of the frontal bone.

Lupus of the nose may cause even greater deformity than lupus of other parts of the face. The new-growth is either macular, and then its degeneration and cicatrization lead to shrinking, wrinkling, and deformity and retraction of that member; or, if the lupus is tubercular, the nose may be somewhat swollen, brownish in color, covered with shallow ulcers and crusts, while the septum and cartilages are swollen, the nasal openings narrowed or closed with products of disease and decay. This hypertrophied condition may last for a long time. When it passes away, however, by the disintegration of the affected parts or on their removal by operation, the nose is found to be destroyed to the very bone, and even the nasal passages may be involved for some distance.

Lupus of the upper lip rapidly attacks the mucous membrane and produces a rough surface resembling granulations. The lip itself is greatly swollen and everted, irregularly fissured with rhagades, and bleeds easily. When these rhagades heal they leave bands of cicatricial tissue with deformity. After a time the mouth cannot be closed, and this favors the production of further ulcers of the mucous membrane; and finally, if medical aid has not been sought, the loss of substance proceeds to such an extent that the nose, upper lip, eyelids, bones of the upper jaw, etc., are more or less destroyed, with hideous deformity. Of course, such a condition is rarely observed in civilized countries.

Lupus may involve the entire mucous membrane of the mouth, the gums, soft and hard palate, and give rise to softening, puffiness, bleeding ulcers, granulations, etc., which may persist or may become gradually covered by cicatricial tissue. When the disease attacks the epiglottis and the larynx, the appearance presented is that of a flat granular surface of a purplish, œdematous appearance. When cicatrization takes place much deformity, loss of voice, etc., result, as has been pointed out by Chiari and Riehl.

Lupus of the external ear gives rise, very soon after its development, to a considerable swelling of the entire auricle. The marked hypertrophy which almost invariably involves the lobule is highly characteristic, causing this part of the ear to hang down like a soft pear-shaped tumor. The epidermic covering may remain intact for a long time—in one case observed by the writer, the surface remained intact for several years—the epidermis meanwhile being thin and transparent, while the whole tissue of the lobule suffered cheesy degeneration in numerous foci, and became so soft that the lobule might have been twisted off between the finger and thumb. The entire auricle may be destroyed by the disease, and the external meatus may be closed by resultant cicatrization.

Lupus occurs in the *neck* usually by extension from the face, with superficial ulceration and the formation of retractile scars ; or the disease may develop in separate foci, sometimes causing openings in the skin over the lymphatic glands and giving rise to appearances resembling those of scrofuloderma with glandular ulceration.

Lupus of the body and limbs commonly assumes the serpiginous form and may, in the course of years, spread over considerable areas without giving rise to very marked discomfort. Lupus deposits about the joints are of considerable interest and importance, because the ulceration and resultant cicatrization may give rise to impairment of movement in the affected joints and limbs. In the hands, caries and necrosis of the bones may occur with anchylosis and much deformity. Amputation of the extremities, upper or lower, as the case may be, must sometimes be performed.

Lupus of the genitalia affects in men usually the prepuce, to which it extends from other parts. In women the lupous ulceration is of importance because of the differential diagnosis. The name "esthiomène" has been peculiarly attached to lupus of the female genitalia. The reader is referred to the verbose and obscure, but important, writings of Mathews Duncan and the French authors for further information on this branch of the subject. The affection in this locality is fortunately rare.

Lupus of the Mucous Membranes.—Although already touched upon, a few more words may be said upon this point. As has been said, the disease in most cases is propagated by extension from the skin to the mucous membrane. No lupus nodules, such as first appear in the skin, can here be seen, and the appearances presented are rather those of papillary excrescences, with whitish epithelial cloudiness over the minute globular lupus, infiltrations which cannot themselves be perceived by the naked eye. The excrescences unite to form patches, with roundish serpiginous borders, which finally ulcerate. These ulcers are distinguished by their long continuance,

cicatrization being prevented by relapses into the granular condition. Excessive granulation with frambœsioid excrescences sometimes occurs afterward, at times breaking down into ulcers and leaving knotty and disfiguring cicatrices. Primary autochthonous lupus of the mucous membrane of the mouth, larynx, or conjunctiva is excessively rare, although it is possible that some cases are overlooked or the nature of the disease may be unrecognized until it appears also upon the skin. It is also not unlikely that some cases of so-called eczema of the nares may be lupus, though difficult to distinguish as such until the disease develops characteristically in the neighboring skin.

A very frequent complication of lupus is erysipelas; so says Neisser, on whose description the foregoing account of the disease is chiefly based; but this is not the case in the comparatively mild forms of lupus vulgaris seen in this country, although the writer has occasionally observed it. Some authors have observed a rapid cure of lupus following an erysipelatous attack occurring in the affected locality.

Course of the Disease.—Lupus vulgaris usually develops between the third and the tenth year, beginning with such trifling lesions that it commonly passes unnoticed until, at the period of puberty, it springs into new life, and a rapid development of the disease, with destruction of the affected parts, is observed. The Germans, who have a large experience in this disease, are sceptical as to the occurrence of lupus vulgaris after puberty, preferring to think that an affection which begins so insidiously, and progresses so entirely without subjective symptoms, must have passed unnoticed at an earlier epoch.

The extension of lupus vulgaris, its growth and spread, are very slow, and it may be years before a patch has developed to any considerable size. This chronicity cannot be too strongly dwelt upon, as it is often a main factor in the diagnosis. There is some difference, however, in this respect between the different varieties of the disease. Lupus maculosus and L. exfoliativus are more lingering and benignant in their course, while lupus exulcerans, with which is connected *purulent* disintegration and destruction of tissue, is far less slow in its course, and has even acquired such synonyms as *L. vorax, exedens, phagédénique, perforant, térébrant*, etc. Such forms, we must state once more, are excessively rare in this country.

The chronic course of lupus vulgaris will perhaps account for the fact that in many, if not most, cases the patient's general health in no way suffers. Occasionally, suppuration of some of the lymphatic glands, the formation of large fistulous ulcers, erysipelas, or lymphangitis may cause more marked general symptoms, but this is rare.

Etiology.—Until recently the etiology of lupus has been obscure. Of late, however, the opinion of pathologists has inclined to the hypothesis that lupus is essentially a tuberculosis of the skin, induced by the bacillus tuberculosus, and only distinguished by its localization in the skin and its rare transference to other organs. Complications with tuberculosis of other organs, glands, joints, bones, and even analogous skin diseases, as scrofuloderma ulcerosum, are, moreover, not uncommon.

Diagnosis.—Lupus is so variable and multiform in its clinical aspects that the essential characteristics of the disease must be carefully borne in mind, if we would make an accurate diagnosis. These are as follows:

As regards its history, it must be remembered that lupus begins in infancy or early childhood, and that, although the absence of such a history does not absolutely exclude the disease, since, as we have seen, its early symptoms may escape observation, yet, if such a history is given in a doubtful case, it should have much weight. The excessively slow, lingering course of the disease is also to be remembered as characteristic.

As regards the objective appearances, we find in lupus: 1. A new-growth composed of soft, rotten granulation-tissue, lying in the skin, or very slightly elevated above its surface. 2. The formation of primary efflorescences in the neighborhood of old foci of disease; the small yellowish-brown papular lesions, which may be easily penetrated by a blunt probe, are the most valuable and characteristic marks of the presence of lupus.

The discoloration of the skin and pigmentation, the scaliness, and the marked and sometimes extensive flat infiltration, may cause lupus to be mistaken for various other affections, and, therefore, it may be well to add some points of differential diagnosis.

Chronic eczema, which may present somewhat similar reddish-brown, infiltrated, scaly patches, and may last for years, often resembles lupus very closely. The diseased patch in eczema is, however, firm and hard, and cannot be penetrated by the blunt probe. Eczema is moist at one time or another, and gives rise to crusts, but does not show true ulceration and is not followed by cicatrices. Eczema spreads as a uniform inflammatory infiltration to the neighboring parts; lupus, on the other hand, shows new independent centres of disease, which may coalesce later with the original patch.

Lupus may sometimes be confounded with *psoriasis* in cases where disseminated flat patches of lupus exfoliativus are numerously distributed, and where there is so little infiltration as to be imperceptible to the finger and to show no defined boundary. The clear, bright red of the psoriasis patch, with the abundant, easily detached scales usually covering it, and showing blood punctæ on removal, the more general distribution of the lesions, with their characteristic localization on the extensor surfaces of the limbs, are all diagnostic points. When, as in some cases, only one or two patches of psoriasis are present, in the face, for instance, it may be difficult to make the diagnosis without watching the course of the disease. The diagnosis between lupus and psoriasis has not been made any more easy by the use of the term "lupus-psoriasis," by Mr. Hutchinson, to denote a peculiar affection which is neither one disease nor the other.

Lupus erythematosus may sometimes be mistaken for L. vulgaris, but the clear red surface, with thin, superficial, greasy scales, the evident involvement, in many cases, of the sebaceous glands, and much less marked infiltration will help to make the diagnosis clear.

Rosacea and acne may be mistaken for lupus on account of the enlargement of the nose accompanying both of these diseases. The firmness of the tissues in acne and rosacea, the intense red staining, and particularly the pustular character and rapid development of these diseases, as well as the absence of any involvement of the nasal mucous membrane, will usually decide the question. Moreover, the more or less abundant telangiectasic development of blood-vessels, and the commonly accompanying seborrhœa, are additional points characteristic of acne and rosacea; while in cases in which the disease has spread to the adjoining cheeks the yellowish-brown patches of lupus, level with the skin, differ much from the bright-red, prominent papules which turn white on pressure, and not infrequently are surrounded by suppurating points.

The ulcerative forms of lupus vulgaris are to be distinguished from *epithelioma* and *syphilis*. As regards the former, the presence of elevated borders, of ivory-like hardness and pearly white, shining surface, the deeper involvement of the tissues, the scanty secretion, the fact that the disease begins in adult life, or even in advanced years, the occasional involvement of neighboring lymphatic glands, and also the occasional accompaniment of pain, with the almost invariable subjective sensations of itching, crawling, pricking, etc., will decide the diagnosis. It must not be forgotten, however, that carcinoma may accompany and even supplant lupus, so that transition forms are occasionally met with, and it may be said here that these forms demand quick and thorough treatment by extirpation or destruction, as the carcinoma finds a field for rapid progress in lupous tissue.

The question as to the diagnosis between lupus and syphilis is a more important one, especially in those countries where lupus is prevalent. Here, too, the subject has been obscured by the use of a double term, "lupus syphiliticus," to mean a disease which must necessarily be one or the other of these affections, or a third one, but cannot by any possibility be both.

The *tubercular syphiloderm*, when the lesions lie close together, may occasionally be mistaken for lupus; but the ulcerative forms of the two diseases having, as they both do, the nose and cheeks as their favorite seat, are most likely to offer difficulties in diagnosis. The history can rarely be depended upon, for lupus is just as likely to occur in a syphilitic individual as in any one else, and the ulcerative syphiloderm occurs so many years after the initial lesion as to make it almost impossible to get an authentic account of any infection. The differential diagnosis, then, must depend upon the appearances presented. The borders of the lupous ulceration are sharply defined indeed, but are flat, soft, not infiltrated, and the base of the ulcer slopes gradually up to the neighboring healthy parts. This base is flabby, red, granular, smooth, and bleeds easily; there is little tenderness.

The syphilitic ulcer, on the other hand, may be tender and sensitive, the borders are steep, sharply defined, firm, and wall-like from the syphilitic infiltration. The base of the ulcer is irregularly eroded and covered with pus and necrotic detritus. The crusts covering syphilitic ulcers are thicker and rise higher above the surface than those of lupus.

In the neighborhood of the lupus ulcer we find a soft, rotten granulation tissue, which gives way easily under any dull instrument, while the syphilitic infiltration is firm and resistant. Further, we often find large gummous tubercles in the neighborhood of the syphilitic ulcer, while around the lupus ulcer are the small, yellowish-red patches of infiltration in the skin, and rising above it, to which allusion has been made several times above. These are the most characteristic lesions of lupus under all circumstances.

Another point in the diagnosis between lupus and syphilis is the fact that lupus occurs in early life and syphilis in later life. The course of lupus is slow, that of syphilis comparatively rapid, and since a gummatous tumor should be dispersed in all cases rather than be allowed to break down, in doubtful cases antisyphilitic treatment should be employed. This cannot injure the lupus if such should be present, whereas waiting too long may result in ulcerative destruction of the nose or some other conspicuous feature if the disease should be syphilitic.

Syphilis and lupus of the female genitals are sometimes distinguished one from the other with difficulty. Fortunately they are rare. The lupus ulcer is deeper, shows less tendency to a circinate form, and is usually much more chronic in its course. However, the test by antisyphilitic treatment must of necessity sometimes be made use of here.

From chancroid of the female genitals lupus is to be distinguished by its history, the occurrence of lupus in other localities, and by the results of attempts at autoinoculation. Chancre is to be distinguished very much in the same way.

TREATMENT.—The treatment of lupus vulgaris is to be undertaken with two objects in view; first, to arrest the spread and progress of the disease; and, second, to destroy the products of disease already formed. Those diseased parts which, if left alone, would go on to ulceration and destruction, are to be removed, and in those which are still relatively firm and sound, absorption of the diffuse or circumscribed lupous cell-infiltration is to be obtained if possible.

The internal treatment, which is most likely to meet with success, consists in the administration of iodide of potassium and cod-liver oil. These remedies, however, must often be continued for a very long time in order to get the benefit of their action. Besnier, indeed, thinks that neither of these remedies is ever effective, but this is too sweeping. Arsenic in small doses, quinine, and iron may be employed as general tonics in cases which seem to require such treatment, but without any idea of a specific effect. For the same reason change of air and climate are also to be recommended in some cases.

Among the topical remedies recommended in lupus are included emollients, discutients, and substitutive irritants. Among the first of these may be mentioned vapor baths, starch poultices etc., the object of which is simply to soothe any inflammatory condition which may be present. Their effect is transient. Among the discutients may be mentioned emplastrum de Vigo, or mercurial plaster alone, tincture of iodine, or iodized glycerine, watery or alcoholic solutions of perchloride of iron, chloride of zinc, etc. But little more can be said of these than of the emollients. No one who has dealt much with lupus vulgaris will dally with these rose-water methods. Something more can be said in favor of the remedies known as substitutive irritants, the effect of which is to replace the chronic morbid process by an acute inflammation, and cases of lupus cured by erysipelas are on record. However, it is not until we get to actual caustics that a good effect can be hoped for with anything like certainty.

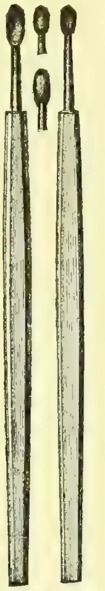
FIG. 2187.—Lupus Curettes. (After Squire.)

Among caustics pyrogallic acid may be mentioned as one of the mildest of those which are really effective. One plan of using this remedy is to apply a saturated solution of pyrogallic acid in ether on a compress, or to spray the disease-patch with the solution and coat the surface afterward with a film of collodion. Another plan is to apply a ten to fifteen per cent. ointment of pyrogallic acid (after removing any crusts), renewing the application two to four times daily, following after several days with mercurial plaster, renewed once daily, or oftener, according to the effect in producing suppuration. The pyrogallic acid melts away the lupous infiltration, leaving the sound tissue nearly uninjured, and the mercurial ointment penetrates beyond the point which the pyrogallic acid has reached. It must be said, however, that none of the above methods is perfectly satisfactory, and for this reason we have omitted mention of a great number of similar applications to proceed to the description of more thorough methods of extirpation. These are of two kinds—operative (bloody) and caustic.

Operative (*Bloody*) *Treatment of Lupus.*—This comprises three varieties: 1. Extirpation by the knife. 2. Scraping. 3. Linear scarification.

Extirpation has the advantage of simplicity, and in the hands of the surgeon is a favorite method. Nothing is easier than to excise or dissect out the lupus patch and thus to remove the whole trouble at a stroke. But this plan cannot be carried out when the lupus is on the nose, or some other prominent part of the face, and when an extensive scar would be to the patient scarcely preferable to the disease. Moreover, relapses are extremely common after extirpation. Even when the growth has seemed to have been completely removed it returns in the neighborhood, or in the scar itself. An attempt to prevent this result has been made by cauterizing the wound with the actual cautery, or with the thermocautery.

Scraping, by means of the sharp spoon or curette, is a treatment recommended by Auspitz, Volkmann, Hans Hebra, Balmanno Squire, and others. The instruments used are similar to the curettes employed in obstetric practice, but modified to suit the circumstances of the case; their appearance can best be understood by reference to the cuts (see Figs. 2187 and 2188). The curette easily penetrates


FIG. 2188.—Lupus Curettes. (After Squire.)

the lupus tissue, while the healthy skin around offers so much greater resistance that the operator can guide his instrument with considerable precision. Linear scarification can be performed by means of a scalpel, or, perhaps better, where the surface to be covered is considerable, by the use of Squire's multiple scarifier.

Previous to employing either of these methods the patient should be etherized, or the patch to be operated upon should be frozen by means of rhigolene spray. As the frozen skin fails to show the boundary line between health and disease, this should be outlined with ink, or by some other means before the operation is attempted.

In order to remedy any defect in the result of the operations just alluded to, and to remove minute points of disease which have been left behind, Dr. G. H. Fox recommends the use of a dentist's burr, or hook, by which foci of disease as small as a pin's head, or smaller, can be removed from the meshes of cicatricial tissue left by linear or other scarification.

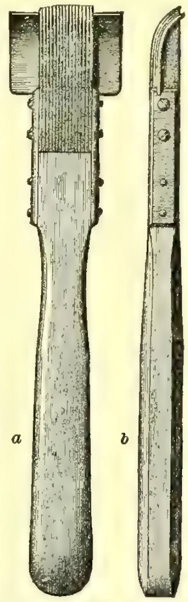

FIG. 2189. — Squire's Multiple Scarifier. *a*, Top view ; *b*, side view.

Cauterization.—Chemical caustics of various kinds applied to the surface, or introduced into the substance of the diseased tissue by sharp-pointed instruments, have long been employed in the treatment of lupus. Among these, caustic potassa, applied in the stick, is effectual, but is a very rough procedure, as it destroys every tissue with which it comes in contact, is occasionally accompanied by severe hæmorrhage, and leaves unsightly scars. The employment of potassa fusa may be recommended, however, when the necessity for immediate removal is urgent, and when appearances are of no importance.

Cauterization with the hot iron is still occasionally employed, and may at times be used to complete operations by excision or scarification. It has the advantage of guarding against the danger of infection, which, it is asserted by some authors, is incurred in operations where blood is shed. But it is a rather coarse and brutal form of treatment, necessitates the employment of general anæsthesia, and seems in the long run to have no advantages over other methods in preventing relapses.

Interstitial and localized cauterization by means of the thermo-cautery or galvano-cautery, as recommended by Besnier, in his able papers on the treatment of lupus, offers, perhaps, the most satisfactory treatment of the disease which has yet been devised. It requires, however, the use of certain instruments, which cannot be had by all. The ordinary Paquelin cautery may be used in most cases, but the galvano-cautery can be kept under more perfect control, and is therefore more convenient, besides allowing the use of a great variety of cauterizing points of various sizes and shapes to meet every emergency. (See Fig. 2191.)

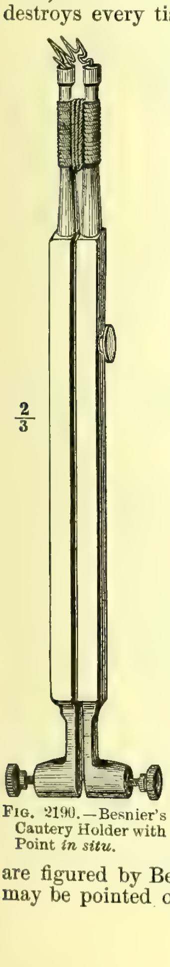

FIG. 2190.—Besnier's Cautery Holder with Point *in situ.*

The instrument here pictured, with the knives belonging thereto, explains itself. Other forms are employed and are figured by Besnier in his articles on the subject. It may be pointed out that, as the connection is made by pressing the little button on the handle, the operator is enabled to stop the action of the cautery at once, while the ordinary bichromate battery may be managed by an assistant who regulates the quantity of current to be employed. (See article on Electricity.)

Of course, in any of the operations above described, the after-treatment is a matter of some moment. Antiseptic measures are desirable, and the patient should be under the constant supervision of the physician, though he need not be confined to his house or to the hospital.

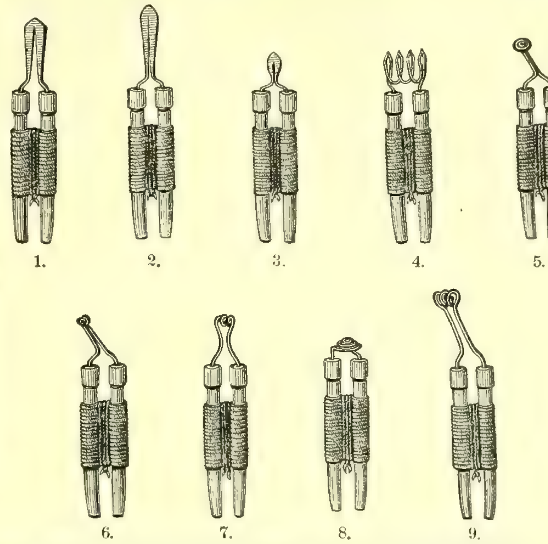

FIG. 2191.—Various Galvano-cautery Points. (Recommended by Besnier.) Of these the writer habitually uses Nos. 2 and 4, and a straight needle-point not figured here.

PROGNOSIS.—The prognosis of lupus must always be cautious. Relapses under any and every kind of treatment are extremely common, and time alone will show whether the disease is entirely gone. Nevertheless, a final cure is in almost all, excepting the very worst cases, the reward of perseverance.

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Arthur Van Harlingen.

LUXEUIL is a town in the department of the Haute-Saône, France, lying at an elevation of 1,200 feet above the sea, which has been known as a healing spa and visited by patients since the time of the Cæsars. There are seventeen thermal mineral springs, which are divided into two sets—fifteen saline and two iron springs. The climate of Luxeuil is mild and equable. Among the most important of the saline springs are the Source de l'Aqueduct, des Bénédictins, des Fleurs, des Dames, du Grand Bain, des Capucins, d'Hygie, Source Nouvelle, and Eugénie. The following is the composition of two of these springs, computed in grammes per litre, after the analysis of M. Leconte:

	Source des Dames. 110° F.	Source d'Hygie. 85° F.
Potassium sesqui-carbonate...	0.04350	0.00980
Potassium chloride	0.02589	0.00644
Sodium chloride.............	0.72333	0.12185
Sodium sulphate.............	0.13716	0.02437
Calcium carbonate...	0.03859	0.04291
Magnesium carbonate........	0.00215	0.01197
Manganese red oxide	C.01385	0.00499
Silicic acid	0.09810	0.03020
Organic matters, etc	0.02589	0.00447
Iodine and arsenic	slight traces	slight traces
Total solid constituents ..	1.10846	0.25700

Of the ferruginous springs only one, the Source du Temple, is employed therapeutically. Its composition does not differ very greatly from that of the Source d'Hygie, except that it is stronger and contains 0.027 Gm. of sesqui-oxide of iron per litre. Its temperature is about 75° F. The waters are used for both bathing and drinking. Atonic dyspepsia, gastralgia, diseases of the female sexual organs, neuralgia, anæmia and chlorosis, rheumatism and gout, hepatic troubles, and hysteria, are some of the most common affections for which the waters of Luxeuil are recommended. The season is from the middle of May to the end of September. The baths of Luxeuil are under government control, and the accommodations are excellent. *T. L. S.*

LYCOPODIUM, U. S. Ph.; Ph. G.; *Lycopode*, Codex Med. An exceedingly mobile, buff-yellow powder, consisting of the microscopic spores of the common club moss, *Lycopodium clavatum* Linn.; order, *Lycopodiaceæ*. This is a little evergreen vine common throughout most of the north temperate zone. It consists of a long, prostrate, occasionally forking stem, covered with minute, awl-shaped leaves in many rows, occasionally giving off rootlets from its lower side, and short ascending or erect, also leafy, branches from the sides and top. These branches are usually simple, or once or twice forked, the sterile generally only a few centimetres long, the fertile from ten to twenty long, terminated by one or two catkin-like spikes, raised on upright peduncles whose leaves are sparser and more closely appressed. The spikes consist of numerous triangular and tipped scales, each bearing a large reniform sporangium in its axis filled with obscurely four-sided reticulate-marked spores. These details can be easily seen by the accompanying cut.

Lycopodium is collected in Europe (Germany, Russia, etc.) by gathering the fruiting tops, drying and threshing them, and sifting and cleaning the powder. It is "a fine powder, pale yellowish, very mobile, inodorous, tasteless, floating upon water and not wetted by it, and burning quickly when thrown into a flame. Under the microscope the granules are seen to be four-sided, reticulated, with short projections on the edges."

It contains forty-seven per cent. of fixed oil (Flückiger), and has no other important constituent. It is only used as a non-adhesive powder for the protection of moist pills from sticking together, and for dusting upon excoriated places—to protect the surface and to prevent chafing; its action in both cases is wholly mechanical.

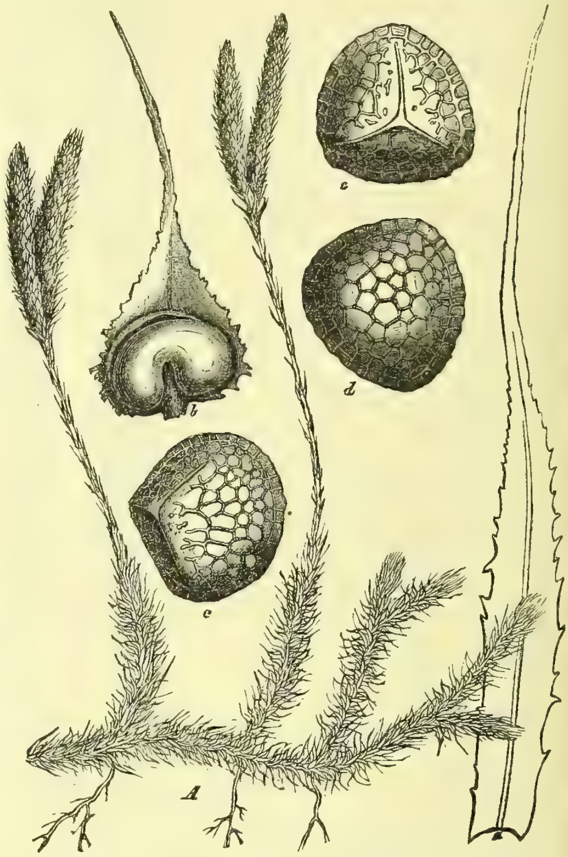

FIG. 2192.—Lycopodium Plant and Spores. *A* is the plant, something less than natural size; *a*, one of the leaves enlarged; *b*, a scale of the spike with the sporangium at the base enlarged; *c*, *d*, *e*, different views of the spores. (Luerssen.)

ALLIED PLANTS.—Several other species of *Lycopodium* contribute a little to the amount of spores obtained. The herb is sometimes used as a diuretic tea.

ALLIED SUBSTANCES.—Several other vegetable powders, *e.g.*, powdered liquorice, starch, etc., are used to protect pills from sticking. Starch, Oxide of Zinc, Bismuth, Chalk, etc., are used as protection against excoriation and chafing. *W. P. Bolles.*

LYMPHANGIOMA. The lymphangioma is a tumor whose chief constituents are lymphatic vessels. It has the same relation to the lymph-vascular system that the ordinary angioma has to the blood-vascular system. It is composed of widened and hypertrophied and newly-formed lymphatic vessels, which are imbedded in a fibrous tissue which is sometimes dense, at other times loose. All authorities agree as to the rarity of this form of tumor. Cornil and Ranvier are inclined to doubt the existence of a tumor made up of newly-formed lymphatic vessels, and are disposed to regard the cases which have been published as such as simply instances of the dilatation of the normal lymphatics of the part. Still, most authors describe such tumors, and there seems little reason to doubt that the greater part of their tissue is composed of newly-formed lymphatics. As in the case of the angiomas, the lymphangiomas can, according to the nature of the vessels composing them, be divided into the lymphangioma simplex and the lymphangioma cavernosum.

These tumors are generally congenital, though they may appear in later years. As such congenital lymph-

angiomas, Billroth reckons the enlargement of the tongue (macroglossia), of the lips (macrochelia), of the labia majora, etc. In the skin they are seated on the thigh and thorax. Sometimes they form large tumors which give well-marked fluctuation. On sections they empty an abundant fluid, which is generally clear and watery; in some cases, however, it is milky and of the same character as the lymph. Several of the French authors have reported these tumors as occurring often in countries where elephantiasis is common. Kaposi has described as lymphangioma tuberosum simplex a case in which sev-

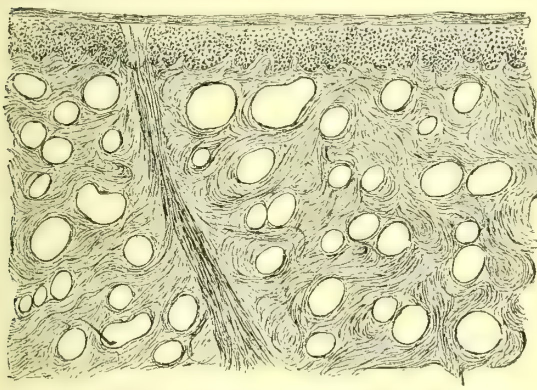

FIG. 2193.—Lymphangioma Tuberosum Simplex. (After Kaposi.)

eral hundred tumors of the size of a pea, or even smaller, were seen covering the skin of a woman, thirty-two years of age. Some of these had existed since childhood. The tumors were seated in the uppermost layer of the cutis; they were smooth on the surface, and on section were found to be composed of a dense fibrous tissue which contained many spaces of an irregular size. These were lined with an endothelium and were in all respects analogous to normal lymphatic vessels. He has never seen but this one case, and no similar case has since been reported. *W. T. Councilman.*

MADDER (*Garance*, Codex Med.). The root of *Rubia tinctoria* Linn., order *Rubiaceæ*. This interesting plant, which has been used from very early times as one of the most valuable dyes, has so little medical interest as to be entitled to little more than a bare notice in this work. It is a perennial herb, originally from the Orient, but cultivated extensively in the Old World, with a thick orange or reddish root, and numerous slender, trailing, four-sided, prickly, *Galium*-like stems, whorled leaves,* and minute tetramerous flowers. Its dried root is cylindrical, from three to ten millimetres thick, dark reddish-brown externally, and pink, red, or reddish-brown internally, according to age. It has a soft, rather parenchymatous structure, and a sweet, slightly astringent and bitter taste, tinging the saliva red. Its composition is very complex, and made still more so by the fact that its fundamental coloring principles are glucosides, which decompose in the roots, partly before manipulation, and wholly after macerating or by treatment with diluted acids, into valuable dyes. Some of them are as follows; *Rubichloric acid*, not important; *ruberythrinic acid* in yellow, silky prisms, decomposing into *alizarin* and sugar; alizarin, which is also one of the constituents of the dry root ready formed, is a valuable red dye; *purpurin*, a second red-purple substance allied to the former and formed with it, and several others. The natural ferment which assists in the glucoside reactions producing these colors is called *erythrozym*. They are, however, often hastened by dilute acids. *Sugar, mucilage*, etc., are other constituents of the root.

Madder has no medicinal value, although it was formerly used in infusions for a number of complaints—hysteria, epilepsy, jaundice, dysentery, etc., and as a diuretic. It is now obsolete. Singularly enough, it is becoming obsolete in dyeing, where it had great value, on account of the synthesis of most of its coloring substances from products of that most prolific of chemical treasures—coal tar.

ADMINISTRATION.—If desired, madder may be given in infusion, *ad libitum*; its qualities are those of its near relations, cleavers, etc.

ALLIED PLANTS.—Madder is the type of one branch of a most interesting family containing Cinchona, Coffee, and Ipecac; the nearest plants to madder are the *Galiums*; Goose-grass, Cleavers, etc., which are drunk in infusion for chronic cystitis, with doubtful benefit.

ALLIED DRUGS.—The majority of simple non-aromatic "herbs." *W. P. Bolles.*

* Or, as Baillon claims, opposite leaves, with stipules equalling the blades, and making false verticils.

MADEIRA. The island of Madeira is the largest in a group bearing the same name, and comprising in all five islands, two of them (Madeira and Porto Santo) inhabited, the other three (The Desertas) rocky and uninhabited. The whole group is of volcanic origin, and the surface of all the islands is irregular and mountainous: thus an elevation of 2,000 feet above sea-level is attained on the largest of the three Desertas islands, although the length of the island is but six and one-half miles; the Pico do Facho, on the island of Porto Santo, rises 1,600 feet above sea-level, although the island is but six and one-third miles long and three miles wide; and in Madeira, which has an extreme length from east to west of thirty miles, and an extreme breadth of thirteen miles, we find a range of mountains, averaging 4,000 feet in height, extending from end to end of the island, and forming its great central ridge or backbone. "Pico Ruivo, the highest summit, stands in the centre of the island, and has a height of 6,100 feet, but some of the adjacent summits are little lower."[1] The side ridges of this central chain extend to the coast in every direction. These ridges "usually terminate in lofty headlands, one of which has the height of 1,920 feet, and much of the coast is bound by precipices of dark basalt. The north coast, having been more exposed to the erosion of the sea, is on the whole more precipitous than the south coast, and presents everywhere a wilder aspect."[1] Funchal, the capital, and the largest town in Madeira (population, 18,000), lies upon the south coast, and is built somewhat in the form of an amphitheatre along the curving shore of a bay, its streets and houses spreading from the shore-line up the encircling hillside to an elevation of some 350 feet above sea-level. The vegetation of Madeira is subtropical, the latitude of Funchal (32° 30′ N.) being but six hundred and twenty miles north of the Tropic of Cancer. The nearest point of the mainland is the Morocco coast at Mogador, distant about three hundred and sixty miles in a direction east by south. The climate of the island is therefore typically insular as well as typically subtropical. Funchal is the point selected for residence by invalids resorting to Madeira during the winter season, and the shelter from northerly winds afforded by the lofty chain of mountains stretching across the island is an important factor in rendering the climate a particularly desirable one at that season. "Funchal is occasionally visited by violent storms of wind, but as it is protected by mountains from the prevailing wind, the northeast, the atmosphere is generally calm from 7 to 9 A.M.; then breezes blow in from the sea till 8 or 9 P.M.; and the land-wind sets in late at night."[2] According to Dr. A. Rotureau, the writer of the article describing Madeira in the "Dictionnaire Encyclopédique des Sciences Médicales," a violent wind occurs at Funchal on not more than twelve days throughout the year, while, as a rule, the winds are no more than breezes ("de simples brises"), scarcely ever causing an uncomfortable sensation of chilliness. The "leste," a hot, dry, and sand-laden sirocco wind blowing from the Morocco coast, is occasionally felt: chiefly in the spring and autumn; less often in winter than in spring, according to Dr. Hermann Weber;[3] least often in summer, according to Dr. Julius Hann.[4] The latter states that during the

prevalence of this "leste" the relative humidity at Funchal has been known to fall below 20 per cent. Such extreme dryness of the atmosphere, brought about by a wind which has traversed four hundred miles of water, is remarkable. As a rule, the humidity of the atmosphere in Madeira is considerable; the mean relative humidity being about 75 per cent., according to the writer in the "Encyclopædia Britannica." Other authorities put the figure lower; thus, Dr. J. Burney Yeo gives 70 to 74 as the mean percentage of saturation, and Dr. Kisch [5] gives 69.5 per cent. for the year, and 71 per cent. for the five months from November to March, inclusive. The mean temperature of these same five months is 62° F., according to Dr. Julius Hann.[4] At Charleston, S. C., the mean temperature of the spring months is 64.9° F.; the mean relative humidity of these months is 70.9 per cent. This comparison will at least serve to show that the humidity of the Madeira climate, during the five months in question, is not extreme. The figures of Dr. Kisch [5] give for the seven remaining months of the year (April to October, inclusive) a mean temperature of 69.2° F., and a mean relative humidity of 69.1 per cent.; from which we see that during the warmer portion of the year the same moderate humidity persists. During spring and autumn the relative humidity is least.[6] The relative humidity at Atlantic City and Cape May is much higher than at Funchal, and reference to the article on Bermuda will show that the climate of the Bermuda Islands is vastly damper than that of Madeira. Dr. Kisch characterizes the Madeira climate as one that is moderately moist. Dr. J. Burney Yeo, a strong advocate of the winter climate of Davos and the Upper Engadine, says that the air of Madeira, "though humid, is not felt by many to be unpleasantly so," and that the climate, "though relaxing, is not felt to be so, except by a few exceptional persons;" and he reminds his readers that "there are great differences of climate to be found in different parts of the island." At the beginning of his account of Madeira he makes the following statement:

"The tonic and stimulating climates of Davos and Upper Egypt on the one hand, and the soft, soothing climate of Madeira on the other, may be regarded as at the two extremes of winter health-resorts for European invalids. Madeira, having been for many years greatly overrated, has, during the last few years, come to be vastly underrated. It has suffered from one of those violent oscillations of medical opinion to which all health-resorts are liable; and after such an acute disturbance we may take it for granted that it will be long before a rational equilibrium is established. It is, however, satisfactory to see that Madeira is again becoming resorted to in increasing numbers."

Madeira lies well down toward the tropics, off the African coast, and about two hundred miles south of the Straits of Gibraltar; therefore its climate must be a warm one. It is an island, and an island lying four hundred miles out to sea; therefore its climate cannot be a very dry one, and must be distinctly insular, that is, equable in temperature. The mean annual temperature of Madeira is about 65.5° F. The lowest mean temperature for any month of the year, which I have seen quoted, is 59.7° F., the temperature of January, given in a table of Sir James Clark, quoted by Dr. Bennet. On the other hand, August is the warmest month of the year, and for the mean temperature of that month the highest figure I have seen given is 73° F., standing opposite that month in Dr. Kisch's table of monthly temperatures, while Sir James Clark's table puts the August mean at 71.88° F., which is a trifle lower than the mean temperature of August at New York City. The mean temperature of the four months, June to September, according to Kisch's figures, is 71.6° F. against 69.9° F. at New York: on the other hand, the mean temperature of the three coldest months at New York is only 31.4° F., one-half a degree below the freezing point, while in Madeira these coldest months have a mean temperature of about 61.5° F., or about 10° F. higher than the average winter temperature of Charleston. The lowest point reached by the mercury during eight years of observation at Funchal was 46.22° F.; the average of the absolute minima for the five months from November to March, according to Dr. Hann's table, is 48.2° F. A table of Dr. Bennet's shows that in 1860 the mean maximum in the shade in Madeira was 66° F. in January and 67° F. in February. The mean nycthemeral range during the six months, November to April, is only 10° ("Encyclopædia Britannica"). The mean monthly range of temperature for each of the five months, November to March, is as follows: November, 16°; December, 16.9°; January, 16.9°; February, 18.7°; March, 18.9° (Hann's "Handbuch der Klimatologie"). Even in summer the temperature scarcely ever rises above 86° F.,[2] and 90.3° F. was the absolute maximum at Funchal throughout eight years of observation.[1] The extremely high temperatures in Madeira are observed during the prevalence of a "leste" wind, and on such an occasion the high ground in the centre of the islands becomes hotter than the coast. "At Funchal frost and snow are wholly unknown, but snow falls on the mountains once or twice during the winter, very seldom, however, below the altitude of two thousand feet."[1]

Dr. Hann reckons Madeira as one of the stations lying within the subtropical region of the Mediterranean basin, all of which stations are characterized climatologically by a peculiar distribution of their annual rainfall, having little or no rainfall in summer and receiving it almost exclusively during the autumn, winter, and spring months. The mean annual rainfall, according to this authority, is 29.13 inches, of which 22 per cent., or 6.3 inches, falls in January, 19 per cent. falls in November, 15 per cent. falls in December, and 10 per cent. falls in February. That is, 66 per cent. of the year's total rainfall occurs during the four months in question, leaving but 34 per cent. to be divided up among the remaining eight months; and of these eight the three summer months (June, July, and August) receive collectively but 3 per cent. of the total amount, or only 0.87 inch. J. G. Johnson, author of "Handbook to Madeira," and contributor of the article on Madeira in the "Encyclopædia Britannica," counts March among the rainy months at Funchal, omitting February from the list. The mean total rainfall, derived from twelve years of observation, he puts at 30½ inches: the maximum total rainfall being 49.15 inches, the minimum, on the other hand, being only 16 inches. It is characteristic of the rainfall during the wet season at Madeira, as in other places having a regular "rainy season," that it is by no means continuous. Thus Dr. Yeo, writing for English readers, says: "The rain is not continuous, but, like our heavy April showers, with intervening sunshine." Of rainy days he says there are "on an average 50 in the winter six months, 85 in the whole year." *

Lombard [7] states that fogs are common among the mountains, but rare along the coast. The total number of rainy days he puts at from 74 to 88. Of cloudy days he says there are 110 per annum, while the fair and clear days he distributes as follows: 37 in autumn, 46 in winter, 52 in summer, and 54 in the spring. It is manifest that Madeira cannot be classed among the especially sunshiny stations. Further information on this point, together with abundant data of the other factors of climate at Madeira, are to be found in a little work by Piazzi Smyth entitled "Madeira Meteorologic." A statement of Dr. Rabuteau to the effect that greater clearness of atmosphere is found upon the high grounds of Madeira than upon the coast, especially during the forenoon, is probably quite reconcilable with Dr. Lombard's assertion respecting the relative frequency of fogs on the mountains and on the coast: for the moisture evaporated by the sun from the sea would be more evenly diffused through the atmosphere over the coast, while it would condense into fogs among the lofty mountains, leaving that portion of the sky not actually concealed by cloud

* The rainfall figures of Dr. A. Rotureau (contributor of the Madeira article in the Dict. Encyclopéd. des Sc. Méd.) are quite different from those of Dr. Hann and of Mr. Johnson. The mean annual rainfall he puts at 49.21 inches; the maximum at 66.93 inches; the minimum at 28.74 inches (1m. 25; 1m. 70; 0m. 73). The number of rainy days he gives as 74 on the average, and states that it has never exceeded 102. Dr. Kisch puts the average yearly number of rainy days at 70 (Eulenburg's Real-Encyclopädie).

freer from obscuration by watery vapor and bluer than the sky seen from the coast. The night sky along the coast is generally very clear, the clouds being driven away from the mountains by the land winds. In spite of this clearness of sky the fall of temperature by night is unusually slight. "It is usual," says Dr. Yeo, "to sleep with open windows at Funchal, for there is an entire absence of that chill at sunset so commonly experienced in the South, and there is no dewfall."

The air in Madeira is very rich in ozone. Malaria is unknown. The water supply is abundant. Living accommodations, both at hotels and in villas, are excellent. "Villas are to be procured at various altitudes adapted for winter or summer quarters, so that there is no necessity for the invalid to leave the island during the hot summer season" (Dr. Yeo). The scenery, as has already been indicated, is extremely picturesque and varied. Roads, on the other hand, are always steep; so that carriages are supplanted by palanquins, sledges, and portable hammocks, and a level walk for an invalid can hardly be a long walk. Sea-bathing may be enjoyed all the year round, the temperature of the water, even in winter, being at least 16° C. (60.8° F.), and sometimes as high as 22° C. (71.6° F.).[5] Dr. Yeo[2] tells us that Funchal has an English club and a good library.

Finally, we come to discuss the question of chief importance to the physician in considering any health-resort, viz., what invalids should be sent to it? This section of our article may be rendered clearer, simpler, and more likely to leave an impression on the memory, if we begin by saying who it is that should not be sent to Madeira. No one who cannot stand the sea voyage, of two days from Lisbon, four days from Plymouth, or six days from Liverpool, could go to the island. A decided tendency to attacks of diarrhœa, or to albuminuria, contraindicates Madeira.[6] Gout and rheumatism would be better treated in a drier climate.

The Madeira climate is admirably suited to cases of chronic laryngitis, chronic bronchitis, and emphysema. Dr. Yeo states that "it is said to be particularly suitable to cases of chronic dysentery, and malarial fever." Strumous patients would naturally be expected to derive benefit from a sojourn in a place possessing the combined advantages of sea air, mild and equable temperature, and long duration of sunshine during the winter; but among such individuals those having the erethitic temperament would be likely to be most benefited. Of the advantages of the Madeira climate in cases of pulmonary phthisis it is difficult to judge with accuracy. Many patients suffering from this disease have undoubtedly derived improvement from sojourn in the island, and in some of these cases the improvement has been great, or has even amounted to cure of the disease. Prolonged residence appears to be a condition upon which the most favorable results depend. As pointed out by Dr. Yeo, the very indifferent success which attended the experiment of the Brompton Hospital authorities in 1865 was probably largely instrumental in detracting from the great reputation formerly enjoyed by Madeira as a health-resort for consumptives. The good results obtained in dry climates, and the new fashion of recommending "high altitude" resorts as a panacea for such cases, together with the well-deserved attention latterly bestowed upon the germ theory of phthisis, unquestionably have operated in the same direction. To assist the reader in forming a just decision as to the merits and value of Madeira as a resort for consumptives the following quotations from five authorities upon climatotherapy, Drs. H. Weber, J. B. Yeo, Kisch, H. C. Lombard, and A. Rotureau, are herewith presented for consideration. The experience of the Brompton Hospital managers is instanced by Dr. Yeo and by Dr. Weber, but they do not agree in their presentment of the facts. Thus Dr. Weber states that of the twenty patients sent to Madeira three returned better, sixteen returned in worse condition than when they left home, and one died. Dr. Yeo's account is to the effect that of the twenty well-selected cases, "two only were greatly benefited, seven improved slightly, six returned no better nor worse than when they left England, four returned worse, one died in the island." The experience of the Drs. Williams, as quoted by Dr. Weber, was that 53 per cent. of their cases of consumption were improved at Madeira, 14.28 per cent. were unaffected, and 34.29 per cent. became worse. Dr. Weber's own experience ("Ziemssen's Handbuch der Allgemeinen Therapie," vol. ii., p. 72), in cases of pulmonary phthisis sent to Madeira, was, at the time of writing (1880), confined to seventeen cases; three of them in the first, seven in the second, and seven in the third stage of the disease. In the three cases of the first stage a good result was attained in one, an uncertain result in another, and an unfavorable result in the third. The proportion of favorable to unfavorable results among the seven patients already advanced to the second stage of their disease was three to four. Of the seven patients sent to Madeira when in the third stage of phthisis two appeared to be unaffected, in two the result was unfavorable, and in three the result was satisfactory when the condition of the patients was taken into account. The special class of phthisical cases in which benefit may be expected from sojourn at Madeira are, in Dr. Weber's opinion, advanced cases having much irritating cough, particularly when occurring in patients of the erethitic type. Tendency to diarrhœa he regards as contraindicating the Madeira climate. Disposition to dry cough, and to attacks of bronchitis occurring upon every change from warm to cold weather, are symptoms which, when well marked, are to be considered as indicating benefit likely to accrue from a sojourn in Madeira; especially if the patient be one upon whose mind a cheerful impression is produced by being surrounded by subtropical vegetation, and in whose case the sea voyage and residence so far from home are unlikely to act detrimentally, while the comforts of Madeira's good hotels and good living are likely to prove especially valuable adjuncts to climatic treatment. In the majority of cases he considers it necessary that the patient shall pass several winters on the island, spending his summers either at some one of the high inland stations of Madeira (*e.g.*, Comacha, two thousand three hundred feet above sea-level) or at some cool continental station. The former he regards as inferior to the high stations of the Alps or Andes.

"Careful observations," says Dr. Kisch,[5] "have proven beyond doubt the healing influence exerted by the Madeira climate upon pulmonary phthisis. Where there exists a predisposition to phthisis, and also in the early stage of the affection, residence at Funchal for several years has produced a complete cure; moreover, when the disease has been well advanced, and considerable loss of lung substance has been present, a favorable result has been quite often attained." He regards rheumatism and gout, and also tendency to diarrhœa and to albuminuria as contraindicating the Madeira climate, alludes to the occurrence at Madeira of a form of chronic diarrhœa known as the "mal de Madeira," and states that some constitutions become debilitated by the climate, the digestive functions becoming enfeebled.

Dr. Lombard[7] reports the case of a patient affected with phthisis in both lungs, who after more than ten years' continuous residence at Madeira was cured of her disease, and states that this case "is not unique," and that he "could cite others which have been benefited or completely cured after passing several years in this happy island." "According to Dr. Mittermayer," he says, "out of two hundred invalids arriving each year at Madeira there have died during recent years only the tenth part; this result is certainly very gratifying if we consider that many invalids reach the island, if not moribund, at least in the last stage of consumption." He considers the climate of Madeira as one not devoid of tonic properties, while at the same time he looks upon it as in the main a sedative climate, and therefore suited only to such conditions and diseases as require a climate of this latter class.

Dr. Rabuteau[6] is a very outspoken advocate of the Madeira climate; calling it the "climat hygiénique par excellence;" claiming that it is "neither exciting nor sedative;" that it is suited to phthisical cases both of the

nervous or erethitic, and of the lymphatic or scrofulous temperament; and maintaining its superiority to continental stations in the treatment of consumption. That it is only to be reached by a sea-voyage he appears to consider its only fault.

Some of Dr. J. Burney Yeo's opinions respecting the advantages of the Madeira climate have been already quoted. With one other, rather lengthy, quotation from the account of Madeira given in his valuable work on "Climate and Health-resorts," we shall close this article:

"It is, I believe, sufficiently well understood now that the climate of Madeira is only suited to a very limited and carefully selected class of cases; but for the proper case it is a climate of the greatest utility. If we bear this fact in mind, we shall be able to reconcile the wide discrepancies which we find in authoritative and evidently unprejudiced statements about this island. Madeira is a type of what is termed an oceanic climate, *i.e.*, a climate essentially soft and equable. It is also moist and sedative, and, no doubt, to persons with considerable constitutional vigor, it seems relaxing and depressing. But to certain persons in a state of great debility, with much feebleness in the organs of circulation, in cases of irritative chronic bronchitis with scanty secretion, and complicated with emphysema, in some cases of advanced consumption, and particularly those complicated with repeated attacks of bronchitis, even cases that have seemed quite hopeless, a prolonged residence in the climate of Madeira has been attended often with most remarkable amelioration. The feeble, flickering lamp burns longer there than in a more stimulating and tonic air, and now and then it seems to gather renewed power, and burns up again with some of its old lustre.

"Madeira has had a great and not altogether undeserved popularity in the past, and it will, I doubt not, have a more stable, because more discriminating, popularity in the future. This moist sedative atmosphere allays cough in cases of irritable mucous membrane, but it often causes loss of appetite and bilious disturbance in persons predisposed to such disorders. It would seem to be more useful in cases of chronic laryngeal and bronchial catarrh, and emphysema, than in phthisis. It is also suitable to persons of feeble circulation, who cannot bear bracing treatment, and who enjoy a sea climate" (op. cit., pp. 329 and 330). A leading article in the London *Lancet* (1884, vol. ii., p. 548), discussing a contribution to Virchow's *Archiv*, from the pen of Professor Paul Langerhans, of Madeira, may be commended to the perusal of any reader who is desirous of pursuing further his investigation respecting the effect of the Madeira climate upon pulmonary phthisis. *Huntington Richards.*

[1] Encyclopædia Britannica.
[2] Climate and Health-resorts (Dr. J. Burney Yeo).
[3] Ziemssen's Handbuch der Allg. Therapie, vol. ii.
[4] Handbuch der Klimatologie (Dr. Julius Hann).
[5] Eulenburg's Real-Encyclopädie (art. Madeira).
[6] Dictionnaire Encycloped. des Sc. Méd. (art. Madère).
[7] Traité de Climatologie Médicale (Dr. H. C. Lombard).

MAGNESIUM. I. General Medicinal Properties of Compounds of Magnesium.—Medicinally magnesium is prominent among metals for its inertness, its compounds exhibiting absolutely no specific effect individual to their basic radicle. As a class, magnesic salts tend to be of low diffusion power and purgative, and, as compared with salts of potassium or of sodium with the same acid radicles, to be less obnoxious to taste, and generally milder in action.

II. The Medicinally used Compounds of Magnesium.—The compounds of magnesium entering into preparations of the United States Pharmacopœia are the *oxide* ("magnesia"), *hydroxide, carbonate, citrate, sulphate,* and *sulphite.* All will be treated of in this article, except the last-named, for whose discussion see Sulphites.

Magnesic Oxide, MgO.—Magnesic oxide, the *magnesia,* or *calcined magnesia* of common parlance, is easily obtained by exposing to a low, red heat the so-called carbonate of magnesia of pharmacy. According to special circumstances in the making, magnesia may be comparatively light or comparatively heavy. Two grades of magnesia thus occur in the markets, both of which are recognized by the U. S. Pharmacopœia. The *light* variety is officinally entitled, simply, *Magnesia,* Magnesia, while the heavy grade is distinctively styled *Magnesia Ponderosa,* Heavy Magnesia. The market brands of magnesia known, respectively, as *Henry's, Husband's,* and *Ellis's,* are examples of heavy magnesias. Both varieties of the substance are "odorless, having an earthy, but no saline taste, and a faintly alkaline reaction when moistened with water. [They are] almost insoluble in water and insoluble in alcohol, and [are] not affected by heat. On stirring 1 part of magnesia with 15 parts of water, in a beaker, and allowing the mixture to stand for about half an hour, it will form a gelatinous mass of sufficient firmness to prevent it from falling out when the glass is inverted" (U. S. Ph.). Magnesia slowly absorbs carbon dioxide from the atmosphere, and is hence directed by the Pharmacopœia to be kept in well-closed vessels.

Magnesia is strongly alkaline in respect of power of saturating acids, but, from its feeble solubility, shows scarcely a trace of the physiological properties exhibited by the soluble alkalies potassa and soda. Locally, magnesia has only the negative properties of a light, smooth, insoluble powder, but taken internally it neutralizes acids in the primæ viæ, and in the condition of soluble magnesian salt thus resulting proves mildly laxative. As an internal medicine, in short, magnesia combines the properties of an antacid and a laxative, and is used exclusively for obtaining the effects of such virtues, either singly or together. Thus it may be prescribed as a simple laxative in constipation, a simple antacid in "sour stomach," or as a medicine of both virtues when, in the case of irritation of the intestines from the products of sour fermentation of the food, both an alkaline and a laxative effect are needed. When given as a simple laxative, it may be necessary to follow the dose of magnesia with a draught of lemonade to secure the necessary acid for the solution of the magnesia. As an antacid, magnesia is given in doses of from 0.65 to 2.00 Gm. (ten to thirty grains), and as a laxative from 2.00 to 4.00 Gm. (thirty to sixty grains). It is administered rubbed to a smooth cream with water or milk, and, in general, "heavy" magnesias are preferable to the "light" variety, by reason of being more readily miscible with fluids. A mixture of magnesia with water, if not weaker than one part to fifteen, slowly gelatinizes on standing, by formation of magnesic hydroxide, and if kept for a day or two may cake into lumps. And such concretions have been found, post mortem, in the human stomach, after habitual full dosing with magnesia.

Magnesic Hydroxide, $Mg(OH)_2$.—Magnesic hydroxide, or *hydrate of magnesia,* is not officinal under its own form, but is an integral part of the composite so-called *carbonate* of the U. S. Pharmacopœia, and is what forms on allowing an aqueous mixture of magnesic oxide to stand, as above described. Magnesic hydroxide also occurs as a bulky gelatinous precipitate on decomposing by caustic soda, magnesic sulphate (Epsom salt) in solution. Such a precipitate, washed and diffused in enough water to make the mixture of creamy consistence, constitutes a preparation that is exceedingly convenient as a means of administering magnesia, and which, if the hydroxide have been thoroughly washed and the water employed for the dilution be perfectly pure, has a mild taste only, resembling that of milk, and will keep without change. A tablespoonful of such preparation is a full antacid dose for an adult, and two tablespoonfuls a laxative. Excellent articles of this preparation are in the market, under the title *milk of magnesia.*

Magnesic Carbonate, $MgCO_3$.—Normal magnesic carbonate is not used in medicine, but under the title *Magnesii Carbonas,* Carbonate of Magnesium, the U. S. Pharmacopœia makes officinal the well-known *magnesia alba* of the shops, a composite salt, which may be regarded as a compound, in variable proportions, of normal magnesic carbonate and magnesic hydroxide. The U. S. Pharmacopœia recognizes the composition represented by the formula $(MgCO_3)_4$, $Mg(OH)_2$, 5 H_2O. This compound

forms as a white precipitate on mixing solutions of magnesic sulphate (Epsom salt) and sodic carbonate. Collected, washed and dried, it then appears as "light, white, friable masses, or a light, white powder, odorless and tasteless, insoluble in alcohol, and almost insoluble in water, to which, however, it imparts a feebly alkaline reaction. When strongly heated, it loses water and carbonic acid gas, and is converted into magnesia. It is soluble in diluted hydrochloric acid, with copious effervescence" (U. S. Ph.). Magnesia alba is made in two grades of density, technically known, respectively, as the *light* and *heavy*. The difference is said to be determined by the strength of the solutions used for the precipitation, concentrated solutions producing a heavy, and weak a light, product. The U. S. Pharmacopœia does not contradistinguish the grades of density.

Magnesia alba is practically identical in medicinal properties with magnesia, and may be used for the same purposes as is that compound. The former is, however, the inferior remedy, because, first, in its uniting with acids in the primæ viæ it necessarily evolves gas—an unpleasant circumstance—and because, secondly, it needs to be given in double the doses of magnesia. Magnesia alba is administered, like magnesia, rubbed to a cream with water or milk, an operation which is greatly facilitated by first rubbing the powder with a little undiluted sirup.

Acid Magnesic Citrate ($MgHC_6H_6O_7$).—This salt is officinal in the U. S. Pharmacopœia only in composite pharmaceutical preparations, as follows: *Liquor Magnesii Citratis*, Solution of Citrate of Magnesium. The salt is formed in solution by adding the pharmacopœial carbonate to a solution of citric acid; the solution is flavored with sirup of citric acid, and the mixture being put into a twelve-ounce bottle, a small charge of acid potassic carbonate ("bicarbonate") is finally added, and the bottle instantly, thereupon, securely corked, the cork being fixed in place by twine. Reaction now takes place between an excess of citric acid present in the mixture and the potassic carbonate, whereby potassic citrate forms and carbon dioxide gas is evolved. But the bottle being stopped, the gas is retained and remains in solution under pressure. There is thus obtained an acidulous, sweetened, and actively effervescing aqueous solution of magnesic citrate, with a little potassic citrate. For the making, the quantity of two hundred grains of magnesian carbonate is ordered for each twelve-ounce bottleful. The solution, in taste, strongly resembles ordinary "lemon soda." *Magnesii Citras Granulatus*, Granulated Citrate of Magnesium. To make this preparation, magnesic citrate is first formed by mixing magnesic carbonate and citric acid together with enough water to make a paste; the resulting mass is next dried, powdered, and mixed with some acid sodic carbonate, sugar, and additional citric acid, in powder. The whole is then dampened with alcohol, granulated, and again dried. The product is "a white, coarsely granular salt, deliquescent on exposure to air, odorless, having a mildly acidulous, refreshing taste, and an acid reaction. Soluble, with copious effervescence, in two parts of water at 15° C. (59° F.), and very soluble in boiling water; almost insoluble in alcohol" (U. S. Ph.). This salt furnishes, substantially, in solid form, the ingredients of the foregoing solution of the citrate, and its solution, extemporaneously made, practically represents the officinal solution of the citrate. It being obviously necessary to keep the preparation dry, the same should be kept in well-closed bottles. The proportion of magnesic carbonate ordered for making the granulated compound is eleven parts for one hundred of product.

Magnesic citrate is a simple saline purgative, mild in character, not disagreeable to taste, and generally very well borne by the stomach. The agreeable flavoring and effervescent property of the pharmaceutical representatives of the salt further make the medicine an especially appropriate one for children, or for use in fevered states requiring the action of a purge. The officinal solution, it will be observed, comes only in twelve-ounce bottles. One bottleful is a purgative dose for an adult, but it is generally given only in wineglassful doses, sipped during the day, so that half a bottleful or more is consumed in the twenty-four hours. The fluid should be ice-cold, and the bottle should be instantly recorked after the drawing off of each dose, and kept, set upside down, in a cool place. But after once opening a bottle, the solution is not good for longer than a day. The granulated salt is to be given in doses of from one to three teaspoonfuls, dissolved, at the time of taking, in iced water, and the solution drunk during effervescence.

Magnesic Sulphate ($MgSO_4.7H_2O$).—Magnesic Sulphate—the well-known *Epsom Salt*—is officinal in the U. S. Pharmacopœia as *Magnesii Sulphas*, Sulphate of Magnesium. It is a widely distributed salt, being an ingredient of sea-water, and of the water of some saline springs, and occurring also native. It is prepared for commerce in a number of different ways. Magnesic Sulphate is described as appearing in "small, colorless, right-rhombic prisms, or acicular needles, slowly efflorescent in dry air, odorless, having a cooling, saline, and bitter taste, and a neutral reaction. Soluble in 0.8 part of water at 15° C. (59° F.), and in 0.15 part of boiling water; insoluble in alcohol. When heated, the salt gradually loses nearly forty-four per cent. of its weight (water of crystallization), and at a strong red heat it fuses, congealing on cooling to a white mass, which amounts to 48.7 per cent. of the original weight" (U. S. Ph.).

Magnesic sulphate is a typical saline purge, and, although of very disagreeable taste, is usually well borne by the stomach. In excessive dose, however, it induces nausea and vomiting in addition to profuse purging. In small, repeated doses, the salt may prove slightly diuretic, and often in such doses it makes an excellent corrective in ordinary gastric derangement. A full purgative dose for an adult is 30.00 Gm. (one ounce), but if taken, as it preferably should be, immediately upon rising in the morning, on an empty stomach, one-fourth of such amount may be sufficient for a purge. As a corrective, 0.30 Gm. (five grains) may be given at a dose, repeated a number of times daily. The salt is best given dissolved in ice-cold lemon-soda. Magnesic sulphate is by far the most commonly used saline purgative, and hence the non-distinctive phrase, a *dose of salts*, is commonly held to mean a dose of this particular salt. *Bitter purging salt*, and, simply, *bitter salt*, are also common names for the sulphate. Epsom salt is an ingredient of the pharmacopœial *compound infusion of senna*. *Edward Curtis.*

MAGNOLIA (U. S. Ph.). The barks of the three following species of *Magnolia* are indiscriminately recognized by the Pharmacopœia under this title:

M. glauca Linn., the small Laurel Magnolia, or Sweet Bay, with scattered, oblong, white-backed leaves, and globular, white, very fragrant flowers, grows in the Middle and Southern States, near the Atlantic coast. A good-sized shrub.

M. acuminata Linn., the Cucumber-tree, so called because the unripe cylindrical fruit bears a slight resemblance to that vegetable, has oblong, pointed leaves, green both sides, and pubescent beneath; flower bell-shaped, greenish yellow. A large tree, whose wood is used for some purposes; Middle, Western, and Southern States.

M. tripetala Linn. (*M. umbrella* Lam.), with obovate-lanceolate leaves, clustered near the ends of the flowering branches "in an umbrella-like circle," and large, white flowers; Pennsylvania and the South. A small tree.

All the Magnolias are trees or shrubs with fine, large, often evergreen, simple leaves, and large, showy, regular flowers. Sepals three, petals from six to nine, stamens numerous, carpels also numerous, imbricate upon a long, superior axis, and cohering together in a long, fleshy mass, each opening at the back at maturity and liberating its single seed suspended by a thread. All are showy, handsome plants, and many are cultivated both in this country and abroad as ornamental trees and shrubs. Almost without exception, the barks of the

species of this genus, both American and Asiatic, are aromatic or spicy, and bitter, and have the same medicinal properties. Following is the description of the bark according to our standard: "The bark from young wood is quilled or curved, thin, externally orange-brown and glossy, or light-gray, with scattered warts, and somewhat fissured; internally whitish or pale brownish and smooth; fracture short, in the inner layer somewhat fibrous; inodorous; taste somewhat astringent, pungent, and bitter. The bark of old wood, deprived of the cork, is whitish or brownish, fibrous, and less pungent."

Their composition is not thoroughly known. *Volatile oil* and some *resin* are present, the former considerably diminished by drying and nearly disappearing if the barks are long kept. The bitter principle is probably either *liriodendron* or something like it.

The Magnolias are a type of the natural combination of aromatic or spicy properties with a bitter tonic principle, a combination which has brought a great many drugs into notice, but has not, although an exceedingly rational one, succeeded in holding them in public favor. Physicians in general prefer to make the union themselves, extemporaneously, or to take some established preparation with these qualities united (*Tinctura Gentianæ Composita*, etc.). The Magnolias are, then, carminative and stimulant tonics. Their supposed value in intermittent fever is without much foundation; in rheumatism much overestimated.

ADMINISTRATION.—In substance two or three grams (grs. xxx. ad l.) may be given several times a day. A tincture or fluid extract would be a convenience, but neither is officinal.

ALLIED PLANTS.—Besides the Magnolias, the order contains the Tulip Tree, *Liriodendron tulipifera* Linn., whose bitter and aromatic bark has the same medicinal properties, and the various species of star-anise (*Illicium*), whose fruits supply much of the anise-oil of commerce.

ALLIED DRUGS.—All spicy bitters. *W. P. Bolles.*

MAIDENHAIR (*Capillaire de Montpellier*, Codex Med.). The frond of *Adiantum Capillus-Veneris* Linn., order *Filices*. This pretty fern, which grows in shady places in most parts of Europe and is a favorite foliage plant in our ferneries, is occasionally used in the south of Europe, in infusion or decoction, as an expectorant or sudorific. It contains *tannin, bitter extractive*, and a little *essential oil*, and possesses no medicinal value of importance. Our Maidenhair (*Capillaire du Canada*, Codex Med.), *Adiantum pedatum* Linn., is more graceful as a plant, and equally unimportant as a medicine.

ALLIED PLANTS, ETC.—See FERN, MALE; also ERGOT. *W. P. Bolles.*

MALARIA, in the widest acceptation of its meaning, signifies air which has been rendered so impure from any cause as to produce harmful effects on the human system. The exhalations of carbonic anhydride, which accumulate in unventilated mines and wells, and asphyxiate the incautious intruder as speedily as if he had been submerged in water instead of air, constitute malaria; the emanations from a specifically infected soil, privy, or cesspool, that develop enteric fever in the susceptible individuals exposed to their influence, are malarial; and the typhous, variolous, and scarlatinal contagia, that propagate these diseases by contaminating the atmosphere surrounding the sick man, are also malarial agencies in this large view of the meaning of the term. Dr. Barker, in the Fothergillian Prize Essay for 1859, uses malaria in this broad sense as bad air—"that is to say, air, or a gas, or a compound of gases, which, being absorbed by the lungs, give rise to certain specific effects or symptoms which, grouped together, constitute a disease." Yet by many, perhaps by a majority of the profession at the present day, malaria has been restricted to that particular poisoning of the air which is caused by the emanations from marshes or other damp soils, and which is the assumed cause of intermittent, remittent, and congestive fevers, enlargement of the spleen, congestion of the liver, dysentery, many neuralgic affections, and that deteriorated condition of the system found in individuals who have lived for some time in insalubrious marshy districts. The identification of the term malaria, by the Italian writers, with the subtile causative agency of the paroxysmal fevers that are so prevalent in their country, has led gradually to the disuse of the word in its generic sense and its employment as a designation for the paludal poison. Malaria, thus used, is a specific title included in the genus miasma. See Miasma.

In this country, until recently, the use of these words was reversed; malaria was generic in its significance, and our paroxysmal and pernicious endemic fevers were miasmatic. Professor Wood made this application of the terms. But the use of the "Official Army Nomenclature" by so many of our medical men during the civil war led to a change in the value attached to the words. In this official list of diseases the order miasmata included the species malaria. Perhaps, also, the very general use of the term typho-malarial, to signify an enteric fever modified by the concurrent operation of the cause of the paroxysmal fevers, did much to restrict the signification of malaria. Recently the discovery of a germ, B. malariæ, claimed to be the cause of intermittent and remittent fevers, has tended still further to identify the word malaria with the causation of a special series of miasmatic fevers. Nevertheless, the sense is somewhat doubtful, even at the present time. We cannot always tell whether an article on miasmatic fever deals with the subject generally, or refers specially to the periodic fevers of a Mississippi bayou, until we have learned from its tenor whether the author regards miasmatic as a generic or a specific adjective. Both are generic, but both are not required; and since the tendency of the times is to invest malaria with a specific significance, its broader sense should at once be dropped as obsolete.

Exceptionally, the term is used to include the causative agencies of certain diseases that are more or less affiliated to the paroxysmal fevers. Thus Dr. Alexander Smith, in his work on "Fever and Cholera" (Calcutta, 1873), argues that the full histories of ague, remittent, and typhoid fevers, cholera, and yellow fever have demonstrated that they are but species of the one genus fever. An ordinary accession of ague is held to represent the simplest form, from which the higher varieties of the genus may gradually be developed. In his view no evidence has been produced that any of the varieties of fever can generate a specific poison, or germ—a poison specific in the sense of its being capable of reproducing the disease by which it was originated, and that only. All these fevers owe their origin to the one fundamental cause: emanations from soils containing organic matter of vegetable or animal origin—to malaria, in fact—and having their times of manifestation, their form, and intensity of expression determined by various accessory causes, and especially by those peculiar general influences usually spoken of as epidemic conditions. This malaria enters the blood and produces its effects on the cerebro-spinal system. His theory is based upon a quotation from Sir R. Christison: "The first appreciable event in the chain of sequences constituting fever is a functional injury of the nervous system." The cerebro-spinal nervous centres affected by the malarial influence react on the blood-vessels within the abdomen, by exercising a special action on the great sympathetic nerve, which produces certain local changes as the inevitable result of the increased activity of the circulation caused by inhibition of the vasomotor nerves. This inhibition is made to explain the typhoid deposits in the solitary and agminated glands as resulting from increased activity of the natural nutritive processes. As the glands are bound down in the deeper layers of the intestine, their over-distention causes inflammation which rapidly runs on to ulceration in the milder cases, and to sloughing in the more aggravated forms. This same inhibition with osmotic action is made to explain the liquid stools of cholera. Dr. Smith is oblivious to the mass of facts which have led the physicians of his time to regard typhoid fever as a specific disease, and he gives no better explanation of the varied effects produced by the one malarial poison evolved from decom-

posing or putrefactive organic matter than epidemic conditions and differences in the physical condition of those subjected to the morbific influence.

Dr. McGowan, in the *Medical Mirror*, 1866, regards malaria as the common cause of remittent and intermittent fevers, cholera, and sunstroke. In his view the sudden derangement of the nervous system produced by the poisonous agent paralyzes for a time the circulation of the blood, the resulting congestion of the lungs and effusion into the cerebral membranes constituting sunstroke, and the intestinal congestion and transudation constituting cholera. In these cases there is no marked enlargement of the spleen. This organ bears congestion better than any other, and the longer the chill of the paroxysmal fever the larger it grows. Macculloch, Rose Cormack, Murray, Boyle, Bird, Armstrong, Scrive, and others, have been cited as entertaining similar views. But, although malarial influences may no doubt be regarded as potent predisposing causes, the occasional occurrence of deadly epidemics of cholera in non-malarious districts, and the absence of indigenous cholera in our southern swamp lands, manifest the operation of a cause for this disease wholly distinct from that which induces the paroxysmal fevers ; and the same argument may be applied in connection with sunstroke.

The ancient writers were acquainted with the paroxysmal fevers and the tumefaction of the viscera consequent on exposure to what is now called malaria. Hippocrates attributed these to the use of marshy waters ; but Galen and Avicenna recognized the existence of a marsh-poison which contaminated the air. The latter is generally credited with referring the evil effects of the air and water of marshes to exhalations from vegetable decomposition—a view which was afterward popularly accepted and affected legislation in several European countries, in which the steeping of flax and hemp in springs, public reservoirs, and ponds where cattle were watered, was prohibited under heavy penalties. Indeed, for ages the exhalations from impure, stagnant water were credited with all the noxious effects now attributed to malaria. Even as late as the beginning of the present century, Alibert held that all matters susceptible of putridity communicate a deleterious quality to stagnant waters, rendering them capable of producing intermittents, although he was aware that marshes, ponds, lakes, etc., "contribute less essentially to the production of malignant intermittents by the quantities of water which stagnate in their interior parts than by the greater or less collections of filth which, on the retreat or evaporation of these waters, they expose to the action of the atmosphere."

The nature of the malarial exhalation was, and has continued to be, an unsolved problem. Some of the classical writers, as Varro and Columella, cultivated the theory of a living contagion in explanation of the morbific effects of the pestilent atmosphere of marshy places. This theory was revived on a basis of microscopic observation after Leuenhoeck had displayed the infusorial life in stagnant waters. Linnæus even is said to have subscribed to this animalcular theory. But a more extended study of the living forms in air and water showed the harmlessness of these infusorial forms of life, and their want of connection with the paroxysmal fevers. Recently, since the discovery of the bacillus of anthrax by Davaine, in 1863, and of the spirillum of relapsing fever by Obermeier, in 1872, the theory of a living contagion has again received a wide acceptance, and the search for the living essence of the disease has been prosecuted with enthusiasm by the most competent microscopists and biologists.

In Italy volcanic soils and salt marshes were conceived to be specially productive of malaria, whence originated the theory that saline and sulphurous vapors constituted the essence of the contamination. These, arising from noxious localities, were conceived to alter the constitution of the atmosphere, or to deprive it of the energy and elasticity by virtue of which, under ordinary circumstances, it vivified the blood and preserved the humors in their normal condition. Long ago Macculloch, in his diffusive way, condemned these theorists: "And I may remark here generally, in aid of those who may have found themselves bewildered in reading on this subject, that not only is this a common occurrence in the voluminous writers on malaria, who are principally also Italian ones, but that while, as far as my reading extends, I have not found one luminous and philosophical view of the production and propagation of this poison, and little which can even serve the purpose of preventing diseases, so is it far too common to find entire volumes filled with idle hypotheses respecting pyrites, and volcanoes, and mines, and attributing to electricity, aurora borealis, magnetism, and similar visions what the writers had forgotten to seek in that which ought to have been obvious to the most superficial and ignorant." Meanwhile it was observed that the most pernicious soils were those which seemed particularly rich in decaying vegetable matters, as, for instance, swamps, jungles, and marsh lands, rice grounds, wet meadow lands in warm climates, and the organic mud left to putrefy in the summer heat on the drying up of ponds and ditches. This suggested the belief that malaria was due to the process of decay in vegetable organic matter, under the favorable action of moisture and a suitable temperature, and led to a close investigation into the products of this decomposition, in the hope that the febrile cause might be identified and isolated.

The gaseous products of this decay were found to consist chiefly of carbonic acid, carburetted, sulphuretted, and phosphoretted hydrogen, and ammonia. Unbiassed observers experimented with these gases in the laboratory, and concluded that, although they were in certain proportions harmful to the system, their action was in no respect that of the unknown morbific agent which was so frequently associated with them. Sulphuretted odors, for instance, had been observed in many unhealthy localities, but intermittent and remittent fevers were just as prevalent and intense in other places where there were no such odors ; besides, sulphuretted waters, though largely used medicinally, and even for household purposes in some regions, do not cause malarial diseases ; and sulphuretted hydrogen evolved as the result of natural processes in many localities, and artificially in the laboratory, produces effects which are not those of the unknown malaria. Carbonic acid has frequently been upheld by theorists as the pernicious agent. In 1824 Dr. Causin, in the *Medical Record* of Philadelphia, expressed himself as well satisfied that this theory may be defended at all times, and at every point, without violating in the slightest degree any cardinal principle of philosophy. Dr. Metcalf, of the University of Transylvania, in his work on Caloric, was disposed to regard this gas as the morbific agent, not only of the marsh-poison, but of the typhous miasm ; and a few years later an article, read at a meeting of one of our State medical societies, proved to its author's satisfaction that carbonic acid was the cause of all our endemic troubles.

The mists that gather at nightfall and hover until sunrise over some pernicious localities suggested the concentration and condensation of the morbific principle in the watery vapor ; but Vauquelin and other chemists, in their analyses of the dew which was assumed to be the vehicle of malaria, failed to discover a specific poison in the organic matter with which it was contaminated.

Eluding all methods of investigation, there appeared to remain in the exhalations from certain soils a subtile poisonous agency which has been closely studied through its effects, with the result of making known much of that which may be called its natural history.

But the subtile nature of the malarial poison has emboldened some writers to deny its existence, in ascribing the effects usually attributed to it to the influence of chill. Macculloch argued against these untenable views, but from time to time an article or a book is published reviving the dead theory, and tacitly claiming the credit of originality in destroying the hypothetical bugbear, malaria. Oldham, in his book "What is Malaria?" (London, 1871), asserts that the so-called malarial diseases are due to cold and chill after exposure to great heat, especially after the body has been exhausted by toil and fatigue. Inman, in an article in the *British Medical*

Journal, 1875, holds similar views. The former found that the extreme susceptibility to cold, which is a result of continued exposure to great heat, intensifies the predisposition to the so-called malarious diseases, thus causing their greater prevalence in hot climates; and that a further effect of great heat on the system, more especially of the white races, is, by lowering the vital powers, to render the type of the disease more grave. It follows that in cool climates the powerfully chilling influence of dampness is necessary to the development of the malarial agent. In such climates the malarial influence is rarely found, except in marshy or humid localities; and its presence is generally manifested during the autumn, that being the season of transition from the period of greatest heat to that of greatest cold, and also the time when the diurnal variations in temperature are greatest. In fact, his argument appears to be summed up in the remark of the old Indian officers quoted by him, "They say it is caused by dead leaves, vegetation, and malaria; but I know that hot days and cold nights always bring fever."

Chills from sudden depressions of temperature in non-malarial regions *occasionally* give rise to internal congestions which may develop into local inflammations, with sympathetic fever; but they, or the exposure which induces them, are in malarious localities so *generally* followed by some of the forms of paroxysmal fever, that those who dwell in such places regard the exposure and the fever as cause and effect.

Dr. Munro, in the fourteenth volume "Army (British) Medical Department Reports," held that there was no such poison as malaria; that cholera, yellow fever, sunstroke, and malarial fevers were due to certain electrical conditions which result from the combinations of heat and moisture. Sir Ranald Martin also attached importance to the electrical condition, but only as a predisposing factor—by inducing a prostration in the individual which renders him unable to resist the influence of exhalations from the soil. In accordance with the experience of this veteran observer in India, the geological nature of the locality was of prime importance in the production of deleterious emanations, a ferruginous soil being most prolific.

Perhaps the most amusing, as well as the most puerile, of the theories offered as a substitute for the marsh miasm is that which refers malarial diseases to mosquito-bites. The "Bulletin of the Philosophical Society of Washington," 1884, gives an abstract of a paper which, after stating the generally admitted facts with regard to malaria, claims that these are insusceptible of scientific explanation by the ordinary marsh-poison hypothesis, but are capable of explanation by the theory that marsh fevers are produced by the bites of proboscidian insects, notably by mosquito-bites. Medical authorities are cited showing that, in all parts of the world where these diseases prevail, immunity was secured by protecting the body from mosquito-bites. The geographical distribution and seasonal evolution of mosquitoes and other proboscidian insects, are shown partially to agree with the times and places in which malarial diseases prevail. That these diseases were ever produced solely by the inhalation of supposed poisonous vapors is held to be untenable, for experimenters who had demonstrated the existence of specific poisons for special fevers, had equally proven that the mode by which such poisons, when obtained, could be introduced into the body for the artificial production of disease, was by inoculation through the skin. The proboscis of the mosquito was nature's inoculating needle; but whether the inoculated pathogenic material was mosquital saliva, the bacillus malariæ of Klebs and Tommasi-Crudeli, or some other deleterious substance, was unknown. The philosophic gravity with which this assumption is discussed creates the impression that the paper was intended as a satire on the tendency of the medical mind to theorize on short-sighted views; but instead of this, the paper seems really to have been an illustration of this very tendency.

Dr. John Macculloch, who wrote in 1827, roused the attention of the English-speaking people to the all-pervading presence of malaria. In his view, malarial exhalations from vegetable decomposition were the cause of the paroxysmal fevers, cholera, dysentery, and the by far most frequent source of those innumerable ailings called in the ordinary language of society ill-health—"headaches, periodical or regular; rheumatism of the face or head, as it is called; toothache, sciatica, with tic-douloureux, or other varieties of neuralgia; bilious affections, as the phrase is, and a whole catalogue of all the nervous ailments, which at different periods, under different fashions, have been attributed to various causes; to the nerves, the spleen, the stomach, the liver, and now, as is a far more convenient phraseology, to the chylopoiëtic viscera." And not only this, but he referred nine-tenths of the mortality ascribed in England to typhus fever as due in reality to malarial fever, charging his contemporaries with ignorance or unwillingness to receive conviction.

The factors needful to the production of these fruitful emanations were assumed to be heat, moisture, and dead vegetation. Heat alone was shown to be incapable of inducing malarial disease: in some climates where the heat is often extreme there are no paroxysmal fevers. Transition from heat to cold was also shown to be unconnected with malaria, by the absence of specific fevers in dry sandy deserts where hot days are followed by cold nights. Moisture, alone or associated with certain temperatures, was also proved to be incapable of causing malarial fevers: fogs, occurring at sea and in elevated mountain ranges, are harmless in this respect. The fogs precipitated on the west coast of England by the winds from the Atlantic are not attended by the malarial manifestations of those of the eastern or fenny coast. Dead vegetable matter, in connection with a certain degree of heat and that proportion of moisture favorable to the processes of decomposition, was regarded as the essential of the evolution. The period of maximum prevalence of malarial disease was found to coincide, in all parts of the world, with that of the decay of annual vegetation after its fruition in the autumn in temperate climates, and after the withdrawal of the waters at the end of the rainy season in tropical climates. The heat and moisture which promote a rank and luxuriant growth operate subsequently in facilitating its decay. The literature of fever is full of illustrations of the greater prevalence of malarial diseases in hot climates having a luxuriant vegetable growth than in the temperate or cooler regions of the globe. Forry has shown, by the mortality statistics of our military posts, that the annual ratio of intermittents and remittents is five-fold greater in our southern than in our northern States, and that a contrast equally great is exhibited between the first and third quarters of the year. So marked is the influence of seasonal heat that our remittents are not infrequently spoken of as autumnal fevers. Drake held that the continuance of a temperature of over 60° F. for two months is needful to the development of malarial fevers, and Hirsch has placed the northern limit of their prevalence on isothermal lines having an average summer temperature of 58.9° to 59° F. The intensity, as well as the prevalence, of the fever is proportioned to the seasonal and climatic heat and the associated rankness of vegetable growth; for, while the most pernicious fevers prevail in the unhealthy sections of tropical countries, the morbid manifestations in the malarious countries of the temperate zones are of a milder and intermittent nature. The geographical distribution of malaria is so extensive as to be independent of geological conditions. Its localization depends on the concurrence of the three factors, heat, moisture, and dead vegetation, and its intensity on the mass of the organic material and the rapidity of its retrogressive changes.

In temperate climates marshes, swamps, ditches, and the low grounds subject to overflow by rivers, lakes, ponds, etc., afford that conjunction of the factors that is most favorable for the evolution of the malarial influence. But it is now well established that a marsh or swamp is not needful for the development of malarial diseases. Macculloch was regarded as a malario-maniac when he called the attention of the profession in England to the existence of the malarial miasm, under numerous circum-

stances not at all suspected, even in what were assumed to be healthy districts. He considered that, if a large tract of marshy land produced a given quantity of malaria, this product must be an union of all the malaria generated by the different parts of the marsh. Malaria is very potent as a morbific agency; the typhus miasm is diluted to harmlessness by a slight ventilation, but the malarial miasm may be borne for miles and be diluted largely by diffusion and ventilation, without losing its noxious qualities. "If the produce of a hundred square feet, or acres, or of any scale and number of parts, can, under a dilution of one thousand or ten thousand times, excite disease, then must, in the inverse ratio, the produce of the one-thousandth on the ten-thousandth portion of that space be capable, before dilution, of producing the same effect." A marsh, therefore, so far as it relates to the causation of malaria, is not defined by space, nor does it require any great extent. The growth of an iris, an equisetum, or a hydrocotyle is as indicative of malarial possibilities to the individual as is a square league of marsh to the neighboring community. In fact, Macculloch would have accepted with readiness the proposition that malarial fevers may be produced by the exhalations from flower-pots. Recently Tommasi-Crudeli, on the authority of Professor von Eichwald, instanced the case of a Russian lady whose aguish relapses, having been referred to this cause, were permanently cured by the removal of the flower-pots.

Since the dung-heap in the farmer's back yard does not breed intermittents, it was argued that for the cause of malaria we must look beyond the decomposition of vegetable matter. Moreover, malaria was frequently found where there was no vegetation. Mud-banks, left bare of vegetable growth by the subsidence of flooded streams in the tropics, are fertile sources of pestilential exhalations. The theory of a marsh miasm became assailed also by observations which indicated the emanation of an identical miasm from soils that had neither an excess of water nor of decaying vegetation. According to the experience of Ferguson in the Iberian Peninsula, during the early part of this century, malaria was exhaled in arid ravines, river bottoms, and bare open lands having a parched soil, and a withered, desiccated vegetation. The army encamped in the Valley of the Guadiana was almost destroyed by remittent fever, while the country was so dry that the river was reduced to a chain of pools. Similarly, near Ciudad Rodrigo, in a bare open-bottom country which, having been flooded, had afterward become quite dry, very malignant fevers prevailed. "In the months of June and July the British army marched through the singularly dry, rocky, and elevated country on the confines of Portugal, the weather having been previously so hot for several weeks as to dry up the mountain streams. In some of the hilly ravines that had lately been water-courses, several regiments took up their bivouac for the sake of being near the stagnant pools of water that were still left among the rocks. Many men were seized with intermittent fever." This finds a parallel in the experience of the writer with troops in Arizona Territory. But there, although the ravines were parched on the surface, water could be obtained at a short distance below. Fort Breckenridge, established in such a ravine in the Santa Rita Mountains, was abandoned on account of the prevalence and fatality of remittent fever. In fact, malaria is often found in sandy soils and arid desert plains, where there seems neither water nor decaying vegetation; but in all such instances the soil contains organic matter, and water is upheld by an impermeable layer a short distance below the surface. The soil in Holland, where the British army has on several occasions suffered so severely from malarial disease, is a level plain of sand with a dry surface, covered only with some stunted heath plants; but on digging it was found to be percolated with water to within a few inches of the surface. The sandy soil of the Landes of Gascony is malarious. At a depth of about three feet is an impermeable stratum, brown in color and strong in structure, known as the *alios*. This, which consists of sand cemented by organic and ferruginous matter, formed by a permanent subsoil water-level, keeps the subsoil moist and retains the products of the decay of the annual vegetation. Indeed, in warm countries the marshy condition, or that of a rank vegetable decomposition, appears unnecessary to the production of malaria. Granite, disintegrated by the permeation of a peculiar fungus, has caused malaria at Hong Kong. According to Staff-Surgeon Gore, the Island of De Los, sixty miles north of Sierra Leone, is a bed of decomposing granite with very little vegetation on the surface; yet this post had to be abandoned on account of the virulence of the malarial diseases that affected the garrison. In this country these experiences may be paralleled by citing the coral rocks on the Florida coast. At Fort Jefferson, Key West, as one of many that might be mentioned, malarial fevers are prevalent, the soil being a coral sand with underlying water and a scanty vegetation.

As a result of these observations, malaria has ceased to be regarded as dependent on the decay of a rank vegetation. The theory of a specific emanation from organic matter in the soil, undergoing the fermentative processes induced by heat and moisture, has superseded that which connected the malarial miasm solely with the marsh, swamp, or jungle, and has permitted Von Eichwald's case of exhalation from the damp soil in a flower-pot to be accepted as consistent with our knowledge of the causation of the poisonous influence.

Some writers, who regard this theory of malaria as incompetent to explain all the phenomena of malarial distribution, instance the prevalence of the disease in localities where one or more of the causative factors are absent. Many regions in the northwest provinces of the Punjab are scourged by malarial diseases, yet in themselves are not producers of malaria, as the soil is exceptionally dry, the subsoil water being as much as thirty feet from the surface, which is sterile, arid, and desiccated. Moreover, Oldham says that the inhabitants of this region suffer in the cold season, when the temperature is below zero. But we do not require to examine the medical literature of India for instances of this kind. In our own western country remittents are of frequent occurrence on the arid mesas of Arizona, where the water is fifty or more feet below the surface. They are to be found also in the regions to the northward, and in the higher plateaux of the mountain ranges, not only during the short hot summer, but occasionally during the long winter season, when the temperature is at or below zero Fahr. and the ground covered with snow. The argument in favor of the propagation of these anomalous cases by means of the drinking-water will be found under the heading, Water, Sanitary Aspect of; but it may be remarked here that Surgeon E. G. Russell, in his work on "Malaria and Diseases of the Spleen" (Calcutta, 1880), has referred the malarial diseases of the Punjab to the contamination of the water-supply, which is derived from streams draining from the forests and jungles of mountain ranges, and the terais and marshes at their base.

The malarial miasm is assumed to arise during the retrogression of organic matter to the inorganic state under favorable conditions as to moisture and heat. When the moisture is in excess, as when the ground is wholly covered with water, there is no malaria. The rainy season in the tropics is not the sickly season, but its commencement is, when the showers are of short duration, and fall upon a dry and parched earth, and also its termination, when the earth remains soaked and covered with a dying or decaying vegetation. Fever and ague prevail not during the period of an inundation, but during the subsequent period of draining and drying up. Yet some recent extensive floods in the Mississippi Valley have not been followed by a marked increase in the prevalence or virulence of the endemic fevers, probably because the temperature of the succeeding summer was insufficient to determine a free generation of the malarial poison. Dams, lakes, and ponds, with an equable water-level and well-defined margins, are not unhealthy; but grounds that are alternately submerged and exposed are malarious. The artificial draining of ponds and the accidental breaking of dams, have occasioned disease in their vicinity.

Shallow mill-dams that uncover a portion of their storage-area during the use of the water, are more dangerous than those that have depth enough to keep the area submerged. Some of the shallow creeks which open into the salt-water on our Atlantic coast, and are subject to tidal influences, are noted for the pernicious character of their fevers. Sullivan, in his "Endemic Diseases of Tropical Climates," London, 1877, speaks of the deadly nature of the fevers in lands bordering upon estuaries where large rivers empty themselves into the sea.

Owing to local causes, the vicinity of a marsh may not be an insalubrious locality. Where a steady wind prevails during the sickly season, people living on the windward side may be unaffected; and even those to the leeward may be protected by the interposition of a strip of forest land. Malaria is diffused into the atmosphere with some difficulty. According to Watson, it loves the ground. In an unhealthy locality it is more dangerous to sleep on the ground or on the ground-floor than on the upper floor of a house. It is often associated with watery vapor in the form of mists or fogs, which, hanging low over the exhalent surface, may be floated into neighboring valleys and upward along the rising grounds. The land breeze may bring the fever-poison from tropical shores to shipping lying off the coast. Monfalcon put the distance to which malaria could be thus transported at from fourteen hundred to sixteen hundred feet of elevation, and from six hundred to ten hundred feet longitudinally. The prevailing tendency of medical writers is to restrict the influence of wind-borne malaria. Hertz says: "We may admit the agency of the wind as a carrier of miasm for a short distance, but when it comes to stretches of many miles it is no longer to be taken into account." Nevertheless, it is well known that the insalubrity of Sierra Leone is due to the winds from the Great Bullam Swamp. Many medical men of the Mississippi Valley are of the opinion that, during a specially unhealthy season, the miasm from the river bottom affects persons living on the generally healthy uplands twenty or thirty miles inland from the eastern shore, but not on the western side. This is accounted for by the direction of the wind, which blows generally across the valley from the west. If this explanation of the occurrence of the disease on these uplands be accepted, the malarious character ascribed to the English east wind by Macculloch, need not be attributed to the tendency of that observer to find malaria in everything. He regarded the east wind as the disseminator of malarial disease in England. There are points, he says, on the coast of Norfolk and Suffolk, where agues could not appear if not imported from Holland by the wind.

But the floating cloud of watery vapor and malaria is known to be intercepted by belts of trees. It was remarked by Pliny that trees destroy or consume the mephitic vapors. There are many instances on record where the planting of a belt of trees between a pestilent marsh and a settlement has protected the latter from disease; and conversely, where the removal of a screen of trees has been followed by an invasion of malaria from neighboring swamps. Not trees only, but all solid substances, appear to attract the malarial poison. It has been stated that by drawing a veil over the face it is possible to sleep without injury in very unhealthy localities. Based on this view is the popular practice in Spain of wearing the mantilla over the mouth; and, perhaps our similar use of the handkerchief acknowledges a like origin. Malarial disease, however, is not propagated by fomites. The analogy of contagion suggests a transmission in this way; but so many examples might be instanced of persons who have slept unharmed on the recently cut vegetation of swamp lands, that the propagation of the disease by this method cannot be accepted.

Dysentery, attributed in its origin to malaria, becomes, when epidemic, of a contagious character. Not that the original malaria is reproduced, but that the morbid secretions of the affected individual are capable of inducing in another person intestinal disorders of a character similar to that which produced them. Contagious remittent fevers have been described as occurring in India, and suggestions of a contagious quality have been heard occasionally even in ordinary cases. Practically, malarial diseases may be regarded as non-contagious; but it may be well to remember these suggestions of contagion as points to be explained when the true nature of malaria becomes known.

But besides acting as a screen, trees are generally credited with exercising a beneficial influence in malarious localities; and from ancient times their cultivation has been recommended for the preservation of the salubrity of the atmosphere. Some regarded this as effected by a disinfecting property exercised by the odoriferous emanations from the trees. Others supposed that the living vegetation absorbed the deleterious miasm. The tendency of the present time is to consider the trees as operating on the soil, shading it, and lessening miasmatic emanations by preventing the access of the heating powers of the sun's rays, or absorbing water by their roots, and giving a dryer and less malarious subsoil. Trees of rapid growth are considered best for this purpose. The eucalyptus, of late years, has been planted extensively, but the results have not been considered satisfactory. Tommasi-Crudeli has been unable to verify a single instance of the destruction of malaria by the eucalyptus, but he does not feel warranted in denying the statements made by others as to the value of their growth. The tree-covered terai, at the base of the Himalaya Mountains, is a notoriously unhealthy strip of saturated soil. On the other hand, forests that are dry and have a low level of the subsoil water, are generally healthy. The fact seems to be that forest lands are healthy or unhealthy according to the condition of the soil as to heat and moisture. Where the trees protect the soil from the sun's rays, and prevent malaria by reducing the temperature, or where they act by depriving the soil of water, the clearing of the ground might be followed by malarial manifestations. On the other hand, a malarious locality has been rendered salubrious by stripping it of its trees, the result being explained by a dissipation of the exhaled malaria and of the causative dampness consequent on the exposure of the soil to the rays of the sun and to a free ventilation. But the general experience is that any interference with the natural growth in forest lands is likely to be followed by malarial developments, if the soil have a certain degree of heat and moisture.

The removal of one of the factors of malarial causation improves the character of an insalubrious district. But if the organic matter were removed, the soil would cease to be fertile, and if the heat were diminished there would be a corresponding interference with the germination and growth of the crops. Drainage, however, which removes excess of moisture, increases salubrity, while promoting rather than interfering with productive husbandry. Drainage has, therefore, from the most ancient times, been recognized as the chief method of improving a malarious soil. Malarial fevers have been rendered a clinical curiosity in England, by means of drainage and systematic and careful cultivation. And the comparative healthfulness of ancient Rome was due to the efficiency of drainage, and the state of cultivation in the now deserted and pestilential tracts of the Campagna. It is to be noted, however, that the first efforts at improvements are almost invariably followed by an increased virulence and prevalence of the malarial influence, which subsides only after a period of continued cultivation. The history of agriculture in this country furnishes many illustrations of febrile outbreaks consequent on the draining, clearing, and upturning of the soil. But as these districts attain a high state of cultivation, they become progressively free from the paroxysmal fevers. Dr. Rush remarked that the intermittents and remittents of Pennsylvania were converted, by the progress of agriculture, into bilious and malignant remittents, and that not until after years of cultivation did general salubrity follow. Engineering works, civil or military, as the digging of canals, the throwing up of embankments for railroads or fortifications, the trenching of the soil for irrigating purposes, as in the culture of rice, and even the clearings and excavations needful to the exten-

sion of our rapidly growing settlements, have all been followed by a notable increase of malarial diseases. In fact, it may be said that any marked interference with the natural vegetation of a soil is likely to induce an endemic of malarial disease, if the soil present the concurrence of the three factors considered essential to the emanation of malaria, viz., heat, moisture, and organic matter.

The evolution of malaria is known, by the experience of ages, to be most active in warm climates and in warm seasons. Hence the singularity of the fact that the warm period of the day corresponds in no locality with the greatest diurnal activity of the poisonous influence. On the contrary, it is well known that in temperate climates there is no danger on marshes that are notorious for their fevers, provided the individual be not exposed after nightfall; and in tropical climates, jungles and other pestilential regions may be penetrated with impunity when the sun is high in the heavens. It may be granted that the resisting power of the individual is diminished during an exposure at night, particulary during sleep, and that the depressing influence of a chilly atmosphere may contribute to still further reduce the energy of the *vis conservatrix naturæ;* but, notwithstanding these considerations, it appears singular that the period which should by analogy be that of greatest exhalation, should be that of diminished manifestation. The known association of malaria with aqueous vapors suggests a coincidence in the exhalation of both from the soil, and as the absorption of the latter into the atmosphere is greatest during the heated period, it would seem that malarial developments should be correspondingly prevalent and intense at that time. In explanation it has been said, that when the air becomes chilly after sunset the difference between its temperature and that of the soil, heated by the absorption of the sun's rays during the day is at its maximum, as is in consequence the ascensional tendency of the air immediately in contact with the soil. But radiation soon cools the soil to the point where the tendency is to deposition of watery vapor rather than to its evaporation, while the malarial influence continues as pernicious as when the ascensional force was greater. To explain this it has been suggested that during the day the surface of the malarious soil becomes heated in the rays of the sun; evaporation takes place with rapidity, and the noxious exhalations carried upward by the ascensional tendency are diluted and dissipated in the higher regions of the atmosphere. There are, therefore, no malarial developments in the locality. At night, when the direct heat of the sun ceases to be felt, the soil speedily evolves its heat by radiation; the stratum of air in contact with it becomes colder than those overlying it, and such exhalations as issue from the soil are stayed in their upward course in the stagnant layers of cold and moist air which first receive them. Hence, although emanation is more active during the day than at night, the state of condensation of the miasm is so much greater during the latter period that pernicious effects are only then attributed to it.

The utility of large fires in dissipating malaria, or in protecting from its evil consequences, has been long a settled belief. Hippocrates considered that protection was thus attained, and in modern times troops operating in unhealthy sections have resorted to this as an agreeable preservative measure.

The generally accepted theory of malarial evolution calls for the concurrence of an organic soil, a certain degree of heat, and a certain proportion of moisture. A deficiency of organic matter in the soil lessens the miasmatic emanation; an excess may develop putrescence, the emanations from which, although harmful, are not causative of malarial disease, but of diarrhœas and continued fevers. The decomposition of organic matter which is essential to the production of malaria is that form of fermentative action which gradually reduces the nitrogen of devitalized tissues into ammonia and nitric acid for the enrichment of the soil and the growth of future vegetation. This fermentation requires the coöperation of heat and moisture. A deficiency of both operates antiseptically; the fermentative action is not instituted, and no malaria is evolved. An excess of both induces putrefaction. A deficiency of heat prevents or retards the fermentative change. There is no malaria in the frozen regions within the Arctic circle; and in less rigorous climates the winter season may be free from malarial disease. Organic matter with moisture in the soil develops malaria in the temperate zone chiefly in the autumn, when the heat is greatest; and the virulence of the evolved miasm progressively increases, through lower latitudes and lesser altitudes, until, in the swamps and jungles of the tropics, it is found at its maximum of deadly intensity. But an excess of heat may diminish its exhalation by desiccating the soil, and thus removing one of the essential factors. In tropical climates the dry season is free from pestilential fevers. The malarious season extends from the cessation of the rains over the period of subsiding floods and draining soils, until, by the continued action of the sun, the surface has become arid and hard-baked. A deficiency of moisture prevents the fermentative change and lessens the development of malaria, as in the dry sage-bush mesas of Arizona, where the subsoil water is forty or more feet below the surface. A similar condition of deficient moisture is found in most of our cities, where the thorough draining of the site is a customary preliminary to building. Malaria is known to disappear with the progress of house construction and its associated improvements, such as the drainage and filling-in of neighboring swamps, the grading and paving of the streets, the curbing of water-courses, and the general lowering of the subsoil water. An excess of water interferes with malarial exhalations, as shown by the cessation of paroxysmal fevers when swamp-lands have been submerged, as in the tropics during the continuance of the rains.

When due consideration is given to all the facts that have been gathered concerning the evolution of malaria from organic soils, the inadequacy of the generally accepted theory to furnish a satisfactory explanation is very manifest. When organic matter and moisture are present the evolution of malaria appears to be proportioned to the degree of heat; yet it is difficult to understand why, when in a temperate climate the heat of the spring months develops vernal fevers, the malarial manifestations do not progressively increase with the rising temperature until the autumnal maximum is attained, instead of halting in their increase, and sometimes even slightly decreasing during the summer months, before suddenly developing their autumnal prevalence. Similarly is it difficult to understand why, when in the tropics the first showers of the rainy season, falling on the hot and parched soil, develop pernicious fevers, these malarial manifestations do not abruptly reach their maximum of prevalence and violence, and continue to prevail until the excess of heat has desiccated the previously rain-sodden soil.

Nevertheless, these anomalous phenomena fall into place and become bound up satisfactorily with all the other collected facts pertaining to malarial exhalation, provided an assumption be made regarding the object of malaria in the economy of nature. What becomes of the malaria that is evolved from the soil of such vast expanses of the surface of the earth as are known to be malarious? Certainly some may be carried upward by the ascending force of evaporation, and meeting no condensing surface, may reach the upper regions of the atmosphere, and be borne far from the low grounds of its origin to be precipitated with the rain-showers on other portions of the country. Some, prior to exhalation, may be absorbed by the water which submerges the producing soil and be drained off into river bottoms, or remain until evaporation, at a more advanced period of the season, shall liberate it into the atmosphere. But these suggestions will not account for the disposition of the whole of the malaria generated from the soil any more than for the disposition of the whole of the carbonic anhydride, which is its concomitant in the reduction of dead vegetation to the condition of a vegetable mould. The carbonic anhydride is used by the living vegetation. What becomes of the malaria?

The assumption suggested in the last paragraph is,

that the living vegetation destroys the malaria during the process of its growth. This is no new theory. Wood gives it a favorable notice in his chapter on miasmata. Whether malaria is absorbed by the roots or the leaves of a plant, is not known; probably by both, the roots absorbing that retained by the subsoil moisture and the leaves that exhaled from the surface of the soil. The epidermis of plants does not exclude the atmospheric air from the tissues beneath, for it is cleft here and there by minute chinks, called stomata, which are each guarded by a pair of reniform cells. The mechanism of these is not well understood, but it is known that they open in a moist atmosphere and close in a dry one. The stomata are placed over, and communicate with, the intercellular passages of the plant. They are found only on the green surfaces exposed to the air, and are most abundant on the under surface of the leaves, and on parts shaded from the sun; but the under surfaces of floating leaves have none. Their number is immense, like the perspiratory pores of the human skin. Many thousands may be counted in the square inch, and on some plants they are more closely set than on others. Physiologists have not clearly defined the use of these innumerable pores that beset the surface of plants, and communicate with their interior cellular passages; and in the absence of knowledge to the contrary, they may well be considered in connection with the mysterious absorption of malaria from the atmosphere in the day-time, when all the functions of plant life are in full activity, and its accumulation in the atmosphere at night, when those functions are temporarily in abeyance. If the stomata were intended for transpiration, we should expect to find them generally diffused on the epidermis; if for the absorption of some material furnished from the atmosphere, we should have anticipated their aggregation chiefly on the upper surface of the leaves; but as they are aggregated on the *under* surface, the absorption of something that comes from below, rather than from above, is indicated—an emanation from the soil rather than a well-diffused aërial constituent.

During the winter, in temperate climates, there are no malarial fevers. We may assume that there is no malaria because, when the same conditions of heat and moisture that characterize their winters are found in the summer in more rigorous latitudes or altitudes, they are not associated with malaria. One or other of the factors needful to the fermentation of organic matter in the soil is absent. But when the sun rises higher and higher above the horizon with the advance of spring, and warm rains begin to fall for the generation of the annual growth of vegetation that will soon cover the surface, the fermentation of the organic matter of the soil begins immediately. As yet, however, there is no green foliage to absorb emanations, and in localities where the conditions for fermentation are particularly favorable, malarial fevers are found to be prevalent. As the summer advances and the annual growth becomes vigorous and luxuriant, these vernal fevers decline in prevalence. The luxuriance of vegetation on a particular soil indicates the existence of a malaria which would manifest itself by its action on the human system but for the presence of this vegetation. Later in the season, when the seed is mature, the energies of the plants flag. Under a continuance of the autumnal heat the leaves wilt and fade, the seed falls, and the plants droop and die. But meanwhile fermentation goes on in the soil so long as the needful moisture concurs with heat in its continuance, and the evolved malaria, no longer so completely absorbed or dissipated as heretofore, accumulates as a pestilential atmosphere. Ferguson, in speaking of the deadly character of certain localities in Spain—arid ravines, river bottoms, and bare open lands, having a parched soil and without vegetation—stated that a healthy condition of soil in these pestiferous regions was infallibly regained by the restoration of the marshy surface to its utmost vigor of vegetable growth.

So in the tropics, the unhealthy season corresponds with soil-fermentation and the absence of a vigorous vegetation to dispose of the products of the fermentation. According to Boyle, it is established at Sierra Leone, as well as in other tropical countries, that the commencement and termination of the rains are the periods at which the greatest number of fever cases is to be expected. At the end of the healthy dry season the ground is parched and hard-baked, like an adobe brick. Occasional tornadoes first break the monotony of the hot season—violent thunder-storms, with wind-gusts and heavy rains, which, although not of long continuance, deluge the country and sweep all surface accumulations into the rivers. After these the sun increases in heat, but the atmosphere is clear and much less sultry. As a consequence of the addition of moisture to the heated soil the face of the country becomes speedily altered; the ground, which had been parched and scorched, teems with vegetation, and the landscape is magically adorned. But these beauties appear to be pestilential—fevers become prevalent. In a few weeks, however, as this vegetation attains a vigorous growth, fresh cases of fever cease to appear. The luxuriance of this vegetation, with its associated freedom from fever, is continued during July and August, the months of but slightly intermitting rainfalls. In September the dry season begins. The annual growth, having matured its fruit, fades and dies in the hot season, and adds fresh organic matter to the already rich soil. The appearance of fever coincides with the death of vegetation; and cases continue to occur until the soil has again become arid and parched under the relentless heat.

Although the dissipation of malaria exhaled during the day may be accounted for by the ascensional force of evaporation carrying it upward into the atmosphere, the theory of its absorption by the growing plants furnishes a better explanation of the freedom of certain localities from malarial manifestations during the day, when plant life is awake and active, and their pestilential character at night, when the functions of the plants are in a state of repose. The association of malarious exhalations with a vegetation that is deficient in vigor from its youthful tenderness in the spring, its decay after maturity in the autumn, or its temporary quiescence after the shades of night have fallen, finds support in many of the observations that have been made on malaria. The upturning of the soil for agricultural purposes—destroying existing vegetation for the sake of a cultivated growth—is productive of paroxysmal fevers. A similar result follows other interferences with the growing vegetation, as in engineering operations and the clearing of forests; even drainage for sanitary purposes is often harmful, at first, by establishing new conditions as to moisture which interfere with the luxuriance of the natural growth before the production of a vegetation suited to the dryer soil. In some parts of India it is claimed that rice cultivation is not insalubrious during the growing period, but only after the crop has been removed, leaving the stubble on the otherwise bare rice-fields. The deleterious character of marshes occasionally overflowed by salt water, which renders the soil unfit for the luxuriant growth of either fresh- or salt-water plants, is well known; the soil is rich, and the conditions of fermentation otherwise favorable, but the growth is deficient. The dangerous nature of recently drained ponds, dams, and bottom-lands is also well recognized; the rich fermenting mould which is exposed has no covering of living vegetation. Such withdrawals of water occurring in the summer or autumn, in temperate climates, give rise to fevers that are analogous in their origin and intensity to those of the early part of the rainy season in the tropics. It may be noticed, also, that all the plants that have been specially recommended as having powers destructive of malaria, such as the eucalyptus and the sunflower, are rapid and vigorous growers.

In view of these considerations it might be said that while there are needful for the *generation* of malaria a soil containing organic matter, a certain degree of humidity, and a temperature of over 60° F., there is needful for its *evolution*, so as to produce morbific effects, a want of relationship between the growing plants and the malaria generated. When the verdure covering the soil is able to assimilate or dispose of the whole of the gener-

ated malaria, there is no evolution. The verdure necessary to effect this need not be luxuriant; if the fermentation in the soil be inactive from any cause, such as deficient heat or moisture, or a poverty of organic matter, a covering of grass may suffice to suppress exhalation. But if the conditions are strongly conducive of fermentative action there will be a richer growth of green vegetation on the surface, as in the tangled undergrowth of the jungle, which may nevertheless be insufficient to prevent the escape of fever-causing emanations. When an exact relationship exists naturally between the conditions of the soil and the vegetation covering it, there is no harmful evolution, but when that relationship is disturbed, malaria appears. When drainage and systematic cultivation have re-established the relationship, the country again becomes healthy.

In malarious air there is, as shown by the experiments of Vauquelin and other chemists, an organic matter which, not being a recognizable gaseous body, may, in accordance with existing views, consist of exceedingly minute particles of albuminoid matter, capable, like diastase, of setting up a fermentative action in the blood or albuminoids of the body, or of bacilli, micrococci, or other exceedingly minute microphytes, also capable of inducing a peculiar fermentation in the human system. The first alternative is deprived of likelihood by the persistence of the virulence of malaria under conditions which would be destructive to a mere zymotic poison. Complex albuminoids which are not protected by vitality are readily destroyed by putrefactive and oxidizing agencies. It is impossible to suppose the preservation of the constitution and powers of a zymotic poison raised into the atmosphere by evaporation, exposed to the most powerful of oxidizing and electrical influences, and subsequently precipitated by the rainfall; yet there is ground for believing that malaria may be thus dissipated, condensed, and precipitated without interfering with its organic qualities. Moreover, analogy supports this view. The poison of typhoid fever retains its virulence for so long that something more than a mere chemical union of its elements must be assumed to account for its power of resistance to decomposing influences. The theory of a living contagion, which was entertained in ancient times, has never completely died out. Even before the recent advances in bacteriological knowledge, as applied to the etiology of disease, the germ theory was frequently sustained as affording the most probable explanation of the morbid phenomena attributed to malaria. Dr. Daniel Drake, for instance, gave, among his speculations on the efficient cause of autumnal fever, no less than fourteen points of argument, from a consideration of which he concluded that the etiological history of autumnal fever can be more successfully explained by the vegeto-animalcular hypothesis than by the malarial. But he regarded both as merely hypotheses; neither could claim the rank of a theory. Since then, however, the connection between bacteria and disease has been carefully studied by an artificial cultivation of the supposed pathogenic micro-organisms, and their subsequent inoculation to test the constancy of their specific effects upon animal life. The association of the germ with disease has been demonstrated in some morbid states, and the probabilities seem to be in favor of the existence of a malarial parasite. Tommasi-Crudeli has deduced an argument in favor of a contagium vivum from the progressive intensity of the morbific production in abandoned malarious districts. "From the fall of Rome," he says, "even to the present day this phenomenon has been manifested in a very evident manner in the Roman Campagna, in certain parts of which, even up to the time of the Renaissance, it was possible to maintain pleasure-houses, but which are now uninhabitable during the hot season. In many cases the physical conditions of the soil have undergone no appreciable change during centuries, so that it is impossible to attribute so enormous an augmentation of malaria to an increase in the annual production, itself increased by a progressive alteration of the chemical composition of the soil. But if, on the contrary, it be admitted that malaria is caused by a living organism whose successive generations accumulate in the soil, the interpretation of this fact becomes very simple."

Salisbury believed that he had found the germ of malaria in an unicellular alga to which he gave the name of palmella gemiasma, but this organism was speedily shown to have no connection whatever with malarial disease. Lanzi and Terrigi referred malarial fevers to a pigment formed in the cells of certain algæ, which in winter and spring cover the swamps of the Roman Campagna with an abundant growth. These algæ die in the summer, when the swamp-water is dried up and the surface becomes covered with a mass of slimy and decomposing organic matter which ultimately is converted into black humus. In the endochome of the cells of the algæ were found dark granules, which these observers regarded as identical with the melanic matter that accumulates in the liver, spleen, brain, and other organs of persons who are affected with malarial disease. The black humus of the marshes was not conceived to reproduce itself when taken into the system, but to induce morbific changes in the albuminoid principles of the blood.

The investigations of Klebs and Tommasi-Crudeli, which were published in 1879, attracted much attention in this country. These observers announced the discovery of a bacillus (malariæ), which was constantly found in the swamp-mud of the Roman marshes, and which, when cultivated and introduced into rabbits, produced a fever similar to that developed in the human subject after exposure to the marsh-miasm. Marchiafava shortly afterward discovered this bacillus in the blood of malarious subjects, and stated that it would always be found at the period of invasion, while the spores alone could be seen when the fever was at its height. Dr. Sternberg, United States Army, who was sent to New Orleans, La., by the National Board of Health to investigate this matter, has thrown doubt upon the reported discovery of the Italian observers. He found many bacterial forms in the marsh-mud of New Orleans; among them were some to which the description given by Klebs and Tommasi-Crudeli might be considered to apply; but similar forms were discovered in Baltimore, Md., and other places where malaria was not in question. Dr. Sternberg also showed that the temperature-curves in the rabbits injected by Klebs and Tommasi-Crudeli were in no case of a distinctly paroxysmal character, while the changes in the spleen, recorded by these experimenters as the result of malarial inoculation, were found to be present as well in cases of septicæmia, produced by the inoculation of human saliva. We must therefore conclude that the evidence on which the bacillary origin of malarial disease rests is not satisfactory. Since then, however, Dr. Dreschfield, of Manchester, England, has seen the bacillus in malarial blood.

Shortly after the announced discovery of the bacillus malariæ, a French observer, Laveran, insisted that the black pigment found in the blood of malarial cases, and deposited in the capillaries of the liver, spleen, brain, etc., is a result of the vital action of a microscopic parasite. Kelsch, who had studied this pigment with much care, regarded it as contained in the white cells of the blood, but Laveran, and, following him, Richard, considered the containing cells as organisms furnished in their complete development with motile filaments, three or four in number, which undulate with a rapid motion, like that of the anguillula. In the examination of the blood in sixty malarial cases, during his service in Algiers, Laveran found the pigment-granules in forty-two cases. His large proportion of negative results was attributed to prolonged treatment in these instances by sulphate of quinine. The interest in his observations attaches to the cellular envelope enclosing the pigment-granules. Three forms were distinguished. In the first the cells were elongated, incurved, and somewhat pointed at the ends—in fact, banana-shaped; sometimes, however, they were oval, with the pigment-granules loosely aggregated or disposed in an annular form toward the centre of the cell. In the second the cells were spherical, and in size even larger than a red blood-corpuscle, with the pigment-grains in a moniliform ring within the circum-

ference. These spherical bodies are figured as possessed of three or four filaments, each about as long as the circumference of a red blood-corpuscle; and when in rapid undulation their action is said to impress a movement on the neighboring blood-disks. In the third form the cells were larger and were not filamented; their pigment-granules were irregularly disposed, but sometimes the annular arrangement was observed. Laveran regards these three kinds of cells as representing different phases of the evolution of the same parasite, the oscillaria malariæ, the form with motile filaments being the perfect condition of the organism, and the third form the cadavers of the parasitic elements. These singular and, according to Laveran, readily observable appearances in malarial blood remained without support or adverse criticism for five years, until Tommasi-Crudeli, Marchiafava, and Celli (*Indian Medical Gazette,* January, 1886) acknowledged their existence, but regarded them as the results of degenerative changes in the red blood-corpuscles. The globular protoplasm becomes aborted or converted into a hyaline material showing amœboid movements, and the hæmaglobin is transformed into melanotic particles which have sometimes an oscillatory motion in the diaphanous spherule. The motile filaments were also recognized, but were viewed as globular protoplasm altered in some unknown way. The corpuscles ultimately are disintegrated, and the pigment-granules in various degrees of aggregation are liberated in the current of the circulation. Tommasi-Crudeli does not explain the connection between these changes and his bacillus malariæ, the filaments of which are wholly distinct from the motile filaments of the degenerating corpuscles.

Camillo Golgi (*Fortschritte der Medicin,* Bd. 4, 1886) has also seen changes in the blood similar to those described, consisting of the development of colorless, plasmic bodies in the red blood-corpuscles. As these bodies enlarge, melanotic particles are found scattered within their substance. All trace of the normal constitution of the blood-corpuscle becomes lost in its transformation into a colorless globule containing particles of pigment. These particles ultimately become aggregated in the centre of the globule as a dark nucleus, around which the colorless substance undergoes fission in radiating lines, the resulting cellules appearing like the rays of a composite flower. When this stage of development has been reached a febrile attack is imminent. Afterward the cellules and the central mass of pigmented matter are liberated into the current of the blood. At Pavia, Golgi examined forty cases, with negative results in only two cases. Most of his fevers were quartans; and he claims that the long intervals between the paroxysms afforded time for the complete development and fission of the altered corpuscles, results which are not observed in fevers having shorter intervals.

Tommasi-Crudeli found that his bacillus required oxygen as well as heat and moisture for its propagation, and thus accounted for the salubrity which follows the complete flooding of a marsh and for the injurious effects of upturning the soil in malarious districts. Oxygen, he claims, is also excluded by a matting of the soil with the roots of grasses; hence the general salubrity of grass-lands. But this does not account for the healthfulness of certain districts during the period of vigorous vegetable growth, and their insalubrity as vegetation falls into the sere and yellow leaf.

Malaria has generally been supposed to enter the system by way of the lungs. Sometimes, however, the skin has been regarded as the absorbent surface. Thus Brocchi, cited by Macculloch, upheld the latter doctrine to the exclusion of the former, and attributed the greater virulence of malarial diseases in modern Rome to the disuse of woollen clothing, and particularly of the toga, which, in the time of the empire, became replaced by garments of linen or silk. But on the theory of a causative micro-organism, the natural pabulum of which is the fermenting organic matter that is contained in its natural habitat, the soil, the entrance into the system would seem rather to be effected by way of the intestinal tract than by either the cutaneous or the pulmonary surfaces. The tendency of the system to succumb to malarious influences, when the exposure occurs during fasting, has been attributed to the general results of lowered vitality; but if the malarial germ before developing its pestilential manifestations has to reach the alkaline environment of the intestinal tract, the protective influence of a full stomach and active gastric digestion may be explained by specific instead of by general statements.

The blood does not appear to present a suitable pabulum, such as may be found in the fermenting contents of the lower bowel, for an organism indigenous to soils containing decaying organic matter. Certainly, in the instances of malarial fever conveyed by means of the water-supply the system must be invaded by way of the alimentary canal. As a result the blood becomes degenerated in the manner described, local congestions are developed, and the pigment-granules of the decayed blood-corpuscles are deposited in various organs. The presence of micro-organisms in the blood is not necessary to the disorganization of this fluid; and, indeed, the close scrutiny to which malarial blood has been subjected during the past few years testifies rather to its absence than to its presence if the appearances figured by Laveran, which only are constant, be the results instead of the causes of degeneration.

A micro-organism that has colonized the intestinal tube may, during its multiplication and growth, evolve a subtile agent as the immediate cause of the febrile phenomena. During the fermentation which it sets up in the organic contents of the intestine a substance may be elaborated, analogous in the method of its production to the alcohol which appears in saccharine liquids under the influence of the yeast-fungus, which, when absorbed into the blood, may occasion the degenerative changes and the paroxysmal phenomena. The febrile action, on this view, represents the temporary intoxication resulting from the absorption of the product of the fermentation.

The intermittence of malarial disease has been, until recently, regarded as an obscure subject. It was considered as inexplicable as are the laws of life, on which it was conceived to depend. Sauvages, Bichat, Broussais, Piorry, and others, referred it to the physiological intermittences that occur in most of the phenomena of life. Metcalfe gives full expression to these views as follows, "The reason why the paroxysms of intermittent fever return at nearly regular intervals of time must obviously be sought in those general laws of periodicity which mark the revolutions of the animal economy in health, under the influence of season, changes of temperature, day and night, sleeping and waking—all of which modify the various functions in a regular and uniform manner. The annual leafing and flowering of trees and plants are governed by thermal influence. All the phenomena of nature are subject to periodicity, from the revolutions of planets to those of the atmosphere and of the ocean, the birth, growth, and decay of organized bodies. And as there are certain periods of the year most favorable to each class of diseases, so are there certain periods of the day when the forces of life are at a minimum and the system most liable to the invasion of fever, modified by circumstances which are often overlooked. This tendency to periodicity is strikingly exemplified in many of our artificial habits, which have been termed 'second nature.' For instance, if an individual accustom himself to remain awake until three o'clock in the morning for several weeks or months, and to rise at ten, it will be some time before he can go to sleep at an earlier hour, although he may rise at seven in the morning; and so of many other acquired habits, all of which, however, are subordinate to the revolutions of nature."

But on the bacillary theory intermittence is readily understood. During the febrile access the poison is eliminated; and the apyrexial period is equivalent to that of incubation in specific fevers—the period of accumulation. The extent of the colonization and the rapidity of the fermentative processes throw light on the connection between intermittent, congestive intermittent, and subcontinued malarial fevers, these being results proportioned to the quantity of the poison generated at one time, and

to the rapidity with which its elaboration is continued. Some writers who have attributed malaria to vegetable decomposition have suggested, in explanation of the various effects produced by its deleterious influence, the very striking differences in the elementary constitution of plants—malaria being thus regarded as a genus producing different diseases or different modifications of disease according to the plants evolving the miasm. The flora of the marshes has been studied with the view of throwing light on this subject, but nothing has been discovered tending to support this theory. At the present time the accepted theory is that there is but a single noxious miasm, which produces different morbid effects according to the prominence of heat or moisture in the conditions affecting its evolution during the decomposition of vegetable matter, to the state of concentration in the miasm, and to the constitution of the affected individual. Drake, although regarding the difference between a simple intermittent and a malignant remittent as greater than that between measles and scarlet fever, considered all malarial diseases as but manifestations of the same morbific influence. All varieties of malarial disease prevail at the same time and at the same place. They frequently change from one type to another, the intermittent becoming a remittent or terminating in a congestive attack, or the more continuous form subsiding gradually into intermittence. The sequelæ of all the manifestations are identical in character, and all acute manifestations are amenable to the action of antiperiodic remedies. Hence they are regarded as the offspring of the same specific cause.

The action of quinine and other antiperiodic remedies is also understood on the theory of an intestinal microphyte. The paroxysm may be averted, or the remission interrupted and the fever stayed in its course, but recurrences take place until the plantations of the malarial microphyte have been uprooted and destroyed. These recurrences have been the occasion of as much learned, but valueless, discussion as the intermittency of malarial disease. The recurring phases of the moon have suggested a connection with malarial fevers which has outlived many generations of observers. Dr. Francis Balfour, in his "Treatise on Pestilent Remitting Fevers," 1790, gave a full exposition of the theory of sol-lunar influence. According to his view the poison of the disease is contained in the intestinal mucus, but its action is controlled by this mysterious influence. Daily remissions and aggravations, septenary returns and seasonal prevalence, were regarded as due to the combined influence of the sun and the moon, the febrile state being greater at the diurnal meridional periods than during the intermeridional intervals; at the novi-lunar and pleni-lunar periods, extending three and a half days on either side of the new and the full moon, than during the intervening periods; and especially at the lunar periods of the equinoxes as compared with those of the interequinoctial intervals. Even at the present time many British medical officers of large experience in India continue to give credit to this theory. A certain connection no doubt exists, as pointed out long ago by Lind, between the moon's phases and the prevalence of fever. High tides and low tides are associated with the production and evolution of malaria, by affecting the moisture of the subsoil and the extent of marshy surface exposed at the ebb. As late as 1861 the influence of the moon was officially investigated in the Bombay Presidency, the result showing that paroxysms of fever do not occur more frequently at one period of the lunar month than at another. *Charles Smart.*

MALARIAL AFFECTIONS IN CHILDREN. Malarial diseases, in some of the forms at least, are not less frequently seen in children than in adults. The following statistics, taken from the Out-department of the Demilt Dispensary, will serve to illustrate this point: Of 1,141 children under ten years of age, treated by me in the year between September 1, 1885, and the same date, 1886, 104 were cases of malarial illness. This constitutes about nine per cent. of all the diseases; and, with the exception of bronchitis, malaria was the disease most frequently met with. It is proper, however, to say that the district under the care of this dispensary is a highly malarious one, and, of course, malaria would not hold so high a rank in other parts of New York.

The conclusion may be reached, nevertheless, that childhood and infancy afford no immunity from this class of diseases, and that we may look for malarial poisoning as a cause of illness with quite as much readiness in children as in adults.

Age.—Cases have been reported in which the diagnosis has been made during the first week of life—the children being born while the mothers were ill with malarial fever. In such cases the disease could fairly be called congenital, since so short a period of time would hardly suffice for its development. The youngest child in whom I have made the diagnosis of malarial fever was six weeks old; and 7 of the 104 cases were in the first year of life.

Nature and Pathology.—There does not seem to be any essential point of difference, as to pathology or causation, from what obtains with adults. The reader is therefore referred to the articles on Intermittent Fever and Malaria for the consideration of these questions.

Varieties.—Intermittent fever has been called the "typical form of malaria," and I think this holds with children. Certainly the great majority of my cases have been of distinctly intermittent character, either quotidian or tertian, and the cases in which there was no interval of apyrexia were seldom seen. Whether intermittent or remittent, quotidian fever comprises most of the cases; Holt says four-fifths, and I do not think that this is an overestimate. The rarer forms—double quotidian, the third, fourth, and seventh day fevers, etc.—are scarcely ever to be seen. We will therefore consider first the clinical history of intermittent fever as manifested in infancy and childhood, and as contrasted with the same in adults; and afterward the exceptional forms.

Symptoms.—All authorities agree that chills are of very infrequent occurrence, if indeed they are ever seen, under two or three years of age. I have never seen, nor been able to obtain from parents, a description of a chill in a child under three years, and very rarely in children under six or seven. After that age chills, though perhaps slight, are usually present, and the disease in other particulars acts as in adults. But this dividing line is overstepped in both directions. There is, however, a cold stage, shown by blueness of the lips and coldness to the touch of the hands and feet, in a few of the cases. The chill of adults is sometimes represented by a convulsion. This is not common, and probably would apply principally to those whose nervous organization was highly sensitive; such children as would have convulsions from dentition or indigestion. This does not apply to a special class of cases, to be mentioned hereafter, in which repeated convulsions constitute a prominent feature. As a general rule, then, the first or cold stage is much less pronounced, and is of shorter duration, than in adults; and the ordinary mothers' description will be that fever comes on quite suddenly, at a stated time. This time is much more apt to be the afternoon or evening than the forenoon, viz., in about two-thirds of the cases. In one instance I was told that this occurred every evening at about nine o'clock, and found that the temperature reached 105° F. at that hour, there being perfect apyrexia all through the day.

Generally the second or hot stage is strongly marked. The heat of the skin is very evident. The face is flushed, the pulse is rapid, sometimes beating 150 or even 200 to the minute; and the respiration is accelerated to 40 or 50 per minute. The temperature rises to 103° or 105°, quite rapidly; and the frequency of the pulse and respiration bears a proportion to it, as in other febrile conditions. There is great restlessness, and the child is clearly in much discomfort. Pain in the head seems to be the principal source of this. Anorexia is almost uniformly present, and vomiting quite frequently occurs, irrespective of food ingested. Epigastric pain is frequent—according to Holt, in four-fifths of the cases. The appearance of the tongue has been considered characteristic. It is clear at the edges, with a yellowish fur in the centre.

Sometimes hyperæsthesia of the skin is observable. Yet the degree of prostration is much less than that which characterizes the same height of fever when due to some inflammatory condition, as pneumonia, or to scarlatina. I have had children brought to the dispensary in a malarial paroxysm, and have found a temperature of 104° and 105°. These children would be quite able to sit up, or stand, while one with pneumonia would be greatly prostrated.

Enlargement of the spleen should always be sought for. It is believed always to exist in a malarial paroxysm, and frequently to subside during the intermissions. It is often very difficult to make out—satisfactory palpation being prevented by the contraction of the abdominal muscles from crying and motion, and the results of percussion being negatived by the transmission of tympanitic resonance from a distended abdomen. Some tenderness over the splenic region is frequently found.

The second stage terminates by defervescence, and sometimes with decided perspiration, as in adults. But profuse sweating is rare in children under six or seven, and is very seldom seen in infants, though more frequently than is the chill at the beginning of the attack.

The foregoing is the most frequent condition of things in an ordinary attack of intermittent fever. But many cases are much less pronounced. The temperature rise is not great—to 102° or thereabouts; and in that case the picture is quite different. The flushed face is absent, pallor being noticeable; the restlessness and tossing about are replaced by languor; there is not so plain evidence of pain in the head or stomach; and the respiration and pulse are quickened to a much less degree. On visiting a child in this condition, one would find it lying down, unwilling to move or be moved, pale, and not to be amused or interested in things. And the mother's description would be that the child acted in this manner every afternoon.

I think that one of these two conditions is almost always to be found. It will thus be seen that the second stage is, in general, alone perceptible—the chill at the beginning and the sweat at the end being absent.

In the intervals between the paroxysms the little patients seem better, but rarely perfectly well. The appetite is generally poor, the tongue is coated, and there is almost always a condition of drowsiness and inactivity—suggestive of the yawning often found in adults. The face is pale, and there are dark bluish rings under the eyes. These points seem to me to be very characteristic—the pallor of the face, the rings under the eyes, and the condition of drowsiness. The last is frequently spoken of by the mothers, without special questioning. This completes the clinical history of the ordinary attacks of intermittent fever. Simple remittent acts in the same way, and the only means of accurate differential diagnosis lies in demonstrating by the thermometer a period of complete apyrexia. Practically there is no advantage in this, as the prognosis and treatment are the same in both. But importance attaches to the discovery of a malarial (remittent) element in typhoid fever, which was formerly called infantile remittent. I have never made the diagnosis of typho-malarial fever in a child, and have seen but few cases of typhoid. But I cannot see any reason why the two conditions should not coexist, and I should expect to find the same characteristics as in the adult.

The pernicious forms (algid, comatose, etc.) have not been observed in children, at least in New York, and the opinion is general that even in adults they do not originate here, but in certain other parts of the world, notably Central America.

There is a certain class of cases which, although rarely seen, are entitled, it seems to me, to special mention, because of the importance of the differential diagnosis. I refer to those in which the cerebro-spinal system is especially affected, and which, nevertheless, could scarcely come under the head of pernicious fever. The prominent symptoms are: General convulsions, frequently violent, coming with each day's febrile paroxysm, and not limited to the first or initial one; rigidity of the neck, with indications of great pain if the head be forcibly bent forward; contortion of the face and frowning eyes, as if the pain were intense; cries loud, sudden, and frequent; pupils dilating and contracting irrespective of the light; very great hyperæsthesia of the surface; and vomiting, frequent and sufficiently sudden and violent to be called projectile. These symptoms may not all be present; but the convulsions, rigid neck, and excessive vomiting would constitute good reason for making the diagnosis of meningitis, and, if the hyperæsthesia were present, of cerebro-spinal meningitis. Twice I have made this mistake, and found my error only after the lapse of two or three days. The essential point in the diagnosis is the periodicity; the convulsions and other symptoms beginning suddenly at a certain time—as the afternoon—and ceasing at a stated time also. To see a child with all, or nearly all, of these symptoms in full activity on one day, and the next morning to find it perfectly quiet and languid, and without elevation of temperature, is sufficient for the diagnosis; for the variation in intensity of symptoms, which is characteristic of meningeal disease, cannot be so pronounced as in this condition. Furthermore, the history will be most significant in the matter of diagnosis, for the characteristic symptoms of meningitis do not come suddenly. There are generally some days of illness, shown by much crying, as from pain, together with vomiting, constipation, and fever, before a convulsion occurs. Then, some symptoms almost pathognomonic of meningitis are not present in the malarial affection, viz., retracted abdomen, irregular and intermittent pulse, and irregular breathing, or the "Cheyne-Stokes respiration." The fluctuations in temperature belonging to meningitis do not reach the point of apyrexia, although a high temperature is not at all characteristic of this particular form of malarial fever. In the four cases that I have seen, it has not exceeded one hundred and four degrees.

A patient in this condition would therefore simulate a case of meningitis fairly well advanced, whereas the child affected with malaria would be reported absolutely well one, two, or three days before.

Dr. Holt speaks of cases which simulate pneumonia—presenting high fever, rapid respiration, cough, and the physical signs of active engorgement of the lungs; these indications being all periodic in character.

The neuralgias so frequently found in adults are seldom, if ever, to be clearly made out in children. The latter have, as before mentioned, a great deal of headache in a malarial paroxysm, but this seems to be dependent on the rise of temperature, and I have never found it without fever.

Chronic malarial infection or cachexia occurs in children. It leads to a condition of anæmia which may become very profound. Œdema, localized, as in the face, or general, is apt to occur in this state of hydræmia, without kidney or cardiac trouble to induce it. The spleen becomes greatly enlarged, and the liver also. The bluish pallor of the face is replaced by sallow or slightly jaundiced coloring. This state of things is to be found occasionally, the history being of repeated previous attacks, or of a very much protracted and obstinate intermittent fever.

Complications.—Malaria is often conjoined with other diseases, as bronchitis and gastro-intestinal affections; but I think that the combination is more a matter of chance than a relation of cause and effect; though, as in adults, almost any sickness seems to render active a previously dormant malarious condition. Of course, such conjunction should greatly modify the management. Malarious children are apt to have attacks of follicular tonsillitis, and hypertrophied tonsils. As gastric irritability, shown by vomiting, is frequently prominent in the course of an intermittent or remittent fever, perhaps it would come under the head of complications. Instances of periodic diarrhœa, or dysenteric trouble, controlled by quinine, are said to have been seen.

Diagnosis.—The diagnostic symptoms of malarial disease are: The pronounced periodicity of the febrile condition and other symptoms; the pallor and dark rings under the eyes, frequently continuing through the in-

tervals; the constant condition of drowsiness and inactivity; and the enlargement of the spleen. There are several diseases which must, in some instances, be excluded. Prominent among these is pneumonia, as the rapidity of the respiration may suggest this disease. In it there would be the moaning or grunting expiration, constant or very frequent cough, a great degree of prostration, and early in the sickness the physical signs of consolidation. But it may require a second or third visit, and a delay of twenty-four hours, before we can be sure. From acute indigestion, with fever, vomiting, and epigastric tenderness, the discrimination may be nearly impossible at the first visit. The condition of a child suffering from habitual indigestion, or, as the parents may think, from intestinal worms, often closely resembles the less pronounced forms of malarial fever. But the vomiting in the latter does not seem to bear any relation to food or medicines ingested.

From meningeal disease, the differential diagnosis has been considered. Practically, then, it is often, if not usually, necessary to wait until a second visit before excluding other affections. The irregular fluctuations in temperature (remissions) which occur in many children's diseases, notably in measles and meningitis; and the more rhythmic remissions belonging to typhoid fever, must be borne in mind, since for the most part they do not indicate a malarial element.

Prognosis.—The prognosis of all malarial troubles in children is exceedingly good, since they yield more quickly, and, I think, more completely, to antiperiodic remedies. But a pronounced case of chronic malarial poisoning is very hard to cure. Improvement to a considerable degree is to be expected, and that in a short time; but the remedies seem to lose efficacy, and the bad condition is easily resumed.

Treatment.—Quinine, of course, constitutes the essential of treatment. Children generally yield more readily and quickly to its influence than adults; although the quantity prescribed by the usual tables proportioned to age ought frequently to be exceeded. Much variety of opinion is expressed on this point, *i.e.*, in regard to the quantity to be given. One author says that one grain once a day, for a child one year old, is sufficient to cure a case of pronounced intermittent. I believe that, at that age, one grain and a half, every three or four hours, should be given until the last paroxysm has occurred. Generally, the continuance of this for two days will suffice to prevent a recurrence. The drug should be given in diminished quantity for some days after the last paroxysm. A solution is much the most desirable form for administration, and seems more reliable in action. It is sometimes difficult to administer, because of the bitterness of taste; and almost always this obstacle can be overcome by giving the solution in about two tablespoonfuls of cold, strong, sweetened coffee. Should immediate vomiting be excited by the drug, a cold wet cloth laid for a few minutes over the throat, at the time the quinine is administered, will frequently check it.

Another available method of administering quinine to children is to give it in the form of the "capsules" of Warburg's tincture. The dried extract can be taken out of the capsules and given in jelly, etc. Warburg's tincture certainly reaches some obstinate cases, which an ordinary solution fails to cure, both among adults and children.

In obstinate cases, or in chronic malarial infection, it may become advisable to make use of arsenic.

As to giving a mercurial purge (calomel) before beginning the quinine, it seems to me that it is unnecessary. There does not seem to be good reason to think that it facilitates absorption. As to vomiting, children sometimes do that because of the disease, and sometimes as a result of taking the quinine; and calomel does not appear to modify this symptom.

If frequent recurrences take place, removal from the malarious region becomes advisable.

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Bemiss: Malarial Fevers, Pepper's Syst. of Med.

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MALPRACTICE. Cases in which malpractice is alleged may give rise to criminal prosecutions of the physician, or to civil actions against him for damages. There is no good reason why he should not be liable to indictment if injury less than that of death results to the patient from grossly careless or grossly ignorant treatment, though no case of the kind is reported. If death ensues under such circumstances, it is well settled that the attending physician or surgeon may be prosecuted for murder or manslaughter.

I. Civil Actions.—To define civil malpractice, that is, such error or neglect in the treatment of a patient as will render the person who commits it amenable in damages, is by no means easy. Casper, an authority in this matter, lays down the rule that malpractice exists where the course taken "is in conflict with general rules prescribed for similar cases by contemporary medical science and adopted in contemporary medical experience." And in another place he says that the physician "should be liable to punishment if in a given case he departs entirely from the treatment which the great majority of physicians of his time adopt in such cases, and which the great majority of medical authorities recommend for such cases." It is true that this definition, when taken literally, would include under the head of malpractice the employment of every new remedy or treatment, however valuable; for advances in medicine, as in other sciences, can usually be made only by running counter to the "great majority" of contemporary authorities. A few years ago, for example, all the faculties of Europe and America would have united in condemning as malpractice the treatment of fevers which is now everywhere adopted by intelligent physicians. Upon this ground Casper's definitions have been condemned in sweeping terms. Saxinger, for instance, in Maschka's "Handbuch," maintains that development of medical science would effectually be stopped if this rigorous standard of malpractice were adopted. But a little reflection shows that Casper is right. He must not be taken to intend that he who departs from the received opinion and treatment is guilty of malpractice, though the patient recovers. He means, of course, that all such departures are instances of malpractice, unless they are justified by the event. The physician or surgeon who strikes out a path for himself does so at his peril; if he succeeds, he will be hailed as a benefactor of his race; if he fails, he will be liable in damages to the patient.* This rule may seem

* In an English case, Slater *vs.* Baker and Stapleton (2 Wilson, 359), one of the earliest recorded cases of malpractice, this principle was recognized.

The defendant Baker was a surgeon of great eminence, noted also for his humanity, who read lectures in surgery and anatomy, and had for twenty years been at the head of St. Bartholomew's Hospital. The other defendant, Stapleton, was an apothecary who assisted him.

From the evidence it appeared that the plaintiff, having broken his leg, was treated successfully by the two defendants; that after the bone had been set for a month the surgeon found that "the leg was healing, and in a good way; the callus was formed; there was a little protuberance, but not more than usual. One John Latham swore that after nine weeks the plaintiff was well enough to go home, that the bones were well united, that he was present with the plaintiff and defendants, and at first the defendants said the plaintiff had fallen into good hands; the second time he saw them all together the defendants said the same, but when he saw them together a third time, there was some altercation; he said the plaintiff was then in a passion, and was unwilling to let the defendants do anything to his leg." What occurred on this third visit was thus stated by the plaintiff's daughter: "The third time the defendants came to the plaintiff, Baker took up the plaintiff's foot in both his hands, and nodded to Stapleton, and then Stapleton took the plaintiff's leg upon his knee, and the leg gave a crack, when the plaintiff cried out to them and said, 'You have broke what nature had formed!' Baker then said to the plaintiff, 'You must go through the operation of extension,' and Stapleton said, 'We have consulted and done for the best.'" Thereupon, in the words of another witness, Baker put on to the plaintiff's leg "an heavy steel thing that had teeth, and would stretch or lengthen the leg," and three or four months afterward the plaintiff was "still very ill and bad of it." A surgeon being called as a witness, swore "that in cases of crooked legs, after they have been set, the way of making them straight is by compression, and not by extension, and said he had

hard, but it is salutary. It is easy to foresee what havoc might be wrought by unprincipled and reckless, or even by conceited or fanciful, practitioners, if they were allowed to justify the most bizarre treatment by alleging the sincerity of their motives. Even gross and culpable ignorance might be covered up under the pretence of a new idea as to the true method of procedure. Nor is it reasonable to believe that this rule, namely, that whoever departs from the received opinion and practice does so at his peril, can have any appreciable effect in retarding the development of medical science. It was never observed that inventors in the other arts and sciences lack confidence in their achievements; and it is absurd to suppose that they who have made real discoveries in physics or surgery will be deterred from putting them to the test by fears of a suit for malpractice. There is, however, one possible case in which a departure from the general practice might be justified, even though it had resulted unfortunately for the patient. If it could be proved by the evidence of physicians competent to testify in the matter that the new step, whether in medicine or surgery, though never thought of before, was yet justifiable on *a priori* grounds, so that a good physician might well have believed in its efficacy (had it been suggested to him), so far as he could do so without trial—in such a case the employment of the new course would probably not be held to constitute malpractice, even though it failed where the ordinary remedy would have been likely to succeed.

Even the use of a highly valuable remedy or course of treatment may fail entirely when it is first tried, not, as might appear to the spectators, because it was futile in itself, but because, though better than any other known treatment for the purpose, it was yet insufficient to overcome the force of the disease in the particular case. If the first fever patient upon whom the cooling treatment was employed had died, the physician would have been liable for malpractice, unless he could have shown, as just suggested, that his treatment, though new, was good.

According to a text-book of recognized authority, "malpractice can only be affirmed where the physician has set aside principles established in the school of which he professes to be a member, and neglected to employ means which are usually employed by respectable physicians of his class and locality under similar conditions."[1]

Chief-Justice Tyndall laid down the law on this subject as follows: "Every person who enters into a learned profession undertakes to bring to the exercise of it a reasonable degree of care and skill. He does not, if he is an attorney, undertake, at all events, to gain the cause; nor does a surgeon undertake that he will perform a cure; nor does the latter undertake to use the highest possible degree of skill, as there may be persons of higher education and greater advantages than himself; but he undertakes to bring a fair, reasonable, and competent degree of skill. And in an action against him by a patient the question for the jury is whether the injury complained of must be referred to a want of a proper degree of skill and care in the defendant or not. Hence he is never presumed to engage for extraordinary skill or for extraordinary diligence and care."[2]

It is implied in the foregoing definitions that a physician or surgeon must first possess the ordinary skill and knowledge of his time in relation to his art; and secondly, that he must exercise such skill and knowledge.

not the least idea of the instrument spoken of for extension." Other surgeons testifying to the same effect, the jury gave a verdict of £500 against the defendants, which was afterward sustained on appeal, the Lord Chief-Justice saying: "That the plaintiff ought to receive a satisfaction, for the injury seems to be admitted; but, then, it is said, the defendants ought to have been charged as trespassers *vi et armis*. The court will not look with eagle's eyes to see whether the evidence applies exactly or not to the case; when they can see the plaintiff has obtained a verdict for such damages as he deserves, they will establish such verdict, if it be possible. For anything that appears to the court, this was the first experiment made with this new instrument, and if it was, it was a rash action, and he who acts rashly, acts ignorantly; and, although the defendants in general may be as skilful in their respective professions as any two gentlemen in England, yet the court cannot help saying that, in this particular case, they have acted ignorantly and unskilfully, contrary to the known rule and usage of surgeons."

Malpractice may result from ignorance, from stupidity, or from recklessness.

For errors of judgment, either in diagnosis or in the choice of remedies, the physician is not responsible, unless they are so gross as to imply culpable ignorance or carelessness.

In an English case the court said: "To render a medical man liable, even civilly, for negligence* or want of due care and skill, it is not enough that there has been a less degree of skill than some other medical man might have shown, or a less degree of care than even he himself might have bestowed; † nor is it enough that he himself acknowledges some degree of want of care; there must have been a want of competent and ordinary care and skill, and to such a degree as to have led to a bad result" (Rich *vs.* Pierpont, 3 F. and F., 35).

In Simonds *vs.* Henry (39 Maine, 155) the jury was instructed that if the physician had used all the knowledge and skill to which the art of medicine had at that time advanced, nothing more would be required of him. An exception to this charge having been taken, the Supreme Court said: "It is undoubtedly correct that no more would be required of him. But upon legal principles, could so much be required of him? We think not. If it could, then every professional man would be bound to possess the highest attainments, and to exercise the greatest skill in his profession. Such a requirement would be unreasonable."

"The diligence and skill required are reasonable or ordinary diligence and skill, such as are manifested or possessed by the profession as a body, not the highest degree, not that degree which is possessed only by the most eminent of the profession (McClelland's "Civil Malpractice," p. 521, where many legal decisions are cited).

It is hardly necessary to remark that physicians cannot be presumed to warrant the recovery of their patients.[3] If, however, a physician makes a contract, written or verbal, to cure his patient and fails to do so, he will be held to have broken the contract, and no compensation will be due him, although it can be shown that the failure to recover was not owing to want of skill or care upon his part.[4]

The same rules of law, in respect to negligence, apply both to physicians and attorneys, and to any persons who engage to perform services for another. In the text-books and in many judicial opinions a distinction has been taken in the degrees of negligence, dividing it into ordinary and gross negligence; and it has been said that when one undertakes to render a service for another gratuitously he will be held responsible for gross negligence only. The legal correctness of this distinction has, however, been denied by eminent authorities. In the case of Wilson *vs.* Brett (11 M. and W., 113), Baron Rolfe remarked: "I said I could see no difference between negligence and gross negligence; that it was the same thing with the addition of a vituperative epithet. There is a tendency in both the English and American courts lately to repudiate the use of the terms."

Mr. Justice Curtis, of the Supreme Court of the United States, said: "It may be doubted if these terms 'slight,' 'ordinary,' and 'gross' can be usefully applied in practice."

In one case Chief-Justice Dallas showed that his understanding of the word "gross," when applied to negligence, amounted to mere vituperation, for he said: "Gross negligence is where the defendant or his servants have not taken the same care of the property as a prudent man would have taken of his own." In other words, he held that ordinary negligence is gross negligence.

But whether or not the law discriminates between different degrees of negligence, it is certain that a physician or surgeon cannot escape the charge of malpractice by taking

* The term "negligence" is used throughout the present article, and in the literature of this subject generally, as a collective word indicating the legal shortcoming of a physician in the treatment of his patient, whether the negligence consist in want of due skill or want of due care.

† That is, extraordinary care, such as it would be unnecessary and impracticable for a physician to bestow in cases of the kind generally.

advantage of such a distinction. The principle is that if the person who undertakes to perform a service for another, gratuitously is not, and does not pretend to be skilled in the art or business concerned, then he is liable only for gross negligence; and in all other cases the person who does a service for another, though gratuitously, and at his own suggestion, is liable for ordinary negligence, *i.e.*, such negligence as a man of ordinary skill and prudence would avoid. In other words, a professional man, or one who gives himself out as such,[5] is liable, but a layman is not liable for ordinary negligence in the treatment of a patient.* A leading case on this subject is that of Shiels *vs.* Blackburn, stated in Story on Bailments, section 180, as follows: "A merchant had undertaken gratuitously, but not, as it should seem, officiously, to enter certain goods of the plaintiff at the custom-house with his own goods of the like kind, and by mistake he entered them by a wrong name, so that all the goods were seized and lost, both the plaintiff's and his own. An action was brought by the plaintiff to recover damages for this misfeasance, and upon full consideration the court held that as there was not any gross negligence the action would not lie." . . . Mr. Justice Heath said: "The defendant was not guilty either of gross negligence or fraud. He acted *bona fide.* If a man applies to a surgeon to attend him in a disorder for a reward, and the surgeon treats him improperly, there is gross negligence, and the surgeon is liable to an action. The surgeon would also be liable for such negligence if he undertook gratis to attend a sick person, because his situation implies skill in surgery. But if the patient applies to a man of different employment or occupation for his gratuitous assistance, who either does not exert all his skill or administers improper remedies to the best of his ability, such person is not liable. It would be attended with injurious consequences if a gratuitous undertaking of this sort should subject the person who made it, and who acted to the best of his knowledge, to an action."

Mr. Justice Wilson said: "Where the undertaking is gratuitous, and the party has acted *bona fide*, it is not consistent either with the spirit or the policy of the law to make him liable to an action. A wrong entry at the custom-house cannot be considered as gross negligence when, from the variety of laws, etc., reliance must be placed on the clerks in the office."

Lord Loughborough said: "I agree with Sir William Jones that where a bailee undertakes to perform a gratuitous act, from which the bailor is alone to receive benefit, then the bailee is only liable for gross negligence. But if a man gratuitously undertakes to do a thing to the best of his skill, where his situation or profession is such as to imply skill, an omission of that skill is imputable to him as gross negligence. If in this case a ship-broker or clerk in the custom-house had undertaken to enter the goods, a wrong entry would in them be gross negligence, because their situation and employment necessarily imply a competent degree of knowledge in making such entries. But when an application under the circumstances of this case is made to a general merchant to make an entry at the custom-house such a mistake as this is not to be imputed to him as gross negligence."

The foregoing quotations have been made at length, in order to give a clear and full statement of the law upon this important point. It is difficult to reconcile all the decisions upon the subject, but the principles laid down as above, in Shiels *vs.* Blackburn, are undoubtedly sound. They do not, however, include those cases where a layman undertakes to perform a service, not only gratuitously, but officiously, preventing, perhaps, the employment of a physician, and representing himself to possess for the matter in hand a skill in which he is really lacking. It is probable that in such a case the agent would be held liable for ordinary negligence; and if his treatment of the patient resulted in death, he might, if the case were an aggravated one, be convicted of manslaughter. There is, however, much conflict of authority as to the liability of laymen, some courts holding that if the motives of the amateur practitioner are good, he cannot be held responsible for the most rash or ignorant treatment.

Higgins *vs.* McCabe (126 Mass., 13) was an action against a midwife for negligently treating the eyes of a newly born child so that it became totally blind. The facts were as follows: The infant began to suffer from inflammation in the eyes about three days after its birth. The mother proposed to send for a physician, but the midwife dissuaded her, saying that the doctor's washes would burn the child's eyes out; that the trouble was a very slight one; that she had cured it in other cases, and could do so in this one. She treated the eyes with rose-water, and subsequently with egg and sugar. In two months the child became entirely blind. Medical witnesses testified that the disease was purulent ophthalmia, and could probably have been cured if proper remedies, such as a solution of alum, or, in a severe case, nitrate of silver, had been applied.

The court charged the jury as follows: . . . "The representations of the defendant that she could cure the child with simple remedies and washes, that she had cured other children in the same way, who were similarly afflicted, and that there was no need of a doctor, were but the expression of an opinion as to the efficacy of her remedies, and did not imply that she undertook to use that higher skill of the medical profession which is required in the treatment of the more complicated and delicate organs. The question was whether she had discharged the duty which she assumed with that skill which she professed to have, and with that diligence which might reasonably be expected of her. Upon that question the fact that the service was rendered without compensation must have an important, if not decisive, bearing. It is often said that a gratuitous agent is liable for gross negligence only; but without regard to degrees of negligence, it is plain that the duty imposed upon such an agent is less stringent than when the service undertaken is founded upon a consideration paid. Under the rule requiring ordinary care as applied to this case, we see no evidence of neglect in any degree. A physician must apply the skill and learning which belong to his profession; but a person who, without special qualification, volunteers to attend the sick, can at most be only required to exercise the skill and diligence usually bestowed by persons of like qualifications under like circumstances. To hold otherwise would be to charge responsibility in damages upon all who make mistakes in the performance of kindly offices for the sick. . . . It was not a case where the defendant, as in the cases cited by the plaintiff, assumed to act as a regular surgeon or a regular practitioner." Verdict for the defendant.

It is difficult to believe that this case was rightly decided; and it is certainly going pretty far to say that the midwife's representations "were but the expression of an opinion as to the efficacy of her remedies, and did not imply that she undertook to use that higher skill of the medical profession which is required in the treatment of the more complicated and delicate organs." This can be so only by a kind of legal fiction, inasmuch as the midwife represented not only that she was equally skilful with regular physicians, but that, for the case in question, she had more skill than they, for she declared that she could heal the eyes which the doctor's washes would destroy.

It might, however, be held that, inasmuch as her representations concerned her ability in that particular case only, she could not on the strength of them be considered to give herself out as a physician generally, and, therefore, she acted merely as a layman. This, of course, is a refinement of meaning which could hardly have been intended by the midwife or understood by the child's mother, but it furnishes perhaps the ground of the opinion, although it is not clearly stated. Even in this view,

* "We read a pleasant story of a man who had sore eyes and came to a horse-doctor for relief. The doctor anointed his eyes with the same ointment he used among his horses, upon which the man falls blind, and the cause is brought before the judge, who acquits the physician. 'For if the fellow,' says he, 'had not been an ass, he had never applied himself to a horse-doctor'" (Puffendorf, L. of Nat. and Nations, Lib. 5, Cap. 4, Sect. 3, fm. Saadi).

however, the case is one of a defendant who officiously prevented the employment of a competent person; and is thus distinguished from that of Shiels *vs.* Blackburn, *supra.*

It remains to notice certain particular circumstances, the existence of which qualifies the general rule of actionable negligence. The most important of these is contributory negligence, as it is called, on the part of the patient. The law is, that a patient cannot recover damages if his own negligence or disobedience is partly the cause of the injury, although the physician also has been negligent; but if the harm caused by the negligence of the physician can be separated from that which is owing to the fault of the patient, then the physician is, to that degree, responsible in damages. Or, if it can be proved that the injury must have followed the negligence of the physician, even though the patient had not been negligent, then, also, the physician is liable for the result. In the case of Hibbard *vs.* Thompson (109 Mass., 286), the jury were rightly instructed as follows: "If it be impossible to separate the injury occasioned by the neglect of the plaintiff from that occasioned by the neglect of the defendant, the plaintiff cannot recover. If, however, they can be separated, for such injury as the plaintiff may show thus proceeded solely from the want of ordinary skill or ordinary care of the defendant, he may recover."

In one case it was held that if a physician has injured the plaintiff by his negligence, the refusal of the patient to allow an operation by another physician to repair the injury is not contributory negligence, unless there was a reasonable assurance of the success of the operation. It may have been negligence in the patient, it is said, to refuse the opportunity, but this will not preclude his recovery of damages from the defendant.[6]

As regards minors, insane persons, and drunkards, contributory negligence cannot be imputed to them, generally speaking; but in each particular case the question must be settled whether or not the patient had sufficient capacity to understand and control his actions in respect to his injury or disease, and the remedies prescribed. If, for example, a physician should put a dangerous medicine into the hands of such a patient, with proper instructions, and he subsequently takes an overdose and is poisoned, contributory negligence could not be proved, unless it were shown that the patient had sufficient capacity, notwithstanding his youth, insanity, or intoxication, to justify the physician in trusting him with the medicine.

If negligence on the part of such a patient is imputable to his parents or attendants, being due to their neglect, and not to any oversight or mistake on the part of the physician, then contributory negligence will be established with the same effect as if it were the negligence of the patient himself. But if the injury sustained by the patient—whatever his mental capacity—is due to the negligence of his physician, he may recover damages against him, although the injury has been aggravated by careless nursing on the part of parents or attendants.[7]

Finally, it is a general principle of law that even where there is contributory negligence on the part of the plaintiff he may, nevertheless, recover damages for wilful or intentional negligence on the part of the defendant. The driver of a carriage who deliberately runs over a foot-traveller is not absolved by the fact that the pedestrian was negligent in the time and place which he chose for crossing the road. A surgeon who should cut off a man's leg with a jack-knife when better instruments were at hand would still be liable in damages for his negligence, although the patient had contributed to the evil effects by drinking a bottle of rum.

Another qualification of the general rules as to what constitutes malpractice is, that a physician is to be judged only by the principles of the school to which he belongs.[8] If he holds himself out as a homœopathic,[9] or as a botanic[10] doctor it will be sufficient for him to show that his treatment has been in accordance with homœopathic or botanical principles, as the case may be. This rule is so obvious that it requires no comment.

A more dangerous principle is that laid down in some books to the effect that city and country physicians should be tried by different standards; that skill and knowledge which are ordinary in the city might be extraordinary in the country. Thus in "Wharton on Negligence," Sec. 734, it is said: "In a city there are many means of professional culture which are inaccessible in the country. In a city hospitals can be readily walked, and new books and appliances promptly purchased, and libraries easily visited; and in a city, also, exists that intercourse with eminent professional men which leads not only to the promotion of keenness and culture, but to the free interchange of new modes of treatment. In the country such opportunities do not exist. What is due diligence, therefore, in the city is not due diligence in the country, and what is due diligence in the country is not due diligence in a city. Hence the question of diligence in each particular case is to be determined, not by inquiring what would be the average diligence of the profession, but what would be the diligence of an honest, intelligent, and responsible expert in the position in which the defendant was placed."

It is no doubt true that new methods and new appliances become known more easily and quickly in the city than in the country, and, to the extent which this fact implies, the rural practitioner should be judged more leniently than his urban contemporary; but it may be doubted if the principle is not carried too far in the extract just quoted. It is in surgery, perhaps, more than in physics that the remoteness of the country doctor places him at a disadvantage.

The case of Small *vs.* Howard (128 Mass., 131) was an action against a physician residing in the village of Townsend, Mass., for malpractice in the treatment of a severe wound upon the plaintiff's thumb. It was in evidence that an eminent surgeon lived about four miles from the defendant's house.

The judge instructed the jury that the defendant "was bound to possess that skill only which physicians and surgeons of ordinary ability and skill, practising in similar localities, with opportunities for no larger experience, ordinarily possess, and he was not bound to possess that high degree of art and skill possessed by eminent surgeons practising in large cities and making a specialty of the practice of surgery;" and further, that if the case was one which the defendant had not the requisite skill and experience to treat, he should have referred the plaintiff to a more skilful surgeon.

These instructions were held to be correct.*

It must not be supposed that the particular neighborhood in which the defendant practises is to furnish the standard of efficiency by which he should be judged.

In Gramm *vs.* Boener (56 Ind., p. 501) the judge refused to instruct the jury that the question was whether the defendant had "employed such reasonable skill and diligence as are ordinarily exercised in his profession *in the locality where he practises.*"

The Supreme Court held that he was right in refusing to give this charge, saying:

"It seems to us that physicians or surgeons, practising in small towns or rural or sparsely populated districts, are bound to possess and exercise at least the average degree of skill possessed and exercised by the profession in such localities generally. . . . There might be but few practising in the given locality, all of whom might be quacks, ignorant pretenders to knowledge not possessed by them, and it would not do to say that because one possessed and exercised as much skill as the others he could not be chargeable with the want of reasonable skill."

There are other accidental circumstances, such as the

* In the case of Mallen *vs.* Boynton (132 Mass., 443) the court said: "The instructions excepted to are, in substance, that if the defendant was not in fact competent, or if he felt that he was not competent to treat the case, he should have recommended the plaintiff to employ another surgeon; that if he was competent, and felt that he was competent to treat the case, but was uncertain or in doubt as to the nature and extent of the injury, he was required to use his best judgment as to whether he should consult some other surgeon. The instructions are clearly correct. To hold otherwise would require a surgeon to possess competent skill and experience, but hold him liable for exercising them."

impossibility of procuring proper instruments, or illness, or exhaustion, which might excuse a lack of skill or care that would usually constitute malpractice. A practitioner laboring under any such disadvantage, not putting himself forward, but acting in the absence of other physicians, could hardly be held responsible for an injury directly caused by his disability.

It is plain that a physician must be liable for the negligence of an assistant to whom he intrusts the care of a patient. Dr. Ordronaux says: "The service which a physician is called upon to render is a *personal* trust, the moving consideration to which is his individual skill and judgment. In contemplation of law, therefore, the service cannot be transferred by him to another without the permission, express or implied, of the patient. . . . Either he has charge of the case or he has not. If he has, then he is responsible for his own acts and those of his agent done under his authority and command. For even though the patient acquiesce in being treated by the agent, it is still only the treatment of the principal, for whose convenience the agent has been acting." [11] But a physician is not responsible for the malpractice of another physician whom he advises his patient to employ while he is absent.[12] Nor is the surgeon in charge of a hospital or asylum liable for the negligence or misconduct of the assistants and nurses.*

In the case of Hancke *vs.* Hooper [13] the plaintiff had gone into the shop of the defendant, a surgeon, and asked to be bled. This was done by an apprentice, unskilfully as the plaintiff alleged but did not satisfactorily prove. Chief Justice Tindal instructed the jury as follows: "The defendant is responsible for the act of his apprentice; therefore the question is whether you think the injury which the plaintiff has sustained is attributable to a want of proper skill on the part of the young man, or to some accident. A surgeon does not become an actual insurer; he is only bound to display sufficient skill and knowledge of his profession. If from some accident or some variation in the frame of a particular individual an injury happens, it is not a fault in the medical man. It does not appear that the plaintiff consulted the defendant as to the propriety of bleeding him; he took that upon himself, and only required the manual operation to be performed. The plaintiff must show that the injury was attributable to want of skill; you are not to infer it. *If there were no indications in the plaintiff's appearance* that bleeding would be improper, the defendant would not be liable for the bleeding not effecting the same result as at other times, because it might depend on the constitution of the plaintiff."

The foregoing case, as the reader will have perceived, is not only an authority on the matter of a physician's liability for the negligence of his assistant, but it also touches upon his responsibility for treatment asked for by the patient. In this respect the words italicized in the opinion of the chief justice contain an important limitation. The fact that a patient requests some particular medicine to be given to him, or a particular operation to be performed upon him, would not absolve the practitioner from injurious results if there were anything in the man's appearance that ought to have put him upon his guard. Nor is it likely that a physician would escape liability for malpractice if in any case he administered a powerful medicine or performed a dangerous operation without proper inquiry into the condition and habits of his patient.

In New England, and in the Eastern States generally, suits for malpractice are much less frequent than they formerly were, litigation of this as well as of every other kind having decreased, especially in country regions where distractions of a different nature have supervened. In the West, however, actions against medical men are very common. The surgeon suffers far more in this way than the physician, most suits for malpractice arising from cases of amputation, of fracture, or of dislocation. Many doctors, in fact, abstain from surgery altogether on this account, and in more than one case reported in the law books a practitioner, yielding to earnest entreaties, has consented for once to act as a surgeon, only to find himself involved in a suit for damages as the result of his good nature.

In respect to amputations, as every medical man is aware, the difficulty consists not in performing them but in deciding when it is really necessary to perform them. In this knowledge immense advances have been made during the present century, and there is every reason to think that in the future amputation will be resorted to less and less frequently. "Within my own recollection," said Mr. Skey, the eminent surgeon, "the operating theatre of St. Bartholomew's Hospital was the scene of weekly mutilations of the human frame by the knife, while at the present day, a little more than a quarter of a century later, such operations are reduced to less than half of their former number."

Dr. Elwell says: "An amputation that would have been justified by the rules of surgery, and the operator protected in court twenty-five years ago, or even within less time than that, would now be repudiated by the best authority, and the operator justly chargeable with ignorance and unskilfulness!"

Dr. Elwell also lays down the following rule: "In order to justify an amputation, whether of a part or of the whole of a limb, the question of recovery by other means must be placed beyond all reasonable doubt. Every resource compatible with the means of the patient should be exhausted, and a consultation with one or more eminent surgeons of the neighborhood be held, and in the case of the proposed removal of a limb, the necessity of this final crisis should be clearly established. Then, and not till then, should amputation be resorted to. Presuming that every expedient that skill can suggest has been adopted, and without success, the amputation may be performed."

Suits for malpractice occur still more frequently in cases of fracture or of dislocation; and it must be confessed that the injustice in which they have often resulted is due in part to the ignorant or boastful assertions of medical men themselves. It is only recently that the difficulty in some cases, and impossibility in others, of curing certain fractures and dislocations without ensuing deformity or loss of function has been realized by surgeons, much less by courts or lawyers. A flood of light was thrown upon this subject by Dr. F. H. Hamilton, in his tables of "Deformities after Fractures," published in the "Transactions of the American Medical Association."

Dr. Hamilton says: "I suppose that most practical surgeons have a tolerably correct appreciation of prognosis in fractures. I say tolerably, because I wish to imply a qualification. I do not think that a majority of even 'practical' surgeons have a full appreciation of the subject. I am frank to confess, that until I commenced these investigations, I had not any just notions of the frequency of deformities after fractures. . . . Students will continue to go out from our hospitals with a belief that perfect union of the broken bones is the rule, and that the exceptions imply, generally, unskilful management; and if when, hereafter, they have themselves occasion to treat a fractured femur the result falls short of their standard of perfect success, they, taught also by the same instinct of self-preservation which actuated their teacher, will conceal the truth from others, and even from themselves, if possible. Nay, I fear that sometimes, under the same urgent promptings and where the moral sense is not superior to all other considerations, they may hesitate to regard the sanctity of an oath!"

Want of space must prevent, in the present article, any attempt at a summary or analysis of Dr. Hamilton's very interesting reports. A good account of them will be found in Elwell's "Medical Jurisprudence;" and his

* In Perionowski *vs.* Freeman (4 F. and F., 977) a patient sued two surgeons of St. George's Hospital on the ground that he was put in an overheated bath by two nurses and there held, so that he became scalded. The evidence was that the surgeons, on their way through the hospital, prescribed the bath for the plaintiff, and then passed on to the next ward. It was proved that it was not customary for surgeons to attend in person to such details, and that they knew no more than the nurses what was the proper temperature of a hot bath. Cockburn, C. J., instructed the jury that the defendants would not be liable for the negligence of the nurses unless near enough to be aware of it and to prevent it.

tables are given in full, together with others scarcely less valuable, in McClelland's "Civil Malpractice."

An anomalous case occurred in Michigan.[14] A physician brought with him in his attendance upon a woman about to be delivered of a child a young man who was neither doctor nor student of medicine. Nothing was said as to the capacity in which he came, but it was taken for granted by the family that he was an assistant of the surgeon, and therefore no objection was made to his presence. A suit was brought by the woman and her husband, and it was rightly held that both the physician and his companion were liable in damages for the outrage.

As to the matter of damages generally, in cases of malpractice, the rule is that they should afford a fair compensation for the injury inflicted and for the loss of money sustained in consequence of it. If, for example, a laboring man who has broken his leg is negligently treated, so that he loses an extra month's work and is put to the expense of another physician to repair the injury done by the defendant, he would, generally speaking, be entitled to a sum equal to the money so lost and spent by him.

In the case of Brown *vs.* Clark (57 Texas, 105) the physician attending at the birth of a child made the mistake of tying a string around its penis instead of the umbilical cord. An action was brought in the child's name, when it was fifteen days old, the evidence being that "most of the glans penis was destroyed, though in its mutilated state it answered for urinating purposes, and physicians thought it might, when the child was grown, be used for getting children, though under difficulties, on account of the destruction of the glans." The jury returned a verdict of damages in the sum of $5,500, and the court refused to disturb it, saying: "In a case of this nature, where the actual damages may include mental suffering through life, the court can rarely set aside a verdict as excessive."

In Kelsey *vs.* Hay (84 Ind., 189), where it was found that the plaintiff lost the use of both legs for life by the malpractice of the defendant, the court refused to set aside a verdict for $4,500.

II. Criminal Prosecutions.—There is probably no reported case in which a regular practitioner was indicted for murder or manslaughter in causing the death of a patient. In these actions the defendant is usually a quack of some description, and occasionally a layman who has undertaken to act as a *nunc pro tunc* physician. In the "Institutes" of Lord Coke the following oft-quoted passage occurs: "If one that is in the mystery of a physician take a man to cure, and give him such physic as within three days he die thereof, without any felonious intent, and against his will, it is no homicide; but Britton saith, that if one that is not of the mystery of a physician or chirurgeon take upon him the cure of a man, and he dieth of the potion or medicine, this is, saith he, covert felony." It is doubtful, however, if this distinction was ever acted upon, and it is now well settled that regular and irregular practitioners, and laymen in general, stand upon the same footing, so far as liability to a criminal prosecution for malpractice is concerned.* What is the extent of that liability? The decisions upon this subject are very conflicting, the degree of ignorance, of stupidity, or of rashness which a person may lawfully exhibit in the destruction of his patients having been determined chiefly by considerations of public policy. On the one hand, courts have a natural anxiety to prevent impostors and enthusiasts from tampering with "the life and health of his majesty's subjects," to use the phrase of Baron Boland; and, on the other hand, they have feared to deprive people in remote districts of all medical aid whatever, if honest mistakes, resulting fatally, should be held to constitute manslaughter. The law is especially tender to midwives. In one case, Williams, J., said: "With respect to the degree of want of skill, he must say that it was not to be expected that a midwife who was called in to attend a person in the humble class of the deceased, a soldier's wife, should exhibit what a regular medical practitioner would call competent skill. It was enough if she exhibited that humble skill which, in ordinary cases, would lead to a safe delivery.* . . . The class of this humble practitioner was absolutely necessary for the poorer people."

In some cases the law of criminal malpractice has been laid down more strictly. In Rex *v.* Simpson (4 C. & P., 398, *note*) an old woman who lived at Liverpool and dealt in medicine was indicted for manslaughter. Her victim, a sailor, had been discharged from the Liverpool Infirmary as cured, after undergoing salivation, and he was recommended by another patient to go to the prisoner for an emetic, "to get the mercury out of his bones." She gave him a dose of the solution of corrosive sublimate, which caused his death. The woman said she had received the mixture from a person who came from Ireland, and had gone back again. Mr. Justice Bayley said:

"I take it to be quite clear that if a person, not of medical education,† in a case where medical aid could be obtained, undertakes to administer medicine which may have a dangerous effect, and thereby causes death, such person is guilty of manslaughter. He may have no evil intention, and may have a good one, but he has no right to hazard the consequences in a case where medical assistance may be obtained. If he does, it is at his peril. It is immaterial whether the person administering the medicine prepares it himself, or gets it of another."

The leading English cases on this subject are two, and in both the defendant was a person named St. John Long, who flourished in London, about fifty years ago, as an expert in the cure of consumption, numbering among his patients the Marchioness of Ormond, and many other "right honorable persons."

In the first case[15] he was indicted for causing the death of one Miss Cashin, who was twenty-four years of age. Two of her family having died of consumption, Long declared—and the remark was carried to her—that unless she put herself under his charge, she would be dead within two months. She accordingly did so, although she was then in good health. His treatment consisted in applying to her back a powerful liniment, and it was first administered on the third day of August. On the 13th of that month the wound was five or six inches square, and the patient was suffering severely from nausea. Long said that this was no harm, but on the contrary a benefit, and that his regimen was taking effect. On the 15th Miss Cashin's condition being still worse, he declared that in two or three days she would be in better health than she ever had been before. On the 16th he remarked that she was doing uncommonly well, and on the 17th she died. Mr. Brodie, the celebrated surgeon, was called to attend her on the 16th, and he testified that the wound which he then saw was quite sufficient to cause death, although he did not suppose that she was in immediate danger. He also testified that the application of a lotion strong enough to produce such an appearance as he saw in the patient's back, would be likely, in a person of her age and physique, to produce disease, and permanent injury to the constitution, if not death. It appeared, however, that other patients had been rubbed with the same liniment that was used in the case of Miss Cashin; and about twenty persons testified that they had received great benefit from Long's treatment.

Baron Parke, in his instructions to the jury, said, referring first to the charge of Lord Ellenborough in the case of Williamson, already cited:

"Lord Ellenborough there says that, from the evidence, it appeared that the prisoner had delivered many women at different times; and from this he must have had some degree of skill. He goes along with me in thinking that skill may be acquired by practice. That is my opinion

* The law does make a distinction, in civil actions for malpractice, between the liability of laymen and the liability of those who give themselves out as physicians. *Vide ante*, p. 631.

* In another case Lord Ellenborough practically directed the jury to acquit a man-midwife, who, mistaking a *prolapsus uteri* for parts of the *placenta*, killed his patient by breaking the mesenteric artery; but this was on the ground that the prisoner committed an error in judgment, having become "shocked and confused." Rex *vs.* Williamson, 3 Car. & P. 635.

† This distinction, as has been seen, is of no importance.

here, and there are twenty-nine witnesses, all speaking to the prisoner's skill in their cases. There is clear evidence that the prisoner did the act that shortened Miss Cashin's life. But that does not prove the case, unless you think there was gross ignorance or inattention to human life to be inferred from it. It is evident he had some information. Whether he drew improper conclusions from it is not for you or me to say. . . . It seems singular that the restlessness and other circumstances did not awaken apprehension and call for further measures; but the question again recurs, whether this was an erroneous judgment of a person who was of general competency, though he unfortunately failed in this particular instance. It appears that he said, on examining the wound on Miss Cashin's back, that he would give a hundred guineas if he could produce a similar wound on some of his patients. This seems to show his confidence in his proceedings; and there is this observation to be made of him throughout, that he seems to have been living in a fashionable part of the metropolis, and attended by right honorable persons, and it would be against his interest to act ignorantly and carelessly. . . . It is not whether the act done is the thing that a person of Mr. Brodie's great skill would do, but whether it shows such total and gross ignorance in the person who did it, as must necessarily produce such a result. On the one hand, we must be careful and most anxious to prevent people from tampering with physic so as to trifle with the life of man; and, on the other hand, we must take care not to charge criminality on a person who is of general skill, because he has been unfortunate in a particular case. . . . These are things for your consideration, when you are considering whether a man is acting wickedly; for I call it acting wickedly when a man is grossly ignorant, and yet affects to cure people, or when he is grossly inattentive to their safety." Despite this charge, so favorable to the prisoner, he was found guilty by the jury, and subsequently he was sentenced to pay a fine of £250 to the king.

In the second case [16] against him, the victim, curiously enough, was one who had been present at the inquest held on the body of Miss Cashin. She was a married woman, in good health, who applied to Long on account of a slight affection of the throat. Long caused a blister to be put upon her chest, which produced a wound that resulted in death. The circumstances were similar to those already narrated as occurring in the case of Miss Cashin.

Bailey, Judge, charged the jury as follows: . . . "To my mind it matters not whether a man has received a medical education or not. The thing to look at is whether, in reference to the remedy he has used, and the conduct he has displayed, he has acted with a degree of caution; or, on the contrary, has acted with gross and improper rashness, and want of caution. I have no hesitation in saying, for your guidance, that if a man be guilty of gross negligence in attending to his patient after he has applied his remedy, or of gross rashness in the application of it, and death ensues in consequence, he will be liable to a conviction for manslaughter. . . . If you should be of opinion that the prisoner made the application with a culpable degree of rashness, and that it was the cause of Mrs. Lloyd's death, then, heavy as the charge against him is, he will be answerable on this indictment for the offence of manslaughter. There was a considerable interval between the application of the liquid and the death of the patient; yet, if you think that the infliction of the wound on October 10th was the cause of the death, then it is no answer to say that a different course of treatment by Mr. Campbell [the attending surgeon] might have prevented it."

It is remarkable that this charge, though more unfavorable to the prisoner than that in the preceding case, was followed by an acquittal, whereas in the first case there was a verdict of guilty.

The leading case in this country, until it was overruled in the year 1883, as will presently be seen, was that of Commonwealth *v.* Thompson.[17] The defendant, founder of the Botanic or Thompsonian School of Medicine, appeared in the town of Beverly, Mass., in December, 1808, announcing his ability to cure all fevers, whether black, gray, green, or yellow, and declaring that the country was much imposed upon by the regular physicians. Being sent for by the deceased, who was ill of a cold, on Monday, January 2, 1809, he gave him a profuse sweat and administered a powerful emetic, and within half an hour he twice repeated the dose. This treatment he kept up, intermitting it on Friday and Saturday, until the following Sunday night. The deceased being then in great distress and very weak, Thompson gave him repeated doses of his emetic, saying, as they failed to operate, that "they would soon get down and unscrew his navel," meaning that they would act as a cathartic. About ten o'clock in the evening the patient was seized with convulsions, and while he was in that condition the defendant forced several more doses of the emetic down his throat, remarking to the son of the deceased that his father had the "hyps" like the devil, but that he would soon fetch him down. The next morning the regular physicians of the town were sent for, but the patient was then completely exhausted, and on Tuesday night he died.

It appeared that the prisoner's emetic was the plant vulgarly known as "Indian tobacco," and called by Linnæus, *lobelia inflata*.* It was stated that the defendant had practised medicine for some years, but the prosecution failed to show that any other patient had died under his hands. On the contrary, a witness called for this purpose, testified that he himself had taken the prisoner's powders several times, in three or four days, for an oppression of the stomach, and had been relieved by them.

Chief Justice Parsons charged the jury, in part, as follows:

"The prisoner's ignorance is in this case very apparent. On any other ground consistent with his innocence, it is not easy to conceive that on the Monday evening before the death, when the second dose of his very powerful emetic had failed to operate, through the extreme weakness of the deceased, he could expect a repetition of these fatal poisons would prove a cathartic, and relieve the patient, or that he could mistake convulsive fits symptomatic of approaching death for a hypochondriac affection. But on considering this point, the court were all of opinion, notwithstanding this ignorance, that if the prisoner acted with an honest intention and expectation of curing the deceased by this treatment, although death unexpected by him was the consequence, he was not guilty of manslaughter. . . .

"The death of a man killed by voluntarily following a medical prescription, cannot be adjudged felony in the party prescribing, unless he, however ignorant of medical science in general, had so much knowledge, or probable information, of the fatal tendency of the prescription, that it may be reasonably presumed by the jury to be the effect of obstinate, wilful rashness, at the least, and not of an honest intention and expectation to cure. . . .

"If, in this case, it had appeared in evidence, as was stated by the Solicitor-General, that the prisoner had previously, by administering this Indian tobacco, experienced its injurious effects in the death or bodily hurt of his patients, and that he afterward administered it in the same form to the deceased, and he was killed by it, the court would have left it to the serious consideration of the jury, whether they would presume that the prisoner administered it from an honest intention to cure, or from obstinate rashness and foolhardy presumption, although he might not have intended any bodily harm to his patient.† If the jury should have been of this latter

* One physician said that he had found a tincture of this plant to be highly beneficial in cases of asthma, and it seems to have been used frequently as a medicine. For a prescription *vide* the report, 6 Mass., R., p. 137.

† It would seem to be a fair conclusion from this *dictum* that the law will allow a quack to kill one patient (but no more) for every drug in his pharmacology; and it must be admitted that such a rule would be in strict accordance with another legal principle which is thus stated by an eminent authority: "By the Common Law of England, every dog in the kingdom is permitted to have one bite at a sheep."

opinion, it would have been reasonable to convict the prisoner of manslaughter, at least." The prisoner was acquitted.*

This case, which has played an important part in the literature of the subject, and as a precedent for other courts, must now, however, be taken as overruled by the recent decision of the same court in Commonwealth *v.* Pierce (138 Mass., 165).

The defendant, who practised publicly as a physician, was called to attend one Mary A. Bemis on January 7, 1883. His patient being very ill and confined to her bed, Pierce directed that she should be clothed in flannel saturated with kerosene oil. This was done, and in about two hours, the patient being in great pain and distress, the flannel clothes were removed and the defendant was sent for. By his persuasions she was induced to have them replaced, and they were kept upon her, kerosene oil being poured on them from time to time, until January 9, 1883, when they were taken off by the defendant's direction. He continued to attend her until January 14th, when he was discharged and other physicians were summoned. But the patient was then past recovery, and on January 16th she died from the burns and blisters produced by the kerosene oil. There was evidence that the defendant had applied the same remedy with good results in other cases, and also that, in one instance, the effect had been similar to that produced in the present case. At the trial the defendant's counsel requested the judge to instruct the jury that the defendant must have "so much knowledge, or probable information, of the fatal tendency of the prescription, that the death may be reasonably presumed by the jury to be the effect of obstinate, wilful rashness, and not of an honest intent and expectation to cure." The judge refused to give this instruction, and charged the jury that "it is not necessary to show an evil intent;" that "if, by gross and reckless negligence, he caused the death, he is guilty of culpable homicide;" that "the question is whether the kerosene (if it was the cause of the death), either in its original application, renewal, or continuance, was applied as the result of foolhardy presumption or gross negligence on the part of the defendant;" and that the defendant was "to be tried by no other or higher standard of skill or learning than that which he necessarily assumed in treating her—that is, that he was able to do so without gross recklessness or foolhardy presumption in undertaking it."

The jury having found the prisoner guilty of manslaughter, his counsel alleged exceptions to the charge and refusal to charge just stated; but the Supreme Court overruled the objections, holding that the judge rightly instructed the jury. The opinion is by Holmes, J., who said: . . . "The defendant relies on the case of Commonwealth *v.* Thompson, 6 Mass., 134, from which his fifth request [quoted above] is taken in terms. His argument is based on another quotation from the same opinion: 'To constitute manslaughter the killing must have been a consequence of some unlawful act. Now, there is no law which prohibits any man from prescribing for a sick person with his consent, if he honestly intends to cure him by his prescription."

"This language is ambiguous, and we must begin by disposing of a doubt to which it might give rise. If it means that the killing must be the consequence of an act which is unlawful for independent reasons apart from its likelihood to kill, it is wrong. Such may once have been the law, but for a long time it has been just as fully, and latterly, we may add, much more willingly, recognized that a man may commit murder or manslaughter by doing otherwise lawful acts recklessly, as that he may by doing acts unlawful for independent reasons from which 'death accidentally ensues.'"

The learned judge then goes on to show what he means by "doing otherwise lawful acts *recklessly*."

Does this mean "recklessly" from the actor's point of view, or "recklessly" from the point of view of men having ordinary prudence? Plainly, if a man cannot in this connection be said to act "recklessly," unless his recklessness is a conscious one, then there can be no manslaughter where the intentions are good, however rash and foolish the conduct may be. But Judge Holmes declares that by "doing otherwise lawful acts recklessly," he means, and the law intends, doing them "recklessly" as men of ordinary prudence and knowledge would consider. This is a wide departure from the law as laid down in Commonwealth *v.* Thompson. A further extract from the opinion is as follows: "We have implied, however, in what we have said, and it is undoubtedly true as a general proposition, that a man's liability for his acts is determined by their tendency under the circumstances known to him, and not by their tendency under all the circumstances actually affecting the result, whether known or unknown. And it may be asked why the dangerous character of kerosene, or 'the fatal tendency of the prescription,' as it was put in the fifth request, is not one of the circumstances, the defendant's knowledge or ignorance of which might have a most important bearing on his guilt or innocence. But knowledge of the dangerous character of a thing is only the equivalent of foresight of the way in which it will act. We admit that, if the thing is generally supposed to be universally harmless, and only a specialist would foresee that in a given case it would do damage, a person who did not foresee it, and who had no warning, would not be held liable for the harm. If men were held answerable for everything they did which was dangerous in fact, they would be held for all their acts from which harm in fact ensued. The use of the thing must be dangerous according to common experience, at least to the extent that there is a manifest and appreciable chance of harm from what is done, in view either of the actor's knowledge, or of his conscious ignorance. And therefore, again, if the danger is due to the specific tendencies of the individual thing, and is not characteristic of the class to which it belongs, which seems to have been the view of the common law with regard to bulls, for instance, a person to be made liable must have notice of some past experience, or, as is commonly said, 'of the quality of his beast' (1 Hale, P. C., 430).

"But if the dangers are characteristic of the class, according to common experience, then he who uses an article of the class upon another cannot escape on the ground that he had less than the common experience. Common experience is necessary to the man of ordinary prudence, and the man who assumes to act as the defendant did must have it at his peril."

The law, then, as now established in Massachusetts, and as it would probably be laid down in other States, should occasion arise, is that he who causes the death of a patient by grossly ignorant or reckless treatment, is guilty of manslaughter, even though he act from good motives, with the expectation of making a cure, and in what seems to him a prudent manner. This conclusion is undoubtedly sound; there is no precedent to the contrary among the English decisions, and there is much to support it in the opinions already cited. It will be remembered that, in the first of the actions against Long, Baron Parke declared that the prisoner would be responsible for "such total and gross ignorance, as must necessarily produce such a result;" and furthermore he said: "I call it acting wickedly when a man is grossly ignorant, and yet affects to cure people." It is true that the charge in this case was, on the whole, favorable to the defendant; but Baron Parke plainly intimated that the prisoner must be acquitted, if acquitted at all, on the ground, not of ignorance, or stupidity, but of an error in judgment; for, he said, "the question again recurs whether this was an erroneous judgment of a person who was of general competency, though he unfortunately failed in this particular instance." It was upon the same ground, precisely, that Lord Ellenborough directed a verdict of acquittal in a case which has been thought an extreme one in the direction of leniency to incompetent persons.[18]

In the second case against Long, Mr. Justice Bailey seems also to adopt the view that manslaughter is inde-

* As a result of this case, the Massachusetts Legislature of 1818 passed a law providing that no person "practising physic or surgery shall be entitled to the benefit of law, for the recovery of his fees, unless he shall have been licensed by the Massachusetts Medical Society, or graduated a doctor in medicine at Harvard University." This act was repealed in 1836.

pendent of intention, for he charged the jury as follows: "I have no hesitation in saying, for your guidance, that if a man be guilty of gross negligence in attending to his patient after he has applied his remedy, or of gross rashness in the application of it, and death ensues in consequence, he will be liable to conviction for manslaughter." And in a case already stated (*ante*, page 634) the same judge said: "I take it to be quite clear that if a person . . . undertakes to administer a medicine which may have a dangerous effect, and thereby causes death, such person is guilty of manslaughter. He may have no evil intention, and may have a good one, but he has no right to hazard the consequences in a case where medical assistance may be obtained."

In this country there appears to be no decision the other way, except the overruled one of Commonwealth *v.* Thompson, and two later cases, which directly followed it, one in Missouri,[19] and one in Iowa.[20] On authority, then, the case of Commonwealth *v.* Pierce may easily be supported, and, so far as the policy of the decision goes, no defence would seem to be required.

Henry Childs Merwin.

[1] Wharton and Stillé: Med. Jurisp., vol. iii., p. 577.
[2] Lanphier *vs.* Phipos, 8 Car. and Payne, 475.
[3] Patten *vs.* Wiggin, 51 Maine, 594; Leighton *vs.* Sargent, 27 N. H., 460; Gallaher *vs.* Thompson, Wright's Ohio R., 466.
[4] Mock *vs.* Kelley, 3 Ala., 387.
[5] Jones *vs.* Fay, 4 F. and F., 525.
[6] Chamberlin *vs.* Morgan (68 Pa. St., 168). See a learned note in vol. xxxvi., American Reports, p. 670.
[7] For the case of an insane person, see a verbose and obscure opinion in People *vs.* New York Hospital (3 Abb. N. C., 229); and for the case of a drunken man, see the Illinois Central R. R. Co. *vs.* Hutchinson (47 Ill., 408).
[8] Carpenter *vs.* Blake (60 Barb., 488); Musser *vs.* Chase (29 Ohio St., 577); Sutton *vs.* Facey (1 Mich., 243).
[9] Corsi *vs.* Maretzek (4 E. D. Smith, 1).
[10] Bowman *vs.* Woods (1 Greene, Iowa, 441).
[11] Ordronaux's Jurisprudence of Medicine, p. 103.
[12] Hitchcock *vs.* Burgett (38 Mich., p. 501).
[13] 7 Carr and P., 81; see also Landon *vs.* Humphrey (9 Conn., 209).
[14] De May *vs.* Roberts (46 Mich., 160).
[15] Rex *vs.* John St. John Long, 4 Car. & P., 398.
[16] Rex *vs.* Long, 4 C. & P., 423.
[17] 6 Mass. R., 134.
[18] *Vide ante*, page 634, footnote.
[19] Rice *vs.* State, 8 Missouri, 561.
[20] The State *vs.* Schulz, 55 Iowa, 628.

MALT (*Maltum*, U. S. Ph.). This is a preparation from the seeds of the common cereals, usually barley, made by sprouting them to a certain degree and then kiln-drying them, so as to stop all action and destroy their vitality. Its manufacture is of great antiquity, having been practised in Europe certainly as long ago as the beginning of the Christian era, and probably much before then, as the art of brewing beer from grains was known, in nearly all the countries of ancient Europe, centuries before that epoch. It is probable, too, that the aborigines of Africa and of other continents understood malting to some extent before their invasion by Europeans. The manufacture of this substance is carried on now in all countries where grain grows, and in most of them to an enormous extent, as the foundation of fermented beers and of the mash from which whiskies and alcohol are distilled. For pharmaceutical and medicinal purposes it should be purchased of the brewers, as it is best made on a large scale and with special apparatus. Grain for malting should be full and fair, well ripened and dried, and, of course, alive. If it has already sprouted, or heated, or has been dried by artificial heat, it is unfit for this process.

The first process in malt-making is steeping the grain. For this it is put into large vats and covered with water, where it is allowed to remain until it becomes soft and mealy. Then it is shovelled into another receptacle, the "couch frame," where it is allowed to heat for two days or so, when it is removed and placed in long, large heaps upon the floor and allowed to remain one or two weeks, until the radicles have protruded and the plumule has grown half the length of the seed. During this time it is watched with great care, frequently turned and stirred, kept at a uniform temperature, and, if need be, sprinkled from time to time to restore moisture exhaled by the process of germination. The next step is the drying, which is conducted in a specially constructed chamber at a low heat (100° F. at first), and kept up until the grain is perfectly dry and brittle again. In the meantime the constant stirring has broken off the sprouts, and rounded and smoothed the ends of the grain, which is now finished malt. The amount of heat used in the kiln determines the color and, to some extent also, the quality of the product. If the temperature does not exceed 160° or 170°, a very pale malt will be produced; at 180° it acquires a rich amber color, and is known as amber malt; for brown or porter malt it is almost roasted like coffee.

Grains gain in size and lose in weight by being malted; the embryo is considerably developed (and broken away); the albumen has become softer, more spongy, and sweeter. The odor is peculiar, sweetish, faintly empyreumatic, the texture chalky. Barley, rye, wheat, and Indian corn are the grains most commonly used for malt, but in some places other less known cereals take their places. Of all these malted barley is by far the most prized, and it is this only that is recognized by the Pharmacopœia, which requires a pale or amber grade of good quality.

COMPOSITION.—There has been a great deal of careful chemical study expended upon this subject, both to ascertain the exact changes which take place in the process, and to learn how to modify them most advantageously; but, for the purposes of this paper, the synopsis can be very brief. All the cereals (and many other seeds) provide, around the embryo itself, a supply of nitrogenous and carbo-hydrate compounds (gluten, casein, starch, sugar, mucilage, etc.) for its nourishment until it has developed roots and green leaves, and is able to assimilate for itself; the chief bulk of these principles in grains suitable for malting is starch, which, in its normal condition, is entirely insoluble and unchangeable at common temperatures. But they contain also a small quantity of the ferment *diastase*, which is increased during germination at the expense of the other protein substances, and is capable of transforming the starch in the living grain into dextrin and sugar, which are soluble, suitable for the nourishment of the embryo, and also desirable to the brewers. The object of malting is to effect this transformation as completely as possible, and to kill the young plant before it has consumed much of the sugar formed. The following outline by Proust (copied from Hager) shows this principal change:

	Barley. Per Cent.	Malt of Barley. Per Cent.
Starch and cellulose	87	68
Sugar	5	15
Dextrin	4	15
Gluten, etc.	3	1
Yellow resin	1	1

Malt also contains one or two per cent. of *diastase*.

ACTION AND USE.—Malt is mostly consumed, as is well known, as the saccharine basis of fermented, and of some distilled, liquors, its watery extract or infusion readily undergoing the alcoholic fermentation, whose product, according to its management, may be beer, or the mash used in distilling for whiskey. As a basis of infants' foods it is also in very extensive use; being, either in substance as a flour, or in the form of powdered or granular extract, mixed with other things or administered in milk. In certain cases it makes an important addition to the cow's milk of bottle-fed babes. In medicine proper, its use is quite modern and rather narrow, but the extract has been recommended by numerous physicians, and pushed by energetic manufacturers, as an efficient reconstructive, both on account of its food-value, and especially because the diastase that it contains is a valuable aid to digestion. Clinically it has not entitled itself to a place among the indispensables. A very good tonic it sometimes seems to be; a food like sugar, glycerine, or oil, it certainly is; as an assistant to digestion its claims are of moderate importance.

ADMINISTRATION.—The officinal extract is made by digesting a quantity of malt in four times its weight of warm water, expressing the liquid, and evaporating in a water-bath or vacuum apparatus to the consistence of thick honey. It is a dark-brown molasses-like liquid, of sweet taste and pleasant odor. It is, however, never made now in a small way by retail dispensers, but is the

product of several large manufacturing establishments, who usually claim to have some peculiarity of process or composition in their particular makes. They generally conform in appearance and taste to the officinal preparation. One of these so-called Malt Extracts is, however, a thin, slightly bitter, dark-colored liquid, apparently an imitation of porter in all but its carbonic acid and alcoholic portions. The thick extracts emulsify cod-liver oil in equal parts, but the emulsion is disagreeably thick. Dose: Of the syrupy (U. S. Ph.) extracts, fifteen or twenty grams (15 to 20 gm. = gr. ccxxv.–ccc.); of the porter-like liquid, six or eight times as much.

ALLIED DRUGS.—Molasses, Syrup, Honey, Glycerine; possibly also the digestive ferments Diastase, Pancreatin, Ptyalin, etc.

ALLIED PLANTS.—The Barley plant, *Hordeum distichon* Linn., order *Gramineæ*, exists in several well-marked, cultivated varieties; Wheat, *Triticum vulgare* Linn.; Rye, *Secale cereale* Linn; Indian Corn, *Zea Mays* Linn., are all in the same enormous order, which is remarkably uniform in the nutritious character of its seeds, and in its almost absolute freedom from poisonous qualities.

W. P. Bolles.

MANACÁ. The stems of *Franciscea uniflora* Pohl., order *Solanaceæ*, a South American shrub, with "alternate, longish, acute leaves, and single, sessile flowers." The stems are tough and woody, with thin, dark bark and yellow wood. The odor is slight, farinaceous; taste bitter and disagreeable. Composition not satisfactorily determined.

Manacá is not a new drug, although recently its use has been revived. Two or three generations ago it was employed in syphilis and rheumatism, and fell into disuse. Its modern introduction is for about the same purposes, and will probably have the same fate. In full doses it is a purgative and diaphoretic, in larger quantities it is said to be poisonous. Dose half a gram or so (gr. viii. ad xx.).

ALLIED PLANTS.—The position of *Franciscea* has not been fully settled; at present it may be referred to the *Solanaceæ*. See BELLADONNA.

ALLIED DRUGS.—The term "Vegetable Mercury," formerly given to this drug, indicates its supposed antisyphilitic power. What its real therapeutic or chemical relations are it is not easy at present to say. *W. P. Bolles.*

MANGANESE. I. GENERAL MEDICINAL PROPERTIES OF COMPOUNDS OF MANGANESE.—In their medicinal relations the compounds of manganese divide into two distinct groups, the one where the metal is the basic radicle of the compound, the other where, on the contrary, it is the acid radicle. The compounds of the former group, after absorption, probably affect nutrition after the general manner of the heavy metals, tending in small dosage to improve blood-quality and quicken general assimilation, and, in large, to derange the nutritive processes, leading to emaciation and nerve-poisoning. Locally, the effects differ with the individual compounds according to their solubility. Therapeutically, the constitutional influence of manganese has been sought as an adjuvant to that of iron, largely upon theoretical grounds, because of the alleged presence of manganese, in small quantity, in association with iron in the composition of hæmoglobin. Doubtless the influence in cachectic states is good so far as it goes, but doubtless also it is, in degree, insignificant as compared with that of iron, with which medicine manganese is, for the present purpose, almost invariably prescribed. Physicians generally have, therefore, failed to see the necessity for combining a salt of manganese with their chalybeates. Locally, the therapeutics of the compounds of manganese are individual to the compounds, and will be detailed below.

The second division of the manganese compounds, where the metal occurs in the acid radicle, is represented in medicine by but a single salt, namely, *potassic permanganate*, whose virtues inhere mainly in the property of permanganates to act as oxidizing agents, as will be set forth further on.

II. THE MEDICINALLY USED PREPARATIONS OF MANGANESE.—These are, of manganese as basic radicle, *manganese dioxide* and *manganous sulphate*, and of the metal as an acid radicle, *potassic permanganate*.

Manganese Dioxide: MnO_2. This compound, commonly known as *black oxide of manganese*, is a native mineral, and as such, of a quality representing at least sixty-six per cent. of the pure oxide, is officinal in the U. S. Pharmacopœia under the title *Mangani Oxidum Nigrum*, Black Oxide of Manganese. The mineral differs a good deal in appearance according to the source from which it is derived. It occurs sometimes in metallic-looking lumps, sometimes in fine shining crystals—the form in which it is purest—but yet is most commonly found in the condition of powder. In the latter condition it is "a heavy, grayish-black, more or less gritty powder, permanent in the air, odorless and tasteless, and insoluble in water or alcohol. At a red heat the oxide gives off oxygen gas; and if heated with hydrochloric acid, it causes the evolution of chlorine gas. On intimately mixing one part of the oxide with one part of hydrate of potassium, and one part of chlorate of potassium, introducing the mass into a crucible, moistening with water, drying and igniting, a dark, fused mass is obtained, which yields a green solution with water, changing to purplish-red on being boiled, or on the addition of diluted sulphuric acid. If 5 Gm. of the finely-powdered oxide be digested with 15 Gm. of water and 20 Gm. of hydrochloric acid, then 21 Gm. of ferrous sulphate be added, and the mixture heated to boiling, the cooled filtrate should not acquire a blue color on the addition of freshly-prepared test-solution of ferricyanide of potassium * (presence of at least sixty-six per cent. of pure dioxide of manganese)" (U. S. Ph.). Black oxide of manganese, as usual with the insoluble metallic oxides, is locally bland, and, in the stomach, tends to allay irritability of that organ. Continuously given, it is capable of absorption, with constitutional effects of manganese. Medicinally, the oxide has been applied in skin-disease, in ointment (twenty-five per cent. strength), and has been given internally in gastric irritation; but its grittiness makes it an unpleasant medicine to take in form of powder. The average dose is 0.65 Gm. (ten grains) three times a day. Much more important than any medicinal application is the use of the black oxide in the laboratory, in the preparation of oxygen gas, chlorine, and also of iodine, when the latter is obtained from kelp.

Manganous Sulphate: $MnSO_4.4H_2O$. The salt is officinal in the U. S. Pharmacopœia as *Mangani Sulphas*, Sulphate of Manganese. It occurs in "colorless or pale rose-colored, transparent, right-rhombic prisms; crystallized at a temperature between 20° and 30° C. (68° to 86° F.), slightly efflorescent in dry air, odorless, having a slightly bitter and astringent taste, and a faintly acid reaction. Soluble in 0.7 part of water at 15° C. (59° F.), and in 0.8 part of boiling water; insoluble in alcohol" (U. S. Ph.). Manganous sulphate is sharply irritant and specifically purgative, and has the reputation of being also specifically cholagogue. This latter reputation is based largely on an old assertion of C. G. Gmelin, that in experimenting with animals with the salt, a considerable outpouring of bile was determined. Rutherford's more recent and careful experiments, however, failed to produce a like effect. In large dose, manganous sulphate is an irritant poison. Medicinally, the purgative and alleged cholagogue action have been availed of by some prescribers, but as the salt is harsh in action and disagreeable to the taste, its use as a medicine has not found much favor. From 0.65 to 1.30 Gm. (ten to twenty grains) is a full purgative dose, not to be exceeded.

Potassic Permanganate: $K_2Mn_2O_8$. The salt is officinal in the U. S. Pharmacopœia as *Potassii Permanganas*, Permanganate of Potassium. It occurs in "deep purple-violet, or nearly black, needle-shaped, rhombic prisms, of a metallic lustre, permanent in the air, odorless, having a sweet, afterward disagreeable, astringent taste, and a neutral reaction. Soluble, with the exception of a scanty,

* Ten per cent. aqueous solution.

brown residue, in 20 parts of water at 15° C. (59° F.), and in 3 parts of boiling water. It is decomposed by alcohol" (U. S. Ph.). Weak solutions of potassic permanganate are of a delicate rose color, which should be free from tinge of green. Strong solutions are of deep purple, and have the troublesome property of staining, not only fabrics, but the skin ; and even porcelain-ware will be colored a rusty purple under sufficient contact. Potassic permanganate in strong application is irritant and even caustic, but its medicinal application hinges mainly on its peculiarity of being a powerful oxidizing agent, because of the ready disengagement, in presence of oxidizable matters, of a portion of the oxygen of the permanganic acid. By virtue of this property the salt promptly destroys fetor and fetid materials as such, and is one of the most efficient agents known for such purpose. Its disadvantages are its comparative costliness and proneness to stain. Because of its oxidizing tendency, it is necessary to keep the compound in well-stopped bottles, and avoid admixture with it of organic or other easily oxidizable matters. Trituration of the crystals with inflammable substances may even determine explosions. Potassic permanganate is a valuable detergent for foul surfaces, as of sloughing wounds, ulcerated cancers, etc., and is applied in aqueous solution ranging from one-fifth per cent. to four per cent. in strength. The weaker solutions are used where a mere deodorizing is sought, the stronger where a vital action also is desired, as in the case of gangrenous ulceration. To sweeten foul drinking-water, a solution of the salt may be added to the water gradually, so long as the color is discharged on stirring, a circumstance that will continue as long as any organic matter remains unoxidized. So soon as the coloration persists, even in faintest shade, further addition is to be discontinued. The small percentage of permanganate then remaining in excess will neither be perceived in taste, nor will it do any harm. In this operation it must not be expected that the permanganate will necessarily kill the contagium of specific disease with which a water may be contaminated, for of such potency there is, as yet, no proof. Potassic permanganate has been used internally in zymotic diseases, presumably with the idea of chemically assaulting the virulent essence of the same ; but inasmuch as any allowable dose of the salt must inevitably exhaust its oxidizing capacity while *en route* through the organic matters of the alimentary canal to the vascular system, the practice has not even a sound theoretical basis to justify it. The doses given are from 0.015 to 0.06 Gm. (one-fourth to one grain) three times a day, taken in solution in distilled water. More recently, Ringer and Murrell have announced success with the internal use of potassic permanganate as an emmenagogue, giving the medicine in doses of a grain, increased to two grains, three or four times a day. Similar success has since been reported by a number of other practitioners, and success also with certain cases of menorrhagia and metrorrhagia, as well as of amenorrhœa (F. H. Martin). The medicine is best borne in pill form, but even when so taken, occasionally produces a good deal of gastric distress. Because of the powerful oxidizing property of the permanganate, care must be taken in the selection of excipients for making the medicine into pills. The following has been recommended as an excipient: "Vaseline, two parts ; paraffin-wax, one part ; melt, stir till cold, and add kaolin, three parts ; mix well." The pills, after being made, are to be dusted with kaolin. *Edward Curtis.*

MANGANESE, POISONING BY. The compounds of manganese have never, so far as the writer can ascertain, been used as poisons by man. The binoxide (black oxide) and potassium permanganate are the only preparations which are at all common. The remaining compounds are seldom met with outside of the chemical laboratory, and are not likely to furnish the occasion for a medico-legal investigation. Professor Couper, of Glasgow (1838), classed manganese among the cumulative poisons, and asserted that it had the property of bringing on gradual paralysis of the muscles of the extremities. He reported five cases of this kind occurring among workmen employed in grinding the black oxide. In those of the patients who were removed early, and put under treatment, the progress of the disease was arrested ; but recovery was complete only after a number of years. In one case, in which the disease had made greater progress before the patient was removed, the disability was permanent. There was no loss of sensation, and the intellect was unimpaired. There was neither colic, constipation, or tremors ; but salivation was observed. The black oxide is manufactured and used very largely ; but similar cases do not appear to have been observed since. It is therefore somewhat doubtful if the symptoms described by Couper can be attributed with certainty to manganese poisoning—an opinion which the comparative insolubility of the oxide goes far to confirm.

Potassium Permanganate.—The most important soluble compound of manganese is potassium permanganate. Both the permanganates and the manganates are at once decomposed, with loss of a portion of their oxygen, by all organic tissues, which they rapidly oxidize. Potassium permanganate is therefore much used as an oxidizing agent in the laboratory. It also acts as an efficient deodorizer and antiseptic, and, in addition, probably has a certain amount of germicide power. Its power as a disinfectant (using this term in the popular sense) is, however, limited, because of its cost, and because of the readiness with which it is decomposed by organic matter. A solution of 0.065–1.3 Gm. (1 to 20 grains) to the ounce is, however, a useful antiseptic and deodorizer in cases of otorrhœa, ozæna, fetid breath, leucorrhœa, and similar affections. It has been recommended internally, in various diseases, in doses of 0.065–0.13 Gm. (1 to 2 grains). But we have no definite knowledge of its action when taken internally in large doses. Its behavior, when brought into contact with organic substances, warrants the statement that, if taken internally in doses much above 0.13–0.19 Gm. (2 to 3 grains), it would act as an irritant, and to some extent probably as a caustic ; and more energetically if taken in the solid form or in concentrated solution. Its effect when not much diluted is, probably, chiefly local. It is asserted by some, however, that, when administered in small doses well diluted, a certain amount of the salt enters the blood.

Vulpian has studied the effects produced by the injection of the permanganate into the veins. Half a gram of a one-half per cent. solution was fatal to small dogs ; one gram to large dogs. The symptoms observed were : a tottering gait, a state of dejection, diarrhœa, progressive weakness, and frequently, after the lapse of ten to twenty hours, an icteric discoloration of the skin, mucous membranes, subcutaneous cellular tissue, and arteries. Putrefactive changes commenced very soon after death. The appearances observed were : frequent ecchymoses in the serous membranes, hyperæmia of the gastric mucous membrane, congestion of the kidneys, decomposed blood, hæmoglobinuria, and pulmonary infarctions. The urine contained very little urea.

Salts of Manganous Oxide.—It has been suggested that these salts might possess therapeutic properties similar to those of the salts of iron. But clinical experience has not confirmed this theory. Dr. Thompson states that the sulphate is a purgative in doses of 3.9–7.75 Gm. (60 to 120 grains), and that 31.1 Gm. (1 ounce) may be administered with safety. On the other hand, doses of 0.2–0.5 Gm. (3 to 7.7 grains), if repeated often, are said to be followed by vomiting and diarrhœa. Practically, it may be said that we know nothing concerning their effects on man. A number of experiments on animals have been recorded. Gmelin states that the sulphate, when given to dogs internally in large doses, caused vomiting. It was borne better by rabbits ; but if the dose was sufficiently large, it caused paralysis, and finally death in convulsions. Slight evidences of gastric irritation were found after death. The salt produced no effect when applied to the subcutaneous cellular tissue. Injected into the veins it caused, in small doses, vomiting only. In larger doses it either caused death immediately, from paralysis of the heart, or it produced, first, a condition resembling

apoplexy, from which the animal recovered, and later, vomiting, purging, dyspnœa, loss of appetite, rapid exhaustion, paralysis, and death. There was a marked increase in the secretion of bile. Goolden states that the salts of manganese induce vomiting, diarrhœa, and an increased secretion of bile. According to Wibmer, manganese carbonate administered in moderate doses for a long time, has no effect whatever on rabbits. Laschkiewitsch's experiments with manganese citrate and lactate show that these salts weaken the heart's action, prolong its diastole, diminish the arterial blood-pressure, and finally paralyze the muscles; death resulting from paralysis of the heart. The amount of urine and urea excreted is increased. There is no change in the temperature. Merti and Luchsinger state that the action of the salts of manganese is manifested by somnolence, a diminution in reflex irritability and in the frequency of respiration, a sinking of the blood-pressure, and general paralysis of the central nervous system. The temperature is diminished in warm-blooded animals. There is marked intestinal irritation. This is attributed to the elimination of the metal through the intestines; for even when the salt of manganese was injected subcutaneously, there was vomiting and diarrhœa, and manganese was detected in the vomitus.

The most extended investigations are those of Kobert (*Archiv f. exper. Pathol. u. Pharmak.*, xvi., p. 361, 1883), who experimented on frogs, dogs, cats, rabbits, and guinea-pigs; using for this purpose the citrate of manganese and sodium. For frogs the salts of manganese are more poisonous than those of iron, cobalt, nickel, or zinc. Manganese acts on these animals by paralyzing the excito-motor ganglia in the heart. Of warm-blooded animals dogs are the most sensitive to the action of manganese salts. For these animals manganese is five times as poisonous as iron. On the supposition that man is as sensitive as the dog, Kobert calculates that an amount equivalent to 0.5 Gm. (7.7 grains) of manganous oxide is a fatal dose for an adult. Cats, rabbits, and guinea-pigs are less sensitive in the order named.

The symptoms which follow a minimum fatal dose in guinea-pigs and rabbits are diarrhœa, loss of appetite, languor, dragging of the limbs, diminution of temperature and of reflex irritability, and paralysis which finally involves the muscles of respiration. The urine always contains manganese. In dogs and cats subcutaneous injection of the salt was soon followed by nausea and vomiting, which continued till death. If the dose was not a fatal one the symptoms continued from one to three days, during which time nourishment was refused, or if taken, was immediately rejected by vomiting. Later the conjunctivæ were discolored by bile-pigment, and the urine contained bile-pigment, albumen, and casts. Convulsions were never observed in dogs after subcutaneous injection; but violent convulsions and death followed injection into the veins. Manganese was detected in the urine, vomitus, and fæces, and in all the organs of the body. The amount was small, however, excepting in the liver, kidneys, and contents of the intestines. Gastro-enteritis was observed in a single case only. Manganese, in the case of warm-blooded animals, paralyzes the vaso-motor centres, at first temporarily, then permanently. Later the heart is affected.

Kobert could not demonstrate chronic poisoning with rabbits. In one experiment fifteen grams of the salt was administered within three months, in gradually increasing doses. The urine never contained more than the merest trace of manganese. There was no evidence of inflammation of the stomach or intestines, and no abnormal appearances in the liver, spleen, or kidneys. Kobert concludes, therefore, that absorption does not take place to any extent through the stomach or intestines. Chronic poisoning was induced in dogs by the subcutaneous injection of the salt. Small doses often caused vomiting and diminution of appetite as the only symptom. If the doses were larger, or repeated more frequently, characteristic changes in the urine were observed. This secretion varied in color from yellow to deep brownish-black, and frequently contained albumen, and hyaline and epithelial casts, owing to an active hyperæmia of the kidney or to acute nephritis. The kidneys were similarly affected in almost all fatal cases of acute manganese poisoning. Six or eight days before death, in cases of chronic poisoning, high fever was observed.

Late experiments of Cahn on the absorption and elimination of manganese, show that the metal is not absorbed through the intestines. It is eliminated in great part through the intestinal mucous membrane, and to some extent through the gastric mucous membrane. The kidneys contain a much larger amount of manganese than the liver does. The brain contains a trace only.

William B. Hills.

MANITOU SPRINGS. *Location and Post-office,* Manitou Springs, El Paso County, Col.

Access.—From Denver by Denver & Rio Grande Railway, Manitou Branch, or from Pueblo by Denver & Rio Grande, or Denver, Texas, & Gulf Railroads to Colorado Springs, thence by carriage five miles to Manitou Springs.

Analysis (O. Leow).—One pint contains:

	Navajo. 50.2° F.	Manitou. 56° F.	Sho-shone.	Iron. 48.5° F.	Little Chief. 43° F.	Spa of Europe.
	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
Carbonate of soda	8 3-4	3 1-3	1 1-5	4 1-7	1 1-17	3-5
Carbonate of lithia	1-50	1-67	trace	trace	trace	......
Carbonate of lime	9 1-17	7 3-4	7 3-5	4 1-8	5 1-4	1-2
Carbonate of magnesia	2 1-5	1 1-2	......	1 1-50	1	1-7
Carbonate of iron	trace	......	......	2-5	1-8	1-3
Sulphate of potash	1 1-7	1	1-3	1-2	1-2	1-14
Sulphate of soda	1 1-4	1 2-3	2 3-5	2 1-5	3 3-5	1-25
Chloride of sodium	2 3-4	2 1-3	3	2 1-5	3 1-3	2-5
Silica	1-10	1-7	trace	1-5	1-7	9-20
Total solid constituents	25 1-3	18 1-5	14	19 3-4	15	3 1-50
Gases	......	Free carbonic acid.			......	......

Therapeutic Properties.—The analysis of these waters shows them to be valuable cathartic and tonic agents, the active constituents—alkalies, iron, sodium chloride, etc.—being in excellent proportion.

The springs, nine in number, are situated in the foothills of the Rocky Mountains, at the base of Pike's Peak, at an altitude of 6,147 feet. They flow from a stratified formation of various sandstones, carbonate and sulphate of lime, magnesian limestone, a mixed iron stratum, and quartzite. The scenery is grand, including some of the most wonderful freaks of nature. Within a few miles is Pike's Peak; Manitou Cañon; Engleman's Cañon; Cheyenne Cañon, with seven cataracts; Rainbow Falls; Cave of the Winds, with two miles of underground chambers; and the famed "Garden of the Gods."

Manitou Springs has schools and churches of the various denominations, is sewered, and supplied with water from a stream flowing from Pike's Peak. Six miles distant, by rail, is Colorado Springs, with a population of five thousand, where there are banks, a college, a library, a theatre, etc.

The annual rainfall is fourteen or fifteen inches. Mosquitoes are entirely unknown. There is no rain from September or October to April or May, but light snows, which disappear in a few hours, are common.

During the summer there are six large, and thirty smaller, hotels open. In winter one first-class hotel remains open.

The aggregate flow of the springs has never been accurately measured, but that of the "Navajo" is about six thousand gallons in twenty-four hours, and it supplies a large bathing establishment. *Geo. B. Fowler.*

MANNA, U. S. Ph.; Br. Ph.; Ph. G. (*Manne,* Codex Med.). A solid, partly crystalline, sugar-like substance, excreted from the bark of one or two species of Ash, in the South of Europe.

The Manna-ash of Italy, Sicily, Asia Minor, etc., *Fraxinus Ornus* Linn., is a small, graceful tree, with smooth gray bark and slender branches. Its leaves are smooth, odd-pinnate (four pairs), bright green. Its flowers in

feathery panicles are numerous, small, and white, appearing after the leaves. Calyx minute, four-parted ; petals four ; stamens two ; ovary one, two-celled, four-ovuled ; stigmas two. Fruit a samara, about an inch long, and one-sixth as wide ; one-seeded. The manna-ash grows to about twenty feet in height, and is often cultivated, both in and beyond its natural habitat, for ornament. It does not, however, yield manna excepting in southern climates. *F. excelsior* Linn., the common European Ash, like our own, is a larger tree. It has inconspicuous, polygamous, greenish flowers, without calyx or corolla. Like many others in the genus, it has a sweet sap, and in Sicily is said to yield a little manna ; but nearly all of this drug is collected from the first-named species. In Sicily, whence most of the manna of the present time comes, the trees are regularly cultivated for this purpose, being planted in rows in "orchards," and allowed to grow unmolested until the stems are nearly as large as the leg. Then the tapping is begun, and repeated every summer for a dozen or more years, until the tree is exhausted. The usual method is to make a transverse cut through the bark near the base of the trunk, and follow it each day with another, about an inch higher up than the last, during favorable weather. It is done in the middle of the summer, and hot, dry days are essential to success. The sap exudes from these cuts—a thick, syrupy, very clear, and sweet liquid—and soon concretes on the bark of the trunk, or on leaves, sticks, straws, etc., laid for it. It often drops in tears to the ground, and sometimes forms large masses at the base of the trunk. Gathered from all these places and further dried, it is manna in various qualities, and requires only sorting to be ready for the market. The inferior, in masses or tears, with its adhering impurities, is called small manna, or manna in sorts ; while the large, light-colored, stalactitic pieces which have concreted upon the trunk are flake-manna, the most prized sort.

The term manna is more interesting historically than the article we now know under that name. It was originally applied to the food that was miraculously supplied to the children of Israel in their passage over to their promised home. What that manna was we do not know. The name has been since applied to a number of sweet exudations from various parts of the world, as the following examples, quoted from the Pharmacopœia, will show : Alhagi manna, from a small leguminous plant of India, is in small, roundish, hard tears. Tamarisk manna, from Arabia and Persia, also in small tears. "Shir Khist" is from a species of *Cotoneaster*, collected in India. Oak manna, from several species of Oak, and Briançon manna, from the Larch. None of these has, however, in European markets, any importance as compared with that of the flowering Ash above mentioned, which is the manna of modern commerce. It has been known and collected for several hundred years, and has probably passed its meridian of popularity.

Description.—Manna, suitable for medicinal use, is thus described in the Pharmacopœia : "In flattish, three-edged pieces, occasionally eight inches (20 centimetres) long, and two inches (5 centimetres) broad, usually smaller ; friable ; externally yellowish-white, internally white, porous, and crystalline ; or in fragments of different sizes, brownish-white, and somewhat glutinous on the surface, internally white and crystalline ; odor, honey-like ; taste sweet, slightly bitter, and faintly acrid. It is slowly, but almost completely, soluble in boiling alcohol."

Composition.—Fine qualities of this drug contain seventy or eighty per cent. of *mannit* ($C_6H_8[OH]^6$), a sweet, crystalline, sugar-like, peculiar substance, also found in other sweet saps. There are also traces of *fraxin*, a neutral bitter substance found in the bark of several other species of ash.

Action and Use.—The best (not bitter) specimens of Manna contain nothing of importance besides this *mannit*. They are not poisonous or deleterious in any quantity, and have on the human body simply the influence of very gentle catharsis. Manna has been for a long time a favorite laxative for infants and children, on account of its pleasant taste, but is becoming less used and scarcer every day. Dose (adult), from twenty-five to fifty grams (℥ j. ad ℥ jss.), which may be taken in substance or dissolved in water. The only officinal preparation is the compound Infusion of Senna (*Infusum Sennæ Compositum*, U. S. Ph.), made as follows :

Senna, six parts.
Manna, twelve parts.
Sulphate of magnesium, twelve parts.
Fennel, bruised, two parts.
Boiling water, one hundred parts.
Water.

Macerate, strain, and add Water enough to make one hundred parts—a cathartic.

Allied Plants.—The genus *Fraxinus* contains about thirty trees and shrubs of temperate climates, of which we have five or six in this country ; none of these has any special medicinal value ; for the order *Oleaceæ*, see Olive Oil.

Allied Drugs.—Sugar, Molasses, Glycerine, *Melezitose, Saccharin*, also the cathartics in general.

W. P. Bolles.

MARIENBAD. This is a well-known Bohemian spa, lying in a pleasant valley, surrounded by forest-covered hills, not far from Carlsbad. Its elevation is about 2,000 feet above the level of the sea. There are eight springs, known as the Kreuz-, Ferdinands-, Carolinen-, and Ambrosius-brunnen, and the Wald-, Wiesen-, Rudolfs-, and Marien-quelle. Of these the most important are the two first-mentioned. The following is the composition of four of the springs, according to analyses made at different times by different chemists. The proportions of the solid constituents are given in grammes per litre.

	Kreuz-brunnen.	Ambrosius-brunnen.	Wald-quelle.	Rudolfs-quelle.
Sodium sulphate	3.873	0.275	1.06	0.11
Potassium sulphate	0.054	.....	0.20	0.02
Sodium chloride	1.237	0.075	0.37	0.06
Sodium carbonate	0.995	0.115	1.00	0.14
Calcium carbonate	0.556	0.270	0.38	1.12
Magnesium carbonate	....	....	0.40	0.67
Aluminium carbonate	0.405	0.200	.....	.....
Lithium carbonate	0.005	.....	.....	.....
Strontium carbonate	0.001	.....	.....	.....
Ferrous carbonate	0.040	0.035	0.02	0.04
Manganous carbonate	trace	.....	trace	0.07
Aluminium and calcium phosphates	0.001	.....	.....	0.03
Silicic acid	0.007	0.050	0.10	0.01
Bromides, fluorides, organic matters, etc.	traces	traces	traces	traces
Total solid constituents	7.174	1.020	3.53	2.27

The springs all contain a certain proportion of carbonic-acid gas. They are employed for the greater part internally. The Marienquelle, however, is used for bathing ; it is very weak in solid constituents, containing only 0.182 part per thousand, but is pleasantly carbonated.

The waters of Marienbad are prescribed in cases of abdominal plethora, gout, hæmorrhoids, chronic dysentery, hepatic congestion, etc., occurring in well-to-do individuals accustomed to indulge rather freely in the pleasures of the table. They are also very useful in obesity, and are especially recommended in affections associated with the menopause. The waters of some of the springs have considerable reputation in the treatment of neuralgia and of chronic catarrhal troubles of the respiratory organs and bladder. Ordinary baths are not much employed, though gas- and mud-baths are made use of to some extent. The season at Marienbad lasts from the beginning of May to the beginning of October. The climate is not mild, yet not disagreeably raw. The waters are exported in very large quantities. This spa is much frequented, the average number of guests each year being from 12,000 to 15,000 or more.

T. L. S.

MARIGOLD (*Calendula*, U. S. Ph.). The herb of the common garden Marigold, *Calendula officinalis* Linn.; Order, *Compositæ*, gathered and used fresh, is officinal. It contains a bitter *essential oil*, malic acid, and a peculiar mucilaginous substance, *calendulin*. It has no medicinal properties, but is occasionally given in the form of a diaphoretic tea, and is sometimes used as a liniment or poultice for sprains and other injuries.

ALLIED PLANTS, etc.—See CHAMOMILE. *Carthamus tinctorius* Linn., the common Safflower or "Saffron," is a closely related plant of similar bland qualities. It contains several inferior dyeing principles, such as *Safflower yellow* and *carthamin*, and was used formerly to some extent for that purpose. In medicine it is a very popular home diaphoretic and sudorific, frequently given in measles and scarlatina. *W. P. Bolles.*

MARJORAM, WILD (*Origanum*, U. S. Ph.; *Origan vulgaire*, Codex Med.). *Origanum vulgare* Linn., is a tall, slender, perennial herb from a creeping stem, with broadly ovate, opposite leaves, and small pink flowers clustered in ovoid or roundish fascicles at the ends of the paniculately branched stem. The rosy-purple bracts of the flowers are more conspicuous than the flowers themselves. Origanum grows wild in most parts of Europe and Western and Central Asia. It has been introduced into the United States, and grows in fields and pastures here. The flowering herb is officinal; it has an aromatic, pungent, bitter taste, and a peculiar, not unpleasant, fragrance.

The constituents of interest are a pale yellow *essential oil*, which has the aromatic odor and taste of the plant, and some ill-defined bitter and astringent principles. Origanum is primarily an aromatic of the sage, summer savory, and hyssop character, with a not very pleasant bitter quality added. It is very little in use. An infusion would be a suitable form in which to give it internally, if desired. The oil, as an article of commerce, is obsolete. A spurious oil is to be had; it is used in liniments, chiefly veterinary. The only officinal preparation, Aromatic Wine (*Vinum Aromaticum*, U. S. Ph.), is a relic of the pharmacy of the past; it is now and then used as a liniment.

ALLIED PLANTS.—*Origanum Marjorana* Linn., Sweet Marjoram, is common in kitchen gardens, and used as a flavor in cooking. For the Order *Labiatæ* see PEPPERMINT.

ALLIED DRUGS.—Numerous bitterish aromatics, Tansy, Horehound, Motherwort, etc. *W. P. Bolles.*

MARSHMALLOW (*Althæa*, U. S. Ph.; *Radix Althææ*, Ph. G.; *Folia Althææ*, Ph. G.; *Guimauve*, Codex Med., root, leaf, flower). The root of *Althæa officinalis* Linn., order *Malvaceæ*. This is a perennial herb, with a large, thick, fleshy root, and several simple, round, upright, velvety, leafy, flowering stems, from one-half to one metre in height, and numerous, short petioled, ovate, pointed, doubly dentate, also velvety leaves, and axillary clusters of pretty pink flowers along the upper part of the stem, of from two to four or five flowers each. Calyx five-parted, supported by an eight- or ten-leaved epicalyx. Corolla bell-shaped, of five petals, convolute in the bud. Stamens numerous, cohering, like those in all the family, in a hollow column; anthers free, one-celled. Ovary flattened vertically, many celled, with one ovule in each cell. A native of the moderate and warmer portions of Europe, growing near the sea or in salt marshes; also naturalized in this country, and growing in similar places. It is cultivated extensively in Bavaria and Würtemberg. The roots of the market come generally from cultivated plants of two or three years' growth, and are collected in the autumn, when they are full and plump. The bark is first scraped off, and the roots are then dried in straightish pieces from five to fifteen centimetres or more in length, and one or two centimetres in diameter; they are deeply wrinkled longitudinally, are of a bright white color, and of rather flexible texture, although breaking short at last. The surface is slightly hairy from loosened fine bast fibres, and generally mealy, on account of its abundant starch. Odor faint, taste sweet, mucilaginous.

COMPOSITION.—About one-fourth of the dried root is *starch*, and another fourth is *mucilage*, for which two substances it is generally valued. It also contains an interesting proximate principle, *asparagin*, to the extent of one or two per cent. All the above constituents are pretty widely diffused in the vegetable kingdom.

FIG. 2194.—Marshmallow. (Baillon.)

USES.—Althæa is a mild demulcent, like gum arabic or slippery elm. A decoction may be given in bronchial or vesical catarrh, or as a bland vehicle for other medicaments. Ground to a fine powder, it is considerably used in poultices, but has no advantage over the other common things used for the same purposes. Dose indefinite. A syrup (*Syrupus Althææ*, U. S. Ph.) is officinal, and used as a vehicle.

ALLIED PLANTS.—There are about a dozen species of *Althæa*, all mild in qualities, most of them having handsome flowers. *A. rosea* Cav., the Hollyhock, is cultivated everywhere. The order itself, *Malvaceæ*, is characterized generally by the absence of active properties. Some of its members are common weeds; many are beautiful garden flowers; one or two are of the greatest economic value.

Malva, Mallows, includes several familiar species, one or two of which are used in medicine; *M. sylvestus* Linn. (*Flores Malvæ*, *Folia Malvæ*, Ph. G.; *Mauve*, Codex Med.); *M. vulgaris* (*Folia Malvæ*, Ph. G.); *M. rotundifolia* Linn.(*Mauve petite*, Codex Med.). All are bland demulcents.

Althæa, as above.

Hibiscus, a large genus of tropical herbs, shrubs, or trees: *H. Triornum* Linn. (Bladder Ketmia); *H. Syriacus* Linn. (the shrubby althæa), are favorite garden plants; *H. esculentus* Linn., of Africa, is Okra of southern gardens, etc.; *H. Moscheutos* Linn., our wild Rose Mallow, has very large showy flowers.

Gossypium. Several species yield the invaluable COTTON, q. v.

ALLIED DRUGS.—Gum arabic, gum tragacanth, etc., cherry-tree and other bassorin gums. Flax-seed, slippery elm, quince-seed, and a host of other mucilaginous substances. Asparagin has been found in twenty or thirty

plants, of which the following are some of the most important: Asparagus, lily of the valley, liquorice, peas, beans, etc., potatoes, lettuce, horsechestnuts, chestnuts, etc.

W. P. Bolles.

MASSAGE. Definition.—Massage, from the Greek, *masso*, I knead or handle; Arabic, *mass*, press softly; is a term now generally accepted to signify a group of procedures which are best accomplished with the hands, such as friction, kneading, manipulation, rolling, and percussion of the external tissues of the body in a variety of ways, with either a curative, palliative, or hygienic object in view. In many instances massage should be combined with movements which may be assistive or passive, resistive or active, as different cases may require; and these are often spoken of as the Swedish movement cure. There is, however, an increasing tendency on the part of scientific men to have the word massage embrace all these varied forms of manual therapeutics, for the reason that the word cure, attached to any form of treatment whatsoever, is objectionable and frequently misleading.

History.—Massage, in some crude form or other, has been used from time immemorial by savage and civilized people. The reason of this is obvious, for almost everyone instinctively seizes a place that is the seat of sudden pain, and attempts, with more or less success, to relieve it by rubbing or pressure, or by both together. Those who have thought it worth while to record their appreciation of massage have, in almost every instance, been men of eminence, either as physicians or philosophers, poets or historians, from the days of Homer and Hippocrates, down to these of Weir Mitchell and Billroth. Homer, in the Odyssey, 800 or 1000 B.C., tells that beautiful women rubbed and anointed the limbs of war-worn heroes to rest and refresh them. In another part of the Odyssey it is narrated that "goodly Odysseus spake among the maidens, saying, I pray you stand thus apart, while I myself wash the brine from my shoulders and anoint me with olive oil, but in your sight I will not bathe, for I am ashamed to make me naked in the company of fair-tressed maidens." Among both the Greeks and Romans, massage, in some form or other, was extensively patronized by people of widely different classes, from the patricians, the wealthy, and the learned, down to poor, decrepit, old slaves; and for the most diverse purposes: with some as a means of hastening tedious convalescence, with others as a luxury in conjunction with the baths, and with others still to render their tissues supple and enduring preparatory to undergoing feats of strength, so that there would be less likelihood of strains and ruptures occurring. The old slaves were submitted to such treatment in order to fill out their tissues and make them appear more comely, so that they would sell to better advantage by thus temporarily deceiving their purchasers. It was also used after the exercises and struggles of the athletes and gladiators, to stroke away and relieve the pains of their bruises, as well as for its reinvigorating effects. Those who applied the rubbing and anointing were as different in character and qualifications as those who received it. Sometimes it was done by medical practitioners themselves, sometimes by priests, at others by slaves, but probably more often by those called *aliptæ* (from *alipes*, swift of foot, nimble), whose business it was to anoint the wrestlers before and after they exercised, and who took care to keep them sound and in good complexion.

It is said that Plato reproached Herodicus for protracting the lives of feeble persons by causing them to exercise and to have their bodies rubbed; and by the same means Herodicus himself was cured of ill health and attained the age of one hundred years. It was he who first proposed gymnastics for the cure of disease and the preservation of health, in the fifth century B.C. Herodotus, the father of history, and others of his time, mention the advantages of external treatment of the human body; but it was not until about a century later that the first rational and definite information appeared on this subject, in the aphorisms of Hippocrates. These embodied the wisdom of the past, and presaged the developments of the future, to an extent that but few ancient or modern writers on massage have shown any evidence of appreciating. "The physician must be experienced in many things," says Hippocrates, "but assuredly also in rubbing; for things that have the same name have not always the same effects; for rubbing can bind a joint that is too loose, and relax a joint that is too rigid. . . . Rubbing can bind and loosen, can make flesh, and cause parts to waste; hard rubbing binds; soft rubbing loosens; much rubbing causes parts to waste; moderate rubbing makes them grow" (Hippocrates, Peri Arthron, Littré, vol. iv., p. 100). When the necessary previous conditions exist the results predicted will follow. Hippocrates was wiser than he was aware of, as we learn from the word that he used to designate his process of rubbing, namely, *anatripsis*, which literally means the art of rubbing up, and not down, thus favoring the returning circulation, which was not understood in those days. Asclepiades, also a celebrated Greek physician, 128–56 B.C., was very popular with the Romans on account of his agreeable remedies. His theories with regard to disturbance of the nutritive fluids in disease led him to use rubbing and anointing, together with passive and active motion, for the restoration of free movement of these fluids; and his efforts in this direction met with so much success, that he almost entirely renounced the use of medicines. Cicero, 106–43 B.C., considered that he owed as much of his good health to his anointer as he did to his physician. Plutarch states that Julius Cæsar had himself pinched all over daily as a means of getting rid of a general neuralgia. Celsus advocated friction for almost every disease, but some of his remarks are worthy of notice for their truth, such as: "Rubbing should sometimes be applied to the whole body, as when an invalid requires his system to be replenished. Chronic pains of the head are relieved by rubbing the head itself; but far more frequently, when one part is in pain another must be rubbed. A paralyzed limb is strengthened by being rubbed. If certain limbs only are rubbed, long and powerful rubbing may be used, for the whole body cannot soon be weakened through a part. But when weakness of the body needs this cure over its whole extent, it ought to be shorter and more gentle." Martialis, of literary fame about the year of our Lord 100, refers to manipulation of some kind in these words:

> "Percurrit agile corpus arte tractatrix
> Manumque doctam spargit omnibus membris."

Galen, A.D. 130–200, whose authority in medical matters for a thousand years was almost supreme throughout Europe, recommended friction in a great number of diseases as auxiliary to other means.

But the Greeks and Romans were not the only descendants of the Aryans who employed external treatment of the body by hand, for Strabo tells us that the Indians contemporary with Alexander, 326 B.C., esteemed friction highly. "They polish their bodies smooth with ebony staves and in other ways, and the king, while receiving foreign ambassadors, listens and is rubbed at the same time." Among the hygienic precepts laid down in the *Ayur Veda* (Art of Life), early Sanscrit of the first century, it is stated that we ought to rise early, bathe, wash the mouth, and anoint the body, submit to friction and shampooing, and then to exercise. To be shampooed one is extended upon a bench, when the operator handles the members as if he were kneading dough; he is struck lightly with the ulnar border of the hands, perfumed, and rubbed, and the operation is terminated by cracking the articulations. Manual treatment of the body has been described in one of the oldest books of the Chinese, the Cong-Fou of the Tao-Ssé, and it is supposed that the practice has been borrowed from the Indians. In place of bleeding their patients, the Chinese use friction and kneading to put the blood in motion. In a Japanese book, published in the sixteenth century, there are engravings of anatomical figures and gymnastic exercises, and also of various ways of pressing, percussing, and vibrating the tissues, as well as of passive motion, all of which have been in use among the Japanese

from the most remote periods. It has long been, and still is, the custom in Japanese cities for poor blind people to go through the streets, blowing a horn or beating a can, in order to notify the inhabitants of their presence and occupation, so that, for an incredibly small sum, those who wish may be rubbed, manipulated, and percussed after the manner of these professionals. The manipulation they call "momemasu;" the percussion, "tatakimasu." In Tonga and other islands of the Pacific Ocean, when one is fatigued he can lie down and have some of the natives practise *toogi-toogi, mili* or *fota* upon him. The first of these words signifies striking continually and gently with the fist; the second that of rubbing with the palm of the hand; the third that of pressing and squeezing the tissues between the thumb and fingers; all of which, besides diminishing fatigue, are often used with success in dispelling pains and headache. The Turks, Egyptians, and Africans use similar procedures, and the Russians apply flagellation and friction by means of a bundle of birch-twigs, after the subject has been well parboiled in a vapor-bath; and finally he is finished off by having a pailful of cold water dashed over him, the effect of which is said to be electrifying. The Siberians and Laplanders indulge in similar luxuries. In the Sandwich Islands a very effectual form of massage is done, though not on very sound physiological or therapeutical principles, for it is proceeded with in a contrary direction to the returning circulation, and often defeats the aim of the surgeon in being applied to recent ununited fractures, thus interfering with immobility and hindering repair. Yet, for all that it is universally testified to as being an excellent means of procuring rest and sleep when excessively fatigued, of relieving pain and muscular stiffness, of securing good digestion, and appeasing the muscular sense of *ennui* that comes from a *craving* for active exercise. Almost amphibious, the Sandwich Islanders often swim long distances, and when one of their number becomes exhausted the others sustain him in the water and *lomi-lomi* him at the same time, which quickly refreshes the weary one. The kings and wealthier natives of the Sandwich Islands, in mind and body, seem like a superior race of people to those around them, and this is mainly attributed to their being *lomi-lomied* after every meal as a means of aiding their digestion. It is astonishing how many there have been who have thought that massage was indigenous to their own or some other country. More pleasing than true or thoughtful is the statement made by Petit that the manœuvres of massage have been imported into Europe from Syria, Palestine, and the East, in consequence of the crusades against the Saracens; but it has found very little credit among physicians.

Paracelsus, 1492–1541, in his "Liber de Vita Longa," extols the effects of friction as indispensable to health. Ambroise Paré, 1517–1590, mentions three degrees of friction, and in dislocation recommends that the joint should be moved about gently to resolve the effused fluids, so as to facilitate the reduction. Mercurialis, in 1573, published a treatise, "De Arte Gymnastica," in which he emphasizes the benefits to be derived from active, passive, and combined movements. Fabricius ab Aquapendente, professor of surgery at Padua, was the author of a treatise, "De Motu Locali Secundum Totum," in which he again brought massage to honor, recommending treatment by rubbing, kneading, and scientific movements as rational in affections of the joints. Hoffman and Sydenham also added their testimony to the value of such treatment. Paullini, in 1698, advised flagellation, percussion, and slapping as a remedy for the sufferings of libertines. It might have been used otherwise than as a remedy. Mr. Grosvenor, professor of surgery at Oxford, about a century ago, became celebrated throughout the United Kingdom by the application of massage to imperfections of motion from stiff and diseased joints. First employed with success in his own case, Mr. Grosvenor was not slow in using his surgical skill to select suitable cases for this method of treatment. His opinions of cases appropriate or otherwise for massage accord very much with those of the present day. He considered this treatment improper in cases of inflammation, in scrofulous cases tending to suppuration, in cases of inflammatory gout and rheumatism, and useless in cases of true anchylosis. Those in which he found this means serviceable were contractions of the joints attended with languid circulation and thickening of the ligaments; cases where there was too great secretion of the synovial fluid; after the healing of wounds of ligamentous, tendinous, or muscular parts, when the function of the limb is impaired; in cases of paralysis; in chorea, combined with attention to the system; after violent strains of joints; in incipient cases of white swelling; after fractures of the articular extremities of joints, when stiffness remains following union; when motion is impaired after reduction of dislocated joints; and in weakly people with languid circulation. A quaint and curious volume of forgotten lore, by Dr. William Balfour, of Edinburgh, was published in 1819, entitled "The Power of Compression and Percussion in the Cure of Rheumatism, Gout, and Debility of the Extremities, and in Promoting Health and Longevity." The book consists of interesting reports of cases of rheumatism, gout, neuralgia, sprains, and the after-effects of injuries, treated by means of percussion, deep rubbing, and firm compression with bandages; and these are interspersed with forcible and philosophical remarks. Most of his cases speedily got well, and few there were but received some benefit.

To Peter Henrik Ling, of Sweden, credit is given for having instituted what is so well known as the Swedish movement cure. In 1813 the Royal Central Institution was established at Stockholm, with the patronage of the Swedish Government, in order that Ling might practise and teach his system of gymnastics, which were adapted to well people and to chronic invalids. The critics of Ling brought forward testimony to show that his method was but a revival of that of the Brahmins of India, of the Egyptian priests, of Asclepiades, of Pythagoras, and of Herodicus; and also that of which Hippocrates, Celsus, Galen, Rufus of Ephesus, and other physicians, have preserved fragments for us; and that all the movements which Ling has indicated are described in an ancient book of the Chinese, the "Cong-Fou of the Tao-Ssé." But, however the genius of Ling and the claims of priority made for him may have been disputed, there seems to be no doubt as to the merits of the system which he rescued from oblivion and, according to all accounts, put upon a scientific basis. In some of the large cities of this and other countries institutions similar to the one at Stockholm exist, where movements and stirring up of the external tissues of the body, by hand and by machinery, are successfully employed. It seems rather strange that in France, the country which gave massage its name and greatest impulse, this method of treatment should have become so much neglected. For seventy years the word massage has found a place in the medical literature of France, but for the past twenty years very little attention has been paid to it. In the summer of 1884 Professor Charcot told me that the physicians of Paris did not interest themselves much in massage, but that they were going to do so. However, with the waning interest of the French in massage, the Germans and Scandinavians have taken up the matter with increased zeal, and have produced a respectable accumulation of evidence as to its proper sphere of usefulness; even though, so late as 1875, it was an every-day question among German physicians as to the meaning of massage, some showing their entire ignorance of it by supposing that Mezger, of Amsterdam, was the originator of this form of treatment. For twenty years prior to 1873 Mezger had been using massage with good results in affections of the joints; but it was in 1873 that his successful treatment of the Danish crown prince for a chronic joint trouble aroused the particular attention of physicians to the benefits of this method. The publication, in 1877, of Weir Mitchell's experience in treating anæmic, nervous, bed-ridden patients, with almost uniform success, by means of rest, seclusion, and excessive feeding, made available by the use of massage and electricity, gave another push forward to the cause of massage, and raised it still higher in the estimation of phy-

sicians. Since then its field of usefulness has gradually been widening, so that now it has found its way into every general and special branch of medicine, frequently meeting with signal success after all other means have failed.

Mode of Doing Massage.—Vague generalities exist as to the manner of doing massage, and these are not rendered much clearer by calling slow and gentle stroking in a centripetal direction, *effleurage ;* or by speaking of deep-rubbing as *massage à friction*, or by using the word *pétrissage* for manipulation without friction, or by calling percussion *tapotement*. Custom having sanctioned the use of these words, it becomes necessary to mention them. These and other subdivisions of massage can all be grouped under four heads : friction, percussion, pressure, and movement. Malaxation, manipulation, kneading, or massage, properly so-called, is a combination of the last two. Each and all of these may be gentle, moderate, or vigorous. Some general remarks will save repetition : 1. All of the single or combined procedures should at first be used moderately, then gradually increased in force and frequency to the fullest extent desirable, and end gradually as begun. 2. The greatest extent of surface of the hands and fingers of the operator, consistent with ease and efficacy of movement, should be adapted to the surface worked upon, in order that no time be lost by working with the ends of the fingers, or one portion of the hands, when all the rest might be occupied. 3. The manipulator, if too near the patient, will be cramped in his movements ; if too far away, they will be lacking in energy, indefinite, and superficial. 4. The patient should be in an easy and comfortable position, with joints midway between flexion and extension in a well-ventilated room, at a temperature of 70° or 75° F. Sensations of tickling, if produced by massage, will soon disappear. 5. What constitutes the dose of massage is to be determined by the force and frequency of the manipulations and the length of time during which they are employed, considered with regard to their effect upon the patient. A good manipulator will accomplish more in fifteen minutes than a poor one will in an hour, just as an old mechanic working deliberately will do more than an inexperienced one working furiously. 6. The direction of the procedures should be from the extremities to the trunk, from the insertion to the origin of the muscles, in the direction of the returning currents of the circulation, unless there be a plug in a vein. Friction may be circular or rectilinear ; the latter may be parallel to the long axis of a limb or to the body, at right angles, or transverse to the same. Transverse friction adds nothing to massage, and may be omitted. A deviation from the other method ordinarily employed in doing straight-line friction I have found to be more advantageous ; it is, where practicable, after the stronger upward stroke, to return downward, lightly grazing the surface, so as to impart a soothing sensation without being so vigorous as to retard the circulation pushed along by the upward stroke ; and thus a saving of time and effort may be gained. The manner in which a carpenter uses his plane represents this to-and-fro movement very well. In giving a general massage it is usually immaterial whether the upper or lower extremities be done first. It is better to be systematic and to divide the surface into convenient spaces. A convenient extent is from the ends of the fingers to the wrist, each stroke being of this length, the returning stroke being light and without removal of the hand. The rapidity of these double strokes may be from ninety to one hundred and eighty per minute. The whole palmar surface of the fingers, held in easy extension, should be employed, and in such a manner that they will fit into the depressions formed by the approximation of the phalanges and metacarpal bones, while the patient's hand is resting in the other hand of the manipulator. Both dorsal and palmar aspects will thus receive attention, and the heel of the operator's hand will be used for vigorous friction of the palm, which is done by a semicircular pushing movement ; and the same can be effectually employed on the sole of the foot, but with less circular motion—the effect in both regions being remarkably agreeable. The right hand of the operator should be used for the right hand and foot of the patient, the left for the left, as in this way they fit each other best. From the wrist to the elbow, and from the elbow to the shoulder, are each suitable extents of surface to be worked upon, and here not only straight-line friction extending from one joint to the other, but also circular friction, may be used. A combination of these two in the form of an oval, possesses the greatest advantages, both hands moving at the same time, the one ascending as the other descends on the anterior and posterior aspects of the arm, on the inner and outer surfaces of the upper arm, each stroke reaching from joint to joint, the upward being carefully kept within the limits of chafing the skin ; while they move at a rate of from seventy-five to one hundred and eighty each per minute, or one hundred and fifty to three hundred and sixty with both hands. It is well to begin these strokes on the inside of both arms and legs, so that the larger superficial and deep vessels may be first acted upon, as this influence extends at once, though indirectly, to their tributaries and ramifications. But sometimes it is not practicable to place the patient's hand on a support so as to work on the arm with both hands, and then one must grasp the right hand by its dorsum, using the left for this purpose, while the other does the oval friction on the anterior surface ; and for the back of the arm the operator will grasp the patient's hand as in the act of shaking hands, while the disengaged hand does the friction.

Time, effort, and effect will be made the most of by doing friction on the foot with the hands at right angles to it, one hand upon the dorsal aspect, and the other upon the plantar, moving alternately and in the form of an oval, the one ascending as the other descends. Around and behind the malleoli requires a special pushing stroke with the fingers, and for this the operator should be so practised that he can unconsciously change his position so as to face the patient. The lateral and posterior aspects from ankle to knee form a convenient territory, while the anterior and lateral aspects make another, for thorough and efficacious friction. This is best accomplished with the patient's knees semi-flexed, and the operator standing facing the patient for the back and sides of the leg ; and after having completed friction here without stopping the upward oval strokes, he will turn with his back to the patient and continue the stroking on the anterior and lateral aspects, each thumb following the other with tolerably firm pressure upon the anterior tibial group of muscles ; but owing to the latter position of the operator, only upward friction can be done, without the light downward stroke. The same systematic divisions of surface may be made above the knees as below, with the addition of another formed by the inner and anterior surface of the thighs, which will first receive attention ; and after this the operator, with his back to the patient, can apply strong upward friction to the back and sides of the thigh, with light returning strokes ; to the front and sides only upward strokes. The number of strokes below the knees will vary from one hundred to one hundred and sixty with each hand ; above, from sixty to one hundred. From the base of the skull to the spine of the scapula forms another region, naturally well bounded for downward and outward semicircular friction ; and from the spine of the scapula to the base of the sacrum and crest of the ilium forms another surface over which one hand can sweep while the other works toward it from the insertion to the origin of the glutei, at an average rate of sixty or seventy-five a minute with each hand, for a person of medium size. It will be observed that on the back and thighs the strokes are not so rapid as on the other parts mentioned, for the reason that the skin is here thicker and coarser, in consequence of which the hands cannot glide so easily, and the larger muscles beneath can bear stronger pressure ; besides, the strokes are somewhat longer, all of which requires an increased expenditure of time. The chest should be done from the insertion to the origin of the pectoral muscles, and the abdomen from the right iliac fossa in the direction of the ascending, transverse, and descending colon. But in these situations friction is seldom necessary, for the procedure about

to be considered accomplishes all that friction can do, and a great deal more. The force used in doing friction is often much greater than is necessary, for it should only be intended to act upon the skin, manipulation and percussion acting much better on the tissues beneath. If redness and irritation of the skin be regarded as the measure of the beneficial effects of friction, then a coarse towel, a hair mitten, or a brush would answer for this purpose a great deal better than the hand alone. But for intelligent variation of pressure, agreeableness of contact, and adaptability to even and uneven surfaces, no instrument has yet been devised to supersede the human hand. In union there is strength, and the fingers should be kept close together in doing friction and manipulation.

The advantages of ordinary rubbing are not to be despised, and by many this is supposed to be all there is to massage; but in reality it is the least essential part of it. One of the old French dictionaries, in saying that there is reason to believe that massage has upon the skin the advantages of friction, that it acts above all upon the more deeply situated tissues, evidently implies that massage, properly so-called, is something different from friction, and yet has the same effect upon the skin, while exerting a more extended range of influence. What else can massage then be than manipulation, deep-rubbing, kneading, or malaxation, which is certainly the most generally important, agreeable, and efficacious procedure of all? It is done by adapting as much as possible of the hands and fingers to the parts thus to be treated, and without allowing them to slip on the skin; the tissues beneath are worked upon in a circulatory manner by a simultaneous sort of kneading, rolling, squeezing, manipulatory motion, proceeding, as in friction, from the insertion to the origin of the muscles, from the extremities to the trunk. For this purpose the same divisions of surface as for friction will be most convenient. Beginning then with the fingers from the roots of the nails, the thumb of the manipulator will be placed on one of the fingers of the patient and parallel to it, while on the opposite surface the second phalanx of the index-finger will be simultaneously placed at right angles to this, and between the two the finger of the patient will be compressed and malaxated at the rate of from seventy-five to one hundred and fifty per minute. The dorsal and palmar surfaces will, of course, receive especial attention, while the sides will come in for a secondary share. If the manipulator be sufficiently expert he can work with both hands on this small surface, or he can take one of the patient's fingers in each of his own hands and proceed as before, and with the same rapidity as with one. Each finger and thumb will be taken in turn, and the manipulations extended over the metacarpal and carpal bones as far as the wrist, and finally the palm of the hand will be done by stretching the tissues vigorously away from its median line. Each part included in a single grasp may receive three, four, or six manipulations before proceeding onward to the adjacent region. The advance upon this should be such as to allow the finger and thumb to overlap half of what has just been worked upon. Advance and review should thus be systematically carried on; and this is of general application to all the other tissues that can be *masséed.* The force used here and elsewhere must be carefully graduated, so as to allow the patient's tissues to glide freely upon each other; for, if this be too great the movement will be frustrated by the compression and, perhaps, bruising of the tissues; if too light the operator's fingers will slip; and if gliding with strong compression be used the skin will be chafed. To avoid this last objection, which is a universal error, various greasy substances are employed, so that ignorant, would-be *masseurs* may rub without injuring the skin. When the skin is cold and dry, or cold and moist, and insufficiently nourished, as well as in certain fevers and other morbid conditions, there can be no doubt of the value of inunction; but no special skill is required to do this, and there is no need of calling it massage unless it be to please, as well as to deceive, the patient. Removal of hair is unnecessary; massage can be done as effectually on the head as on any other part.

The feet can be manipulated in much the same way as the hands, using the ends of the fingers to work between the metatarsal as between the metacarpal bones, and the tissues of the sole will be stretched vigorously away from the median line; and lastly the heel will be worked upon by allowing it to fit accurately into the palm of the hand while it receives squeezing, circulatory manipulations. Upon the arms and legs, and, indeed, upon all the rest of the body, both hands can be used to better advantage than when the surfaces are small. Each group of muscles should be systematically worked upon, and for this purpose, one hand should be placed opposite the other; and where the circumference of the limb is not great, one hand can also be placed in advance of the other, the fingers of one partly reaching on the territory of the other, so that two groups of muscles may be manipulated at the same time, with grasping, circulatory, spiral manipulations, one hand contracting as the other relaxes, the greatest extension of the tissues being upward and laterally, and on the trunk, forearms, and legs, away from the median line. It is needlessly wearisome, to both patient and manipulator, if the hands are kept closely adapted to the limb its whole length in doing this vermicular squeezing; besides, it interferes with the circulation in both directions. To avoid this it is only necessary to raise the hands slightly in advancing. Subcutaneous, bony surfaces, as those of the tibia and ulna, incidentally get sufficient attention (unless œdema be present) while manipulating the muscles adjacent to them, for if bone and muscle be included in a vigorous grasp unnecessary discomfort results. Care should be taken not to place the fingers and thumb of one hand too near those of the other, for by so doing their movements would be cramped. With the fingers and thumbs at suitable distances from each other, not only are the tissues immediately under them acted upon, but those between them are agreeably stretched. The advance should be upon the previously unoccupied stretched region. Space and force will be indicated by the elasticity, or want of it, in the patient's tissues, the object being to obtain their normal stretch; and in this every one is a law to himself, the character of the tissues varying with the amount and quality of adipose, modes of life, habits of exercise, etc. A frequent error on the part of the manipulator is in attempting to stretch the tissues in opposite directions at the same time, especially at the flexures of the joints, where the skin is delicate and sensitive, and where the temptation to such procedure is greatest, because easiest, the effect being a sensation of tearing of the skin. It is well to go over a surface gently and superficially, before doing the manipulation more thoroughly. In the case of the arm, the two hands will embrace the whole circumference, the thumbs occupying the median line on the front as well as on the back. The supinators should receive a special malaxation with the grasp of one hand. Above the elbow, the biceps will be seized with one hand while the other takes the triceps. The median portion of the deltoid will receive most thorough attention from the thumbs placed parallel to its fibres, while the fingers and palms are engaged with the anterior and posterior aspects of the muscles; and after this its margins, and also the whole muscle, can be worked with the hand at right angles to its fibres.

In manipulating a leg of considerable size three divisions of surface are necessary: the posterior and lateral aspects form one, the stretching of the peroneal muscles from those of the anterior tibial region form another; and this is done by placing one thumb in advance of the other on the outer side of the fibula, and alternately rolling the muscles away from each other; and for the third the thumbs should be placed on the tibialis anticus, and a simultaneous rolling of the tissues made away from the anterior border of the tibia. In all of these procedures no parts of the hands need be idle, for when not specially occupied they can be giving secondary attention to the surfaces they cover. If the limb is small, of course it can all be *masséed* at once on the spaces formed by the encircling of the two hands; but even in this event, when special massage is required, these three divisions are neces-

sary. The cushions of the thumbs, the heels of the hands, the thenar and hypothenar eminences, fit admirably into the depressions of the joints, especially those of the ankle and knee, wrist and elbow, while the rest of the hand is occupied with the neighboring tissues. Above the knee one hand will grasp the adductors while the other embraces the quadriceps extensor, and the alternate contraction and relaxation of the hands will be made in such a way as to stretch these two groups of muscles away from the course of the femoral artery. The posterior femoral region should next be gone over, which will principally engage the fingers, while the upper parts of the hands work upon the sides of the limb. The external aspect of the thigh may receive as vigorous kneading as it is possible to give with evenly distributed force; and, with the thumbs in advance of each other on the rectus femoris, more especial and effectual manipulation can be given to the extensors, while the palms and fingers make a review of the lateral aspects of the thigh. The rate of these manœuvres varies from seventy-five to one hundred and fifty with each hand per minute on the arms, from sixty to ninety on the legs, and from forty to eighty on the thighs, where more force is required on account of the larger size and density of the muscles, and the need of using sufficient force to extend beneath the strong, tense fascia lata.

On the back the direction of these efforts will be from the base of the skull downward, stretching the tissues away from the spinal column while manipulating in graceful curves at an average rate of sixty per minute with each hand. This is best done on one side of the back while the patient lies on the other side, and in this position it is one of the most difficult manœuvres for beginners to learn, and even some old hands never succeed in acquiring it. In words it looks as if it might be simple enough. While each hand works on a separate space near the other, the one follows the other, not in an opposite, but in the same circular manner alternately, the one contracting as the other relaxes. And here, on large people with firm tissues, one hand should often be reinforced by placing the other upon it, and thus manipulating with all the strength the *masseur* or *masseuse* can put forth. The position of the shoulder-blades is important, for if the upper arm be parallel with the side, then the posterior border of the scapula will be so near the spinal column that scarcely any space will be allowed to work upon the muscles between this and the scapula. If the upper arm be stretched forward its full length, then the superficial layer of muscles between the spinal column and the scapula will be so tense that those beneath cannot be effectually reached by massage. Hence the arm should be placed midway between these two positions. With the ends of the fingers the muscles on each side of the spinal column can be rolled outward, and the supra-spinous ligament can be effectually *masséed* by transverse to-and-fro movements. The ends of the fingers and part of their palmar surfaces should also be placed on each side of the spinous processes, and the tissues situated between these and the transverse processes worked by up-and-down motions parallel to the spine, being careful to avoid the too frequent error of making pushing, jerky manipulations in place of smooth, uniform motions in each direction.

On the chest and abdomen the same general direction will be observed as in using friction, but the manipulation will be more gentle than on the back and limbs, for the tissues here will not tolerate being so vigorously squeezed and pinched. Here the massage will consist of moderate pressure and movement with the palms of the hands, and of rolling and grasping the skin and superficial fascia; and, after this, on the abdomen, of firm, deep kneading in the direction of the ascending, transverse, and descending colon, using for this purpose the greatest force with the heel of the hand on the side of the abdomen next the operator, and on the other side the strongest manipulations with the fingers, avoiding the frequent and disagreeable mistake of pressing at the same time on the anterior portions of the pelvis. The sides of the trunk will incidentally receive sufficient attention while the back, chest, and abdomen are being manipulated. When constipation is obstinate, it is a good plan to deviate from the method just mentioned, and to commence manipulation over the left venter of the ileum, and work so as to push the contents of the descending colon toward the rectum; then begin again a little farther upward on the colon, and work in the same direction as before, attempting to unload the large intestine—and so on until the whole colon is traversed to the ileo-cæcal valve, and again reviewing from there to the sigmoid flexure. Tolerably fair and rapid rolling of the muscles of the back may be done by means of a roller made of rubber, about three inches in length, and one and a fourth inch in diameter. None of the electro-massage machines do anything worthy of the name of massage, or of electricity either. The sponges or poles of any battery may be pressed and moved so as to give a sort of massage while the current is passing. Zabludowsky scorns the idea of doing anything worthy of the name of massage with instruments, and emphatically declares that only in the hands of physicians can it prove an effectual remedy.

Friction should alternate with manipulation far less frequently than it does, and both may be varied with rapid pinching of the skin and deeper grasping of the subcutaneous cellular tissue, and, when necessary, with percussion and movements, passive, assistive, or resistive, finishing one limb or convenient surface before passing to another, and occupying from half an hour to a whole hour with all or part of these procedures. Pinching is an agreeable way of exciting the circulation and innervation of an inert skin, and for this purpose it is best done rapidly, at the rate of one hundred to one hundred and twenty-five per minute with each hand. The grasp of a fold of skin should not be relaxed until seized by the finger and thumb of the other hand. To act upon the subcutaneous cellular tissue, a handful of skin is grasped, and rolled, and stretched more slowly than by the preceding method. A deeper, momentary grasping of the muscles is often advantageous, and may be called a *mobile intermittent compression*, and this, indeed, is what the whole of massage, strictly speaking, consists of. Percussion, generally applicable only over muscular masses, may be done in various ways. In the relative order of their importance they are as follows: 1. With the ulnar borders of the hands and fingers. 2. The same as the first, but with the fingers separated so that the adjacent sides will strike against each other when the blow occurs. 3. With the ends of the fingers, the tips being united on the same plane. 4. With the back of the upper halves of the fingers loosely flexed. 5. With the palms of the hands. 6. With the ulnar borders tightly shut. 7. With the palms of the hands held in a concave manner, so as to compress the air while percussing. The back of a brush or the sole of a slipper, sometimes answers very well for percussion; but still better are india-rubber air-balls secured to steel or whalebone stems with suitable handles. With these one gets the spring of the stems together with the rebound of the balls, and thus rapidity of motion with easily varying intensity may be gained, provided the operator has learnt how to let his wrists play freely—as he should do in all the different ways of percussing. The number of blows may vary from two hundred and fifty to six hundred with both hands. The blows should be smart, quick, and springy—not solid and hard—and they should be transversely to the course of the muscular fibres with the ulnar border of the hands and palmar surfaces; except in the case of the back, which may not only be percussed with the hands at right angles to it while the patient is lying, but still more effectually when the patient is standing bent slightly forward, so as to put the dorsal muscles on the stretch. The hands of the *masseur* or *masseuse* are then most easily held parallel to the spinal column, and can rapidly strike the muscles on each side of it, causing, we have every reason to suppose, a vibratory effect as when the string of a bow is vibrated. Moreover, in this position, the muscles, being tense, protect the transverse processes from the impact of the blows which impact is communicated to the nerves as they emerge from the intervertebral foramina, and the effect is usually perceived to their distribution as a peculiar and

delightful thrill. Percussion must be used carefully, or it will leave the muscles sore.

Remedial movements have been more fully than clearly described in books on "Movement Cure." A comparison of the different ways of executing them demonstrates that the part of the limb or body taken hold of for lever age, the manner of seizing the same, and the direction of resistance and force opposed, are all of importance in order that the movements may be done easily, efficaciously, and harmoniously. Those who apply them should know the anatomy and physiology of the joints, and their natural limits of motion. Save in the case of relaxed joints, passive motion should be pushed until there is a feeling of slight resistance to both patient and manipulator; for this is the only way we can know that in healthy joints the ligaments, capsules, muscles, and fasciæ around them are being acted upon. Resistive movements are such as the patient can make while the operator resists; or such as the operator overcomes when the patient resists; as when a group of muscles is voluntarily contracted, the operator extends them against resistance from the patient. The former has been called double concentric, and the latter double eccentric, by some eccentric individuals. Brown-Séquard first pointed out the fact to me, that when it is desirable to exercise a group of much enfeebled muscles, it is best that they should first be contracted to their utmost, for then it will require much greater force to overcome this contraction, or to extend them, than they could overcome in passing from a state of relaxation to contraction. Most frequently, however, it will be necessary to make resistance against the patient's movements, and then the opposing force should be carefully and instinctively kept within the limits of the patient's strength, so that he may not recognize any weakness; and this, with all these other manœuvres, should stop short of fatigue—at least such fatigue that is not soon recovered from. To alternately resist flexion and extension is the *pons asinorum* of manipulators, and, in not a small experience of teaching massage, I have found but few who could learn to do it well, and many who could not learn to do it at all. Many a patient who has recovered from an old injury is still as much incapacitated as ever, from the fact that his or her latent energies can only be discovered and cultivated for use in this manner. Midway between passive and resistive movements in the course of certain recoveries stand assistive movements. They are but little understood and seldom used, the patient being credited with complete loss of motion. For instance, in the absence of completely and permanently disabling injury or disease, let it be supposed that the deltoid has but one-half the requisite strength or power of contraction to elevate the arm. So far as any use is concerned, this is practically the same as if no power of contraction were left in the muscle. But, if only the other half of the impaired vigor be supplemented by the carefully graduated assistance of the operator, the required movement will take place, and, in some cases, if this be regularly persisted in together with manipulation and percussion, more vigorous contraction will be gained, and, by-and-by, the patient will exert three-fourths of the necessary strength, and later the whole movement will be done without aid; and as strength increases, even resistance can be opposed to the movement. The importance of these measures can hardly be overestimated in cultivating the strength of weakened muscles, while at the same time finding out how much they can be used. Still another kind of movement deserves mention here, namely, vigorous passive motion, with a view to breaking up adhesions in and around joints. This is the secret of success and of failure of people who call themselves "bone-setters."

But movements must be considered more in detail. In doing a resistive movement in which the patient is the prime mover, the operator waits until he finds the movement begun, then he gradually increases the resistance to the utmost within the limits of the patient's strength, and finally slacks up more slowly. This must be practised upon well people until the manipulator can judge instinctively of the strength exerted, and make elastic resistance. The resistance must be in line with the movement of the patient, and the grasp of the operator must not be so firm as to interfere with his own or the patient's sensation. It will often be found that the patient uses nearly all his strength in contracting his muscles, and scarcely any in overcoming the resistance—a habit that apparently would not be easy to break. But it will only be necessary to tell him or her to move more quickly, and not try so hard. Here physiology steps in and gives us a reason for the faith that is in us, showing how science agrees with art. Muscular contraction presents three phases: 1. A preparatory or latent period, during which there is no visible movement when nerve and muscle are getting ready to act. 2. A phase of shortening or contraction. 3. That of relaxation or return to its former length. In harmony with these phenomena, and with the manner of doing each and all of the manipulations, and especially resistive movements, physiology teaches us that at the close of the latent period the muscle shortens in each fibre, at first slowly, then more rapidly, and lastly more slowly again. Hence it would be difficult to conceive of anything that would make graduated and harmonious resistance, save human power guided by human intelligence. Springs and elastic contrivances come nearest to it, and do very well on starting; but the longer the pull or push, the stronger becomes the opposing force, and there is no third stage of lessened resistance.

The manner of taking the hand to give it passive motion of flexion and extension, as well as to resist flexion, is the same. Let the hand of the patient be midway between pronation and supination, and then seize the hand as if to shake hands, the right hand for the right of the patient, and the left for the left, so as to bring the resistance on a line with the metacarpo-phalangeal joints, which affords the best leverage for both patient and operator; the other hand at the same time will support and make counter-resistance on the back of the arm, about an inch above the wrist. To resist extension of the hand, the patient's forearm should be pronated, then the operator will take the hand in such a way as to bring the resistance over the heads of the metacarpal bones, his right hand for the left of the patient, and the left for the right, while the other supports and steadies the arm above the wrist on the anterior surface. For passive pronation and resistive supination the manner of holding the arm is the same: the operator's right hand seizes the left wrist and lower ends of the radius and ulna of the patient, so that the metacarpo-phalangeal joint of his thumb is upon and behind the styloid process of the radius—the point of resistance—care being taken not to squeeze so tightly as to prevent these bones from rotating upon each other; and in the meantime the other hand of the operator gently supports the arm of the patient near the elbow. For passive supination or resistive pronation the same hold suffices, with the right hand of the manipulator for the right arm of the patient, the left for the left, which seizes the wrist and the lower ends of the radius and ulna, so that the metacarpo-phalangeal joint of the thumb is anterior to the styloid process of the radius, the same care being observed not to hinder the motion by grasping too tightly, while the arm of the patient rests gently in the other hand of the manipulator. In doing passive or resistive motion of the forearm, the right wrist of the patient is gently held by the right hand of the manipulator, or the left by the left, while the other hand steadies the arm just above the condyles of the humerus. The same hold and support also serves for the combined passive motion of flexion, extension, pronation, and supination, abduction, and adduction, together with rotation of the humerus; all of these seven movements being accomplished at one and the same time, by simply making the wrist describe a circle. Circumduction of the humerus is most easily and effectually done by standing behind the patient, and while fixing the right shoulder with the left hand above it, or the left with the right, the other hand takes the arm just below the elbow and makes this traverse as great a circle as moderate resistance will allow—the operator remembering that the greatest resist-

ance will naturally be met with at the upper and backward third of the circle, owing to the formation of the joint. The same hold and support answer well for resisting a forward motion of the upper arm. If the patient be lying on the right side, or the operator be standing in front of the patient while the latter is sitting, tolerably good circumduction may be done by taking the left wrist in the left hand and placing the right upon the elbow. But this is not so effectual as the first method, owing to the great mobility of the scapula. Backward motion of the humerus can be steadily and definitely resisted by taking the right hand of the patient in the right of the manipulator, or the left with the left, while the other is placed above and behind the elbow. The action of the deltoid in elevating the arm can be well resisted by steadying the shoulder with one hand while the other is placed on the outside of the upper arm, and the opposing force can easily be increased by moving the hand toward the elbow, or diminished by moving the hand toward the shoulder, the operator in the meantime standing behind the patient. When it is desired to limit motion to one joint, it will be observed that the proximal side should be steadied while the distal side is moved, and nowhere is this more disregarded than with the fingers.

For passive or resistive motion of the ankle-joint, the best way of taking hold is not by seizing the heel with one hand while the other surmounts the toes, as is generally done, but with the right hand for the right foot, or the left for the left, which grasps the metatarso-phalangeal joints at right angles while the other hand supports the limb just above the ankle. This affords the best leverage for flexing and extending the foot, as well as for a circumductory motion, by making the place of seizure describe a circle, the outer half of which will offer the greatest resistance, owing to the large internal lateral ligament, and the stronger structures on the inside of the joint. When alternately resisting flexion and extension of the foot, in the interval of change, here and for other joints, the hand of the operator must alter its position slightly so as to present a closely adapted surface for resistance. In the case of the foot and forearm the fingers will pull and resist flexion, and the heel of the hand will push against extension. On the foot the tendency of the operator is to make resistance too near the toes ; opposite the heads of the metatarsal bones and in the middle of the foot on the dorsum and sole are the points that afford the best and most natural leverage. By seizing the heel with one hand and holding the ball of the foot, as just described, with the other, a twisting motion can be given to the whole foot which acts more decidedly on the tarsal and metatarsal articulations. Flexion and extension of the leg at the knee, either passively or resistively, are seldom necessary to be done alone (except for some special reason), as they are accomplished so much better with flexion and extension of the thigh ; and for this purpose the right heel of the patient is taken in the palm of the right hand of the operator, or the left in the left, while the other hand holds or rather supports the leg by the calf, and a steady, uniform push is made, the limb, by its own resiliency, usually returning to a state of extension. Circumduction of the thigh will be performed by simply changing the hand that holds the calf on to the top of the knee, which affords excellent leverage for the manipulator and support for the patient. On each side of the forefinger of the hand that manages the heel the bed-covering should be held by the thumb and middle finger, so as to avoid the production of a draught. Resisting flexion and extension of the leg and thigh together can be done by holding the leg and foot as for passive or resistive movements of the ankle, and if the couch or bed in which the patient lies be low, the operator may not be able to accomplish this while sitting, but will require to rest the knee next the patient on the floor, and in resisting extension will throw the whole weight of his or her body against the extending limb, and in doing this the arm must not be extended, but flexed, so as to bring the hand near the shoulder in order that the resistance may be steady and strong. To resist extension alone, the operator can stand with his back to the patient and clasp his hands on the sole at the instep. Opposing abduction and adduction of the thighs is done by alternately placing the hands on the outer and inner aspects of the semi-flexed knees ; and to resist the contraction of the psoas magnus and iliacus internus alone, resistance may be made to the flexing thigh on any part of its anterior aspect.

Passive stretching of the arms and shoulders, of the pectoral muscles and latissimus dorsi, can be done agreeably and effectually while the patient lies squarely on the back, the head and shoulders being slightly elevated on an inclined plane. The arms of the patient are extended upward on a line with the body, and the operator, standing behind, seizes the hands and makes a gentle, elastic, and vigorous pull ; and, if the feet be held at the same time, a stretch of the lower limbs and trunk can also be obtained. The manner of seizing the hands of the patient for this purpose is worthy of especial notice. They are grasped so that their palmar surfaces obliquely cross those of the operator, the fingers of the operator surrounding the metacarpal region of the thumb, while the thumb of the operator passes between the thumb and the index-finger of the patient and the heel of the hand rests securely upon the metacarpal region of the little finger. This is a puzzle for most people to do, even after having seen it done. The same hold suffices for resisting a downward pull of the arms, which brings the aforesaid muscles more strongly into play, elevates the chest, and deepens inspiration. With the patient sitting slightly inclined forward and the hands clasped at the back of the head, the oblique and transverse muscles of the abdomen can be passively exercised by seizing the patient at or near the shoulder-joints and rotating the body, the manipulator standing behind the patient. The same position of the patient does well to make these muscles act more vigorously by opposing their voluntary contraction. In doing this the operator stands behind and to one side of the patient, to the side on which the hand grasps the upper arm at or near the elbow for leverage, while the other hand steadies the patient upon the opposite shoulder. In this way great leverage is obtained. At first patients will naturally err in limiting this motion to the arms and chest, but they can gradually be educated to lessen this and to increase the rotation at the waist. Upon a vigorous and healthy tone of the muscles of the abdomen depends, to a large extent, the welfare of the organs situated beneath them, and no muscles are so much neglected for want of exercise as these. Gentle rowing exercise for the muscles of the back can be given to invalids by standing in front of them and taking hold of their hands ; but for this purpose elastic tubes or straps answer well, for the weight of the body makes the pull strongest at its termination. Other manipulations and movements, passive and resistive, can be devised to meet the indications of different cases, and voluntary movements, with modifications, may be turned to good account as remedial agents. More will be said of these under the affections in which massage is of benefit. But in learning to do massage no amount of detailed descriptions can make up for the *savoir faire*, gumption, and rule of thumb that experience alone can teach, any more than one can become a skilful surgeon, an expert swimmer, or a good cook, by reading about such matters. A knowledge of normal and pathological anatomy and the usual course of diseases is essential in order to judge of the indications and contraindications for massage, to modify the manipulations, and to form an estimate of their effects.

Physiological Effects of Massage.—The pressure of massage exerts a simultaneous influence upon all the tissues within its reach—upon skin, fasciæ, muscles, blood-vessels, lymphatics, nerves, etc. Tough, flexible, and elastic, as the skin in its natural condition should be, owing to the white fibrous and yellow elastic tissue entering into its composition, it is rendered none the less so by a prolonged course of massage. On the contrary, while it becomes softer, suppler, and finer under manipulation, it also at the same time becomes more tough, flexible, and elastic, so that whereas, at the beginning of massage it could scarcely be gently pinched and grasped

without hurting, later on the patient will often delight in being almost lifted up by the skin like one of the agile domestic animals; thus showing also a marked change in its sensibility. The soothing effect of gentle stroking is familiar to everyone, and the anæsthetic effect of vigorous pinching so that a hypodermic needle can be inserted without pain is also well known. Insensible perspiration, when deficient, is increased. "Weynrich has shown that by the mechanical action of friction the excretion of water through the skin can be increased sixty per cent. or more" (*London Practitioner*, August, 1878). The sebaceous secretion is facilitated by massage, as is evidenced by the moisture and gloss of the hair after manipulation. For rousing the action of languid skin alone, friction, pinching, and percussion would commend themselves. In malnutrition from digestive, respiratory, and other disturbances, inunction has often proved an efficient means of furnishing nourishment to the system when other means have failed. The skin is in the best condition for absorbing oils toward the end of an application of massage, when its circulation has been thoroughly aroused. For this purpose a preliminary warm bath is of great aid.

The normal function of the superficial fascia in facilitating the movement of the skin over the subjacent tissues is favorably influenced by massage, especially when there exists a tough, *matted, hide-bound* condition; and this, if looked for, will be found as often in the human race as in the equine, indicating that there is neither swiftness of motion nor clearness and vigor of thought. Its diagnosis and removal are accomplished by the same means, and the superficial vessels and nerves that pass through this fascia are thus freed from the hindrance of pressure, besides being themselves acted upon directly. Grasping a convenient portion of skin, and slowly moving and stretching it, effects this object most easily.

A study of the natural functions of the human body, especially of the muscles, might teach one to use massage when they are in a state of suspension, abeyance, or morbid action. By their intermittent compression and relaxation, muscles in action exert a sort of massage upon each other. The ascent and descent of the diaphragm in respiration make continual massage and passive motion upon the organs above and below it, more especially of the abdominal and pelvic organs; and when its movements are limited from want of exercise or restrained by tight lacing, it is only too familiar how feeble are appetite and digestion and how constipated the bowels become. The voluntary muscles should receive about one-fourth of the total amount of the blood in the body, and their vessels may, with propriety, be considered as derivative channels for the relief of hyperæmic conditions of internal organs. Their action presents a great similarity to that of a beating heart, for at every contraction the blood is driven out of them, and by this it at the same time receives an additional impulse in its return to the heart, while at every relaxation the vessels are again allowed to fill. The parallel may be carried still further in order to point out a practical lesson; for the heart, which is abundantly supplied with blood for its own nourishment, lasts a lifetime usually without fatigue, though in constant activity, while voluntary muscles, if allowed to remain inactive soon suffer in size and strength, for the circulation will follow the paths of least resistance and go around rather than through them. Hence the importance of some measure that will overcome the evils of inactivity, that will at once attract the circulation to the muscles, and at the same time aid it in its return. This indication is better fulfilled by the intermittent pressure of massage than by any other known remedy, for plain common-sense, without elaborate physiological experiment, tells us that massage must make more blood go through the skin and muscles, and consequently less to the brain, spinal cord, and internal organs generally. Not that the effects of massage and exercise are alike in all respects, and that massage is only a substitute for exercise and nothing more, as some would have it, for voluntary exercise means exercise of the nervous system quite as much as of the muscular, and sometimes more; besides, the cases that are often benefited by massage are those of overtaxed brain and used up nervous energy, to whom exercise, in the ordinary sense, must only increase their exhaustion and who yet require a mechanical stimulus for their nutritive functions. True, a certain store of latent energy is necessary in order to undergo massage, but this is much less than would be required for voluntary exercise, were this possible. Fatigue is an indication that waste is greater than repair. Muscular fatigue from over-exertion or want of exercise is relieved by massage, which promotes a more rapid absorption of waste products and stimulates the tardy peripheral circulation, upon which weariness to a large extent depends, thus showing a marked difference between the effects of exercise and those of massage. Fatigue from mental straining is often relieved by the same means, which increases the area and quantity of the circulation in the external tissues of the body, and thus depletes the overfilled or relaxed cerebral vessels.

Zabludowski carefully watched the effects of massage upon three healthy persons. They were all living in the same house, under the same circumstances, and observations were made for ten days while they had massage, and also for eight days afterward. The muscular strength of all three increased during the massage. The weight of the one who was tolerably corpulent decreased, as did also that of the slender one, and, corresponding with this, there was an increased excretion of urates and phosphates. The weight of the one who was moderately nourished increased, and with this there was found a diminution of urates and an increase of sulphates in the urine. Massage of the abdomen excited the large intestine to powerful peristaltic action, and caused regular evacuations. The functions of life in general were elevated, and with an improved frame of mind there were also easier movements of the body. Appetite increased, and sleep was soft, gentle, and easy. These effects disappeared soonest from the moderately nourished person, and lasted longest upon the thin and slender one, though she had lost weight, while upon the moderately corpulent one they varied at different times.

Dr. Hopadzé has made similar observations. He estimated daily the nitrogen of the food, fæces, and urine, and found that the nitrogeneous metamorphosis in all four persons to whom he gave daily massage for one week invariably increased, and lasted for two weeks after massage. The assimilation of the nitrogenous substances of the food increased in all the cases, and lasted during one week after the massage. All the four subjects increased in weight during the week following the massage; but during the week of massage one gained in weight, two lost, and one was unchanged. During the week of massage the appetite of all four persons increased. Another series of observations showed that massage on the abdomen for ten minutes shortened the sojourn of the food in the stomach from fifteen to seventy-five minutes (London *Medical Record*, March 15, 1886).

Zabludowski has made some interesting experiments, showing how fatigued muscles are influenced by massage. After severe exercise a rest of fifteen minutes made no essential difference in the fatigued muscles, but after massage for the same period the exercise could be more than doubled over what it was at first. One person experimented upon lifted a weight of one kilogramme (two pounds eight ounces) eight hundred and forty times, at intervals of one second, by extreme flexion of the elbow-joint, from a table on which the forearm rested horizontally, and after this he could do no more. After the arm had been *masséed* for five minutes it lifted the weight more than eleven hundred times in the same manner as before without fatigue. The difference in muscular sensation was very striking after rest alone from work in comparison with that after massage. Afer six hundred lifts of two kilogrammes the feeling was that of unchanging stiffness, during, and after a pause of five minutes for rest; but after five minutes of massage the muscles felt supple and pliable.

Muscles of frogs were exhausted by a series of rhythmical contractions caused by an induction current. Under

massage they quickly regained their lost vigor more completely than by rest alone for the same time. Of the influence of massage on reflex irritability Zabludowski found by a series of experiments on rabbits that sensibility was lessened while the reflex action of the spinal cord remained unchanged (*Centralb. für die Med. Wissenschaften*, April 7, 1883; *Archiv für Klin. Chirurgie*, p. 374, 1884). Kroneker and Stirling have shown that muscles when fatigued can be tetanized by much less frequent irritations than when fresh and rested. A fresh muscle that receives six irritations per second passes gradually from its intermittent contraction into that of tetanic contraction. These will become less as fatigue increases. If the muscles are allowed to recover by rest alone for a short time, upon renewed irritation they very soon pass into a tetanic condition. If, however, during the same pause for rest the muscles have been *masséed*, then their motility returns, so that they have the power of contracting a great many times. These observers, therefore, consider massage as a perfect *perfusion*, bringing nourishment to the muscles and thoroughly removing asphyxiated juices. It was found that the sensitive nerves of the skin lost much of their irritability during massage; but over-irritation from vigorous massage might sometimes be useful. Upon testing the influence of massage over the irritability of muscles, it was unexpectedly discovered that irritability was diminished by massage. The contractility of the muscles was first exhausted by the secondary current, and after a rest of twenty minutes they again responded to the same intensity of current; but after having had massage for the same length of time the current had to be increased in order to make the muscles contract as formerly. My own observations, often repeated, teach me that muscles deficient in contractility give a much more ready, vigorous, and agreeable response to the will and to faradization after massage than they do before. In 1872 Weir Mitchell stated, on page 250 of "Injuries of Nerves:" "I have several times noticed that muscles which were previously sluggish, after being thoroughly kneaded would contract far more readily when faradized." The difference in these results may be harmonized by the fact that in Kroneker's and Stirling's observations the muscles were first exhausted by the secondary current, and they were not in the other cases.

The apparent mystery and contradiction of many elaborate physiological experiments need seldom arise if we only bear in mind that mild irritation produces symptoms of stimulation, and that when the same irritation is increased in severity, symptoms of exhaustion result. Gentle centripetal stroking, though soothing, is, in a physiological sense, a mild irritant to the superficial vessels, causing a narrowing of their calibre and a stronger and swifter current in them by reason of its stimulating influence on their muscular coat and vaso-motor nerves. The mechanical effect of centripetal stroking is to push along the returning currents, and the suction-power created by the collapsing vessels creates another force to aid the returning circulation. The outgoing or arterial current in the parts thus treated is, at the same time, momentarily impeded, an accumulation of blood and a dilatation of the arterial walls taking place on the cardiac side of the pressure. As soon as this is removed the increased volume of blood rushes onward with greater force and rapidity, owing to its sudden liberation, into the partially emptied continuation of the arteries in the neighborhood, and this is still further aided by the contraction of the dilated vessels. Here, then, we see that by this simple procedure the circulation is aided in six different ways, independently of the always acting *vis a tergo* of the heart's action. Let centripetal stroking, or any other form of massage, be continued sufficiently long or become strong enough, and hyperæmia results, indicating relaxation of the vascular walls, which may be attributed to over-incitation or exhaustion of the tone of their muscular coat and vaso-motor nerves. But the mechanical aid of massage in pushing along the returning current obviates retardation, so that in either case the ultimate result is an increase in the rapidity of the circulation in the parts manipulated, and hence there will be an increase in the interchange between the blood and the tissues, the work done by the circulation will be greater, and the share borne by each quantity less. In this manner the collateral circulation in the deeper vessels is both aided and relieved, as well as the more distal stream in the capillaries and arterioles. But the same pressure also acts upon the tissues external to the lymph and blood-vessels, causing a more rapid absorption of natural and pathological products through the walls of the lymphatics and venous capillaries, evidence of which is shown in the fact that an arm or leg of ordinary size is from one-eighth to one-fourth of an inch less in circumference after ten or fifteen minutes of massage, even when in the intervals between these applications increased growth is going on.

Exercise accelerates the action of the heart and diminishes blood-pressure. Massage also diminishes blood-pressure, but lessens the action of the heart in force and frequency. On reflection this is what might be expected, for natural obstacles to the circulation are gravity and the friction of the blood against the walls of the vessels, and these, working backward to the heart, have to be overcome at each systole of the left ventricle. These hindrances are by massage, both directly and through the medium of the vaso-motor nerves, in great part temporarily removed. The contracting hands of the manipulator are, as it were, two more propelling hearts at the peripheral ends of the circulation co-operating with the one at the centre, and the analogy will not suffer if we bear in mind that the size of one's heart is about the size of one's fist, and the number of intermittent squeezes of massage that act most favorably are about seventy-two per minute, or the usual pulse-rate.

In a patient who suffered from severe and constant pain in the calves of his legs Dr. W. W. Keen found an albuminuria of from three to fifteen per cent., which disappeared quickly on resting, but would reappear promptly on resuming walking. On examining the urine immediately before and after the patient had submitted to massage for forty or fifty minutes no trace of albumen was found. This would indicate the promotion of nutrition without such changes of blood-pressure and vaso-motor tonus as induced the albuminuria after voluntary exercise (Philadelphia *Medical News*, February 21, 1885).

Physiological experiments involving section of tissues are often too pathological in character to present a strict analogy between themselves and what must go on in the uninjured body under similar circumstances; but when they agree with clinical observation and common-sense they may be accepted as corroborative testimony. Thus we should judge of the experiments of Golz (Virchow's *Archiv*, Bd. xxviii., p. 428), in which, after the abdomen of an animal was opened and percussion applied to the stomach and intestines, the peritoneum at first became paler from constriction of the vessels, but on the continuance of percussion this was soon replaced by dilatation. When the percussion was first applied thoroughly over the abdominal walls, and these laid open afterward, it was observed that the vessels of the abdominal cavity, especially the veins, were dilated and distended with blood. The distention was due to relaxation of the vascular walls, caused by the mechanical irritation, and this might have been increased to the extent of paralyzing them. The heart's action was materially retarded, and this was ascribed to the reflex influence of the percussion upon the inhibitory action of the vagus and also to the sudden withdrawal of a great quantity of blood into the abdominal vessels. The heart of a frog was exposed and percussion applied to the intact abdominal walls; the pulsations of the heart gradually became less, and finally ceased. Respiration also became less frequent and finally ceased, and symptoms of motor paralysis were induced in like manner. Utilized in practice, then, brief percussion may be used to cause vascular contraction; longer continued, dilatation.

In the circulation of the lymph, as in that of the blood, pressure is an all-important element—compression, fluidity, and resistance being the conditions which reg-

ulate the mechanical function of the circulation. Besides the peculiar function of endosmosis the lymphatics are materially aided in their absorptive power by the pressure of the blood, by the natural elasticity of the tissues, and by the contraction and relaxation of the muscles. Now, it must be self-evident that all these forces can be increased to a much higher degree by the additional pressure of massage, which, being intermittent, does not hinder the circulation. The pressure of a fluid from endosmotic action alone can support a column of mercury at the height of six hundred millimetres (twenty-four inches), and certain soluble substances that will not ordinarily transude may be made to do so by increasing their pressure and rapidity of movement. Reibmayr inserted a small glass tube into the lymphatic vessel which accompanies the saphenous vein of a dog, and found that no flow of lymph took place through this so long as the leg was quiet; but as soon as the paw was moved or muscular contractions were excited, lymph flowed profusely from the tube. Centripetal stroking and kneading of the paw, although this was at rest, had the same effect. The flow, at first abundant, gradually diminished, and after a short interval increased again. Lassar had similar experience with the paws of dogs in which inflammation had been artificially produced. When the inflamed leg was manipulated or passively moved, lymph flowed abundantly from the divided absorbents, and this was much greater in quantity than that obtained from a sound leg of the same animal by like procedures. The flow was seven or eight times more plentiful than that from the sound limb, and in the latter case it was only obtained with greater efforts of kneading and passive motion. The swollen extremity diminished in circumference, and finally the flow ceased. Considerable time elapsed before lymph could be obtained again in this manner. From these experiments may be drawn the lesson that this limit must not be overstepped in practice, the sensations of the patient and the state of the affected parts usually indicating that the limit of benefit from a sitting has been obtained.

The classical observations of Ludwig, Genersich, and others on the structure and function of the lymphatics have materially increased our understanding of the effects of massage and movements. In their experiments on animals, where the flow of lymph through the thoracic duct was measured, it was found that passive movements increased the flow in a remarkable manner. Galvanization had a similar, but less powerful, effect. The alternate widening and narrowing of the lymph-spaces in the fasciæ contribute much to this result by the pump-like action thus exerted upon the absorption of lymph from the adjacent parts, and also its onward propulsion in the lymphatic vessels, the valves of which prevent any backward flow. But the lymphatics of fasciæ are not the only ones concerned in this function, as some would seem to have it, for it is evident that this influence must be in direct proportion to the abundance of lymphatics in organs submitted to it, and as these are more numerous in muscles than in fasciæ, the effect would therefore be greater on the former.

Not only is the effect of massage upon the rootlets of the lymphatics in the fasciæ and muscles of the greatest interest, as we have seen, but of quite as much importance is its influence also on the large lymph-cavities accessible to its intermittent compression, such as the peritoneal cavity, the synovial cavities, and the cavities of the sheaths of the tendons. The experiments of Reibmayr and Hoffinger, showing the increased absorptive power of the peritoneum under the influence of massage, support clinical results and are regarded as conclusive. Measured quantities of water were injected into the peritoneal cavities of rabbits. The animals were killed at the end of one and two hours respectively, and the quantity of fluid remaining was ascertained in each case, massage not having been used. The same quantities of fluid were again injected into the peritoneal cavities of rabbits, and the abdomen was kneaded for a short time every ten minutes. Some were killed at the end of one hour, others at the end of two hours, and the fluid remaining in the cavity of the peritoneum of each was ascertained. Though the natural absorbent power of the peritoneum is enormous, yet, under the influence of massage, these observers found that twice as much fluid was absorbed during the first hour as there had been without massage during the same time. But during the second hour only half as much fluid was absorbed under massage as without. The reason of this is apparent, though it has not been stated; for there was so much fluid absorbed from the peritoneum during the first hour of massage that there was but little left to be absorbed during the second hour. Altogether there was so much absorbed during the two hours of massage, that it amounted to thirty-nine per cent. more than the total absorbed without massage. The proportion absorbed in two hours under massage was 10.29; without massage 7.40; difference, 2.89 or a fraction over thirty-nine per cent. in favor of massage. (Reibmayr has made a mistake in his own figures in stating this difference, 2.89, as per cent.) These experiments, again, point out the lesson that there is a limit to the benefit of a sitting of massage beyond which it is useless to prolong it. But these observers should have given us a third series of experiments, showing the quantity of fluid that might have been absorbed during an hour of repose following an hour of massage, compared with the results of two hours with and without massage.

Lassar found that massage of the lymphatic glands, whether healthy or inflamed, caused large quantities of lymph to escape from them, while electrical irritation had no such effect. Into various joints of rabbits Professor von Mosengeil, of Bonn, injected a concentrated solution of Indian ink. Some of these joints he *masséed*, while others he did not, for the sake of comparison. The swelling that arose from the injection disappeared rapidly under massage, but remained stationary for some time in those joints not subjected to this treatment. After killing the animals the joints were examined. No ink was found in the cavities of the joints which had been manipulated; whereas, in those that had not been so treated the ink still remained mixed with the synovia, and it had not even penetrated into the tissue of the synovial membrane. Even when the examination was made soon after the injection and the use of massage, scarcely any ink was found in the joint; part of it was upon the synovial membrane, and upon microscopic examination it was seen that the greatest part had been forced into and through the synovial membrane, and the blackened lymphatic vessels could be seen even with the unaided eye from the injected joint to the lymphatic glands, and the latter were black from the absorption of the ink. A transverse section of the upper part of the thigh of the *masséed* limbs showed deposits of coloring matter in the intermuscular connective tissue and the crural muscles were stained black, while the limbs that had not been manipulated showed no such appearances.

Upon the nervous system as a whole massage most usually exerts a peculiarly delightful, and at the same time profoundly sedative and tonic, effect. While it is being done, and often for hours afterward, those who submit to it are in a blissful state of repose; they feel as if they were enjoying a long rest, or as if they had just returned from a refreshing vacation: it makes optimists of them for the time being. An aptitude for either rest or work generally follows, though usually those who submit to this treatment feel gloriously indifferent, and needless apprehensions are dispelled. Hence it has been recommended by high authorities "for certain melancholics with trophic and vaso-motor affections, and where dementia is threatened after an attack of excitement; for under this treatment mental comfort and a sense of well-being take the place of apathy and lassitude." Through the medium of the central nervous system, even local massage is radiated or reflected throughout the body, thus acting at the same time as a nervous and vascular revulsive or physiological counter-irritant, if one may be allowed this expression in contradistinction to pathological counter-irritants, such as blisters or rubefacients. Massage of the back alone will often relieve headache, and of the limbs alone will frequently put a patient to sleep.

But massage may be exerting a favorable influence upon nutrition in general while the patient is totally indifferent to the usual agreeable sensation accompanying and following its application. In such cases the nerves are, without doubt, insufficiently nourished, and may continue so, in spite of suitable food, tonics and ordinary exercise, until their languid circulation is aroused by massage. This has the same effect upon the vessels of nerves that it has upon those of muscles, and ultimately, though not so soon as in the case of muscles, the same result is obtained, improved nutrition, and with this improved function. Bearing in mind that the essential element of nerve-fibres, the axis-cylinder, is a delicate, soft-solid, albuminoid substance, possessed of a certain degree of elasticity, it must appear evident that pressure exerted by the alternate contraction and relaxation of the muscles upon nerves passing through, under, or between them, as well as the direct stretching of nerves themselves in every movement, must be of considerable importance in keeping up their normal tone. In the absence of this natural stimulus a still greater of a similar kind can be made to take its place by the intermittent pressure and stretching of massage, which should be of a uniform character, in imitation of muscular action, and this can be so much greater as the increase of pressure and extension made by massage are greater than the compression and stretching that the muscles in contracting make, plus the influence of the compression and extension of massage upon the cutaneous, subcutaneous, and other accessible nerves not directly squeezed and pulled by muscular contraction. Thus the patient gets the advantage of exercise without exertion, often a very desirable object.

The results of Tigerstedt's experiments on the action of mild forms of extension of nerves, showing that the irritability of nerves increases under moderate extension but declines when the extension is increased beyond a certain limit, were constant and satisfactory. Zederbaum has demonstrated that when sudden and heavy pressure is applied to a nerve its irritability is rapidly lessened, but when the same pressure is gradually increased up to the same extent the decrease in irritability is not so marked, and occurs more slowly. It has been found by Luderitz that motor nerve-fibres are more easily paralyzed by continuous pressure than sensitive ones. The quality of percussion, whether light or strong, seems to have an effect upon nerves similar to pressure applied in like manner. Tigerstedt's very careful experiments proved that light percussion increased the irritability of nerves, while slow and strong percussion produced exhaustion of nerves. Quickly repeated percussion increased the contractility of muscles supplied by the nerves thus operated upon, but if kept up for a comparatively long time exhaustion of the nerves resulted ("Researches of Dr. George W. Jacoby on Massage," *Journal of Nervous and Mental Diseases*, 1885).

Upon sensitive nerves percussion produces effects similar to those produced on motor nerves; when lightly applied, at first there is an increase of pain, which soon diminishes, then disappears altogether and gives place to complete loss of feeling. The more sensitive the nerve the less force and time are required to bring about these changes. This is quite analagous to the effects of percussion on the vascular system, which at first causes contraction and later dilatation, and if continued, symptoms of paralysis of the vascular walls. All this is in harmony with the statement that irritation, when mild, gives rise to symptoms of stimulation; when longer continued or increased in severity, symptoms of exhaustion.

It is a wonder that greater thermal changes are not induced by massage, for arrested force, such as friction, percussion, and compression, develop heat in the human body as well as outside of it. Cooling by radiation and insensible perspiration lessen these, so that they do not correspond to the usual comfortable warmth and glow that patients experience from massage. With those in whom the temperature is normal a change is not likely to occur from massage, whereas, if the temperature be a degree or so below natural, a rise to the normal, or very near, will usually follow. In nervous and hysterical women, with high or low temperature, Weir Mitchell often noticed at first a slight fall in the thermometer, then a fairly constant rise, and later, as the health improved, less marked changes. He found the most notable rise in those who had some organic disease and a natural liability to great changes of temperature.

Zabludowsky found that the *perception* of temperature was lessened by massage, though at first it was slightly increased. My own experience has shown me that patients are much more indifferent to extremes of heat and cold after massage than they were before.

The effect of massage in changing the response of muscles to electricity has already been mentioned. Further observations in this and other directions are necessary in order to show in what ways the natural electricity of the tissues is varied by massage, whether currents are changed so as to be in themselves beneficial, or whether the alteration of the natural currents may only serve as a good or a bad indication. It can be no longer doubted that changes of some sort do occur, for disturbance of natural electricity takes place whenever bodies are subjected to disturbance of any kind, be it friction, percussion, heat, or chemical action. The electrical properties of tissues are regarded as in direct proportion to the activity with which changes of matter proceed in them, and as massage produces rapid nutritive changes, it would be expected to proportionately alter the electrical properties of tissues. Even dissimilar stretching of the skin has been shown to give rise to electro-motive action. The palm of the hand has been found to be negative to the back of the hand, the whole hand negative to the elbow, to the chest, and usually to the foot; and currents are found to pass from the longitudinal surface to a transverse section of muscle, nerve, or brain, and during the contraction of a muscle or the activity of a nerve the natural current diminishes. But while there is no lack of evidence to show that currents are constantly passing in the tissues of one and the same individual, there is, as yet, no proof that electricity can be transmitted from one person to another. Those who claim to be able to impart their own electricity or magnetism to others are too ignorant to comprehend the one experiment that comes nearest affording them ground for their assertion. Thus, Rosenthal has shown that the power of the will can generate an electric current and set the magnetic needle in motion, simply by contracting the muscles of one arm while the other is at rest; the current then ascends in the contracting arm, and passes to the passive one, and this may be reversed if the passive arm be contracted while the other rests.

The manner of doing massage which I have described, one hand contracting as the other relaxes, would, as shown by this experiment, give the patient the benefit of the doubt as to whether a to-and-fro current could, in this way, be made to traverse the tissues manipulated, and thus combine a utilization of force with ease and efficacy of movement. Certainly, the way in which the so-called "magnetic doctors" work is not in harmony with this experiment, or the way of doing massage here described. But still the benefit, if any, that might be derived from this source would be so little in comparison to the other effects of massage, that it would be much better to take at once a definite quantity and intensity of electricity directly from a battery.

Hysterical women may, but are not likely to, be put into an hypnotic state by means of massage, just as they might in other ways, by gentle, prolonged stimulation of the sensory nerves of the face, or of the optic or auditory nerve. Heidenhain considers that in this condition there is inhibition of the activity of the ganglion-cells of the cerebral cortex, and that this is not due to anæmia reflexly produced by contraction of the cerebral vessels, for he induced hypnotism in one person during the action of nitrite of amyl, which dilates the cerebral blood-vessels.

Massage in Affections of the Nervous System.—Once for all, be it remembered that, according to the requirements of individual cases, massage may be of primary importance or of secondary importance, of no use at all, or even injurious. As to the range of its useful-

ness, experience and observation have shown that, at tolerably definite stages in one or more classes of affections in every general and special department of medicine, it has proved either directly or indirectly beneficial, or has led to recovery when other means had been but slowly operative or apparently had failed altogether. In what affections and at what stages may massage be beneficial? Briefly answered, for the present, in local and general disturbances of circulation, locomotion, and nutrition, either in their incipient stages or after acute symptoms have passed away. At the commencement of many affections local congestion and irritation can often be relieved by massage, and this may serve for cure or prevention of further mischief. In cases that have come to a stand-still or lapsed into a chronic condition, languid circulation can be aroused, waste products absorbed, and nerves and muscles nourished and strengthened.

Of late years massage has been considered of great importance in the treatment of neurasthenia, and often without very clear notions as to its relative value in various forms of this disorder. Neurasthenia is the background to the picture of nearly all diseases and injuries, whether of an organic or functional nature, but for our present purpose we will regard it from other points of view. First, there is the natural and not unpleasant fatigue the result of an active and satisfactory day's work, from which we recover by food and sleep. Then comes the fatigue from which we do not recuperate as usual, the fatigue of being overworked, worried, or "played out." Here rest and change of scene are of the first importance ; but if these are impracticable or without effect, tonics and sedatives may suffice. Before rest, change, or medication had been resorted to I have used massage in several cases of this class and found it to be the sole means of procuring them good sleep with resulting vigor of body and mind, so that they were able to proceed with their duties uninterruptedly and as easily as ever. Thirdly, there are the continually wearied, wakeful, and nervous business or professional people, with numerous and varying ailments, who have learned by experience that "the labor they delight in physics pain," and who find more relief in work than in rest. Massage will often put such on a higher plane of existence and give them a zest for work which they could not derive from any other source. But unfortunately the interest they gain on their stock of vitality in this way is apt to be used up as fast as it accumulates. Fourthly, there are the neurasthenics who are simply spoiled children, who have enough, and usually more than enough, to live on without work, who have little or no object in life, who can do what they please and need not do what they do not please, who take delight in telling of all the eminent medical authorities whose care they have been under without any benefit, and who are never happier than when they can be regarded as interesting by trying some method of treatment that is novel to them, in order that they may have the final satisfaction of saying that it did them no good. Massage in such cases succeeds no better than other remedies. Fifthly, there are those who, in spite of rest, change, and medication, have become chronic neurasthenics, the result of business reverses, overwork, worry, loss of relatives, disappointed hopes, or as a sequel to some affection that has occurred in some other part of the system, but which has passed off or become of secondary importance. If, in these, the symptoms point most prominently to spinal exhaustion—myelasthenia, where exercise easily tires and aggravates, massage will be of marked benefit as a tonic and sedative and corrective of morbid sensations, and will most likely be of curative value ; of less advantage, but not useless, in cases where the symptoms point about equally to easy exhaustion of both brain and spinal cord. In cases of cerebral exhaustion, cerebrasthenia as some call it, where, as a rule, physical exercise can be freely taken, this will be of greater benefit than massage. The value of the latter here is almost *nil*, and might be dispensed with unless it be for a luxurious *placebo* to fill up time and keep the patient from trying something worse.

More common with neurasthenics than with people in good health, is an inadequate conception of passing time. Even with the same person, at different times and under the same circumstances, time may drag along slowly and heavily ; at others, it will seem to pass so quickly that it is impossible to accomplish anything, even if working in the greatest hurry. Haste is generally a sign of weakness. In some neurasthenics the cause of wakefulness is doubtless due to a languid condition or want of nerve-force in the respiratory centre, so that lessened and shallow respiratory movements have to be suplemented by voluntary ones, and these require the patient to wake, for the *besoin de respirer* becomes so urgent that breathing can no longer take place involuntarily. Even in health excessive fatigue may prevent sleep. The cardio-inhibitory and the vaso-motor centres in the neighborhood of the respiratory centre may be affected by sympathy with the latter, or all of these may suffer from impaired nutrition, deficient nervous energy, or irregular blood-supply, as may other nerve-centres. For the relief of incorrect appreciation of time and frequent repetitions of waking at night, as well as for the majority of other symptoms of neurasthenia, massage has proved an efficient agent in my hands. In this and other respects its action is similar to the primary and agreeable effects of opium and alcohol in restoring tone to the respiratory centre and vascular system, without, however, the injurious after-effects of these internal remedies. After sleep from massage, in place of headache, drowsiness, and disordered digestion, the patient is refreshed in body and mind ; yea, more, massage will often counteract the disagreeable feelings that result from opiates or too free indulgence in alcoholic stimuli.

There are some people who are born neurasthenic, go through life neurasthenic, and die neurasthenic. Some of these never know that they are lacking in nerve-force, while a few similar cases do find out, from an occasional day of good feelings, or lucid intervals, if one may say so, that their customary vigor is far below what it ought to be. If this class could have massage for a long period, or all their lives, they would get a great deal more out of what makes life worth living for. There are those who seldom feel any lack of energy so long as they are occupied, but who have a hard struggle to rest and go to sleep ; and these are benefited by massage. Massage is often the only remedy for numerous and indescribable unpleasant feelings, and the subjects of these who have experienced the relief it affords crave its application as they do food and drink when hungry and thirsty. But most physicians know how fickle neurasthenic patients are ; for even while improving they will often suddenly give up treatment, for no apparent reason except it be that they are afraid of getting well.

In these and other cases where massage seems to be indicated, it may be given daily or every other day, locally or generally. If there be no apparent effect from this treatment at or soon after its application, it is well to repeat it daily, or twice daily, until the latent energies of the patient seem to be rousing, as shown by increased comfort, vigor, and sleep. Then the intervals between the séances may be lengthened, but not to the extent that the effects of the preceding manipulation shall have entirely passed away before another is administered. In some patients reaction is slow, and they feel better the day following that on which they have the massage than they do the remainder of the day on which it is given. In such cases, every other day is sufficiently often to manipulate. Massage of the back alone will often relieve fulness of the cerebral vessels and headache, and this repeated may be all that is necessary. Massage of the back and head will more frequently be used, but general massage is the best for the majority of cases. However, this must be used with care, for I have more than once defeated the object in view by overdoing massage on starting, when, as the sequel showed, fifteen minutes were all that the patient could stand with advantage. At the request of patients for a longer application, I have sometimes overdone the matter, though I had warned them beforehand, and, following the advice of an eminent physician, I have sometimes used massage too freely. The

argument often used, that massage can do no harm if it does no good, is a dangerous one.

The time of day at which massage should be given is in some cases of importance. When patients are not very weak, as a general rule I prefer the time of day at which they feel the worst, or just before this, so as, if possible, to tide them over this period. When patients do not sleep well, the later in the day massage can be done the better. To patients of nervous temperament who sleep well massage should not be administered in the evening, as it is very sure to make them wakeful; and this applies also to such as are otherwise well in their nervous system, but may require only local massage for a joint or muscular affection. These are usually so refreshed after massage that they do not feel the need of sleep. Patients may be benefited by massage when they are too weak to travel. It requires a certain amount of nerve-force to sustain life at its lowest ebb; more than this, to receive massage with benefit; still more, to be able to travel; and more than all, to exercise freely.

Massage is seldom disagreeable, even from the first, if sufficient tact be used. When, however, at its commencement it is unpleasant, it soon becomes acceptable, so that it is looked forward to as a luxury and a pleasure; and spots that are sensitive, tender, and painful to pressure, can gradually be encroached upon, and soon disappear. It is not unlikely that, as the quality of massage improves, the quantity often given to neurasthenics will be lessened. The fact that grease is so constantly and freely used where its nutritive properties are not indicated, in order to prevent chafing of the skin, is sufficient indication of the quality of the massage; and two doses of an hour to an hour and a half daily, as given in many cases, seem inordinately large and frequent, even to cases at absolute rest. When a patient is at all subject to the influence of massage, subsequent applications of the same force and duration as the first have an increased effect. It is but fair to say that the later massages may be much longer and stronger than the earlier, and, indeed, there may be no limit to the patient's acquired tolerance of, and pleasure in, vigorous and long-continued séances. They may end in useless luxury and indolence, unless there be a clear head and a strong will to push the patient along and supply the missing link between will and action. It is still a question to be decided, what the minimum of massage may be that will do the greatest good in any given case. Many a time I have relieved a tired headache, and put a wakeful patient to sleep, by ten minutes' massage of the head alone, when subsequent applications of longer duration, including both head and body, had no greater effect.

In recent times, as an auxiliary in the treatment of neurasthenia and impoverishment of the tissues in females, massage has won great credit under the direction of Weir Mitchell, and, following his example, also by Professor W. S. Playfair, of London, both of whom have succeeded admirably in combining the very natural remedies of rest, seclusion, food, massage, and electricity, so as to build anew the broken-down constitutions of many of these previously hopeless invalids. Professor Playfair calls them cases of "nerve prostration and hysteria," and mentions several who were cured by this combination of treatment after having been bed-ridden for six, nine, sixteen, twenty, and twenty-three years, respectively; and some of these were such sufferers that they had to be transported from their homes to London for treatment under an anæsthetic. In the therapeutics of these cases the first place is accorded to massage, which more than overcomes the evils of absolute rest, and soon enables patients to assimilate large quantities of food. The duration of the treatment is two or three months, and most of the well-selected cases recover. The best cures have been obtained in the worst cases of long-standing, bedridden, wasted invalids. No reason has been vouchsafed by either Mitchell or Playfair for these wonderful results. I think it is clear on the application of the principles of treatment which they themselves inculcate. These worst cases have had a long period of absolute rest, and in this have already undergone a great part of the treatment necessary to make them responsive to the remainder; while with those who struggte to keep up, growing worse at every effort, it is necessary to put them to bed and enforce absolute rest. From this combination of treatment Professor Playfair says he has had more satisfactory and surprising results than he has ever witnessed in any branch of his profession.

Writer's Cramp and Allied Affections.—Overuse of nerves and muscles, especially in fine work requiring a high degree of delicate co-ordination of individual movements and voluntary impulses, as in writing, sewing, knitting, watchmaking, playing the piano, harp, or violin, etc., gives rise to similar disturbances. So does also, but less frequently, excessive use of muscles in heavier occupations, such as painting, telegraphing, tailoring, shoemaking, blacksmithing, milking, etc., occasion like troubles of motion and sensation. Predominance of symptoms may be of a spastic, tremulous, or paralytic form, accompanied with extreme fatigue, pain, formication, hyperæsthesia, or anæsthesia, and thrills like those of electricity. There may be total inability to perform the accustomed movements, or if they be attempted, even but for a few minutes, the symptoms just named appear. The spasms may be of flexors or extensors; there may be rigidity or contraction of the muscles, local or general tremor. No two cases are exactly alike, as these symptoms are variously combined, and usually only called forth on attempting the work that has brought them on, while for all other purposes the hands and arms are well. As I predicted some time ago, we can now add another form of cramp to the list, namely, manipulator's cramp, the penalty of those who would do massage without knowing how; and the sufferer supposes that the trouble in his arms is owing to his having imparted so much of what he styles magnetism out of them to his patients—his conceit not allowing him to think that he is only suffering from an unnatural, constrained, and awkward manner of working. In recent and slight cases, good results, though few, have been obtained from galvanism; but the prognosis in general, from any treatment whatsoever, has hitherto been regarded as unfavorable, unless some objective points can be discovered as the source of the malady, such as neuritis, painful scar, or bad writing materials. In one case of Drachman's this trouble was due to a neuroma of the median nerve, which almost entirely disappeared under massage, and the patient recovered in two months with no other treatment. In another case of Gottlieb's, of nine years' duration, that recovered under thirty-seven massages, the objective symptoms were œdema of both arms and of the metacarpal spaces, and between the muscular interstices of the arms were spots of infiltrated connective tissue, painful on pressure.

The indications for the employment of massage in these cases could not be better expressed than has been done by Althaus, in referring to electricity in the following words: "A really effective treatment of scrivener's palsy must be an agent which is at the same time both tonic and sedative in its neuropathical effects; which must have the power of restoring the circulation of the blood in the suffering parts to its proper condition; which is capable of promoting the absorption of serous effusions, and will thus cause the nutrition of the maimed ganglia to be raised to a normal standard. Such an agent we possess in the constant current;" and I would add, often a more effectual one in massage also. Again, the following remark of Russell Reynolds, with regard to the effects of faradization upon nerves and muscles, applies with equal, if not greater, force to massage: "By stirring up the nerves and muscles of a limb, you may to a certain extent, act upon the other ends of the nerves that are in the brain and spinal cord, and so improve by careful usage the nutrition of the brain and spinal cord." Percussion is to massage what faradization is to electricity, and will often answer the same purpose; manipulation or deep-kneading is to massage what the constant current is to electricity, and the ultimate effects of each are very much alike. Instances of various affections are recorded in which massage has succeeded after electricity and other

means had failed; indeed, massage is seldom employed except as a last resort. The reverse of this may be true, but proof of it has not been put on record, that I can find.

When sufficient time for rest has been allowed in the cases under consideration, and in the absence of spasm, or when spasm of the flexors alone is present, in addition to manipulation and friction, which may be used at all stages, it will be found useful to give active or resistive movements, so as to bring systematically into more powerful action the opposing and less used extensors; for this would tend to restore harmony of action by a counterbalancing distribution of will, nerve, and muscular effort. To arouse the activity of the less-used extensors and their nerves, percussion would aid materially.

By means of massage and gymnastics, vigorously applied and often repeated, Herr J. Wolff has obtained better results than anyone else in the treatment of writer's cramp and similar affections. From 1877 to 1882 Wolff treated in this manner 277 cases. Of these 245 were writer's cramp, and 132 were radically cured, 22 improved, and 91 received no benefit. Thirty-two were cases of pianist's, violinist's, telegrapher's, and painter's cramp; and of these 25 were cured. In all 157 were cured, 22 improved, and 98 not cured. The duration of the treatment in the cases that were cured was from two to four weeks, and the séances were given twice daily, with exercises of bending and stretching, spreading and contracting the hand and arm, continued for hours until the hand was fatigued; and these were repeated until the patient was able to move each finger voluntarily in all directions. Elementary exercises in writing, prescribed and adapted to each case, also formed part of the treatment. Fixation of muscles by elastic bands, so as to give special exercises, was resorted to in some cases. The excellent results obtained by Wolff are vouched for by the highest European authorities—Billroth, Charcot, Esmarch, and others.

An analytical study of Wolff's cases has not yet been attempted by anyone. So far as I have had access to the details of his cases, the successful ones seemed to be characterized by *spasm and tremor*, and these were apparently not present in the unsuccessful ones. In three of my own cases, the results of massage and movements, and subsequently the use of electricity and injections of strychnia, were unsatisfactory, though the affected limbs became stronger, and uncomfortable feelings disappeared. They all arose from overuse. One was inability to write, another could not play upon the piano, and the third experienced great difficulty in telegraphing. Spasm and tremor were absent in these.

The advantages of massage and gymnastics, then, in the majority of cases of writer's cramp and allied affections, would seem to be removal of painful fatigue, spasm, tremor, weakness, inco-ordination of motion, feelings of constriction or tension, and disturbances of sensation. Hence, so far as we can judge, this method is capable, in many cases, of fulfilling therapeutical indications of the utmost importance, such as removal of increase and decrease of resistance in the paths of conduction, excitation, and motion; restoration of harmonious co-operation of individual movements, of natural conductivity and excitability, and of muscular sense and muscular effort—in a word, correction of underaction and overaction of muscles, nerves, and their central reflex apparatus. Impalpable trophic disturbances of the co-ordinating machinery in the central nervous system are regarded as the origin and predisposing cause of writer's cramp and such maladies. If massage excels galvanism in correcting these disturbances, as would seem to be the case, it must indeed be a remedy of rare value, and worthy of being used by the most skilful physicians. But just where lies the uniformity of Wolff's brilliant results no one has ventured to suggest. Evidently it is in tiring out the affected muscles and nerves, and their central connections, thus allaying overexcitability, which manifests itself usually in spasm. The same means incites nerves and muscles that are inactive, but to be beneficial in this case must evidently stop short of overexciting or tiring them out. Hence, the necessity of careful diagnosis and tolerable precision in using massage and movements in these cases. When peripheral nerves and muscles are less excitable than natural, there is absent or defective contraction. It is true of massage, in these and other cases, that one person may succeed with it where another has failed or even done harm.

Massage in Chorea.—Encouraging success has attended the use of massage and gymnastics in chorea, without much regard to the pathology or causation of the affection. It is generally agreed that the seat of this malady is for the most part in the brain, though the spinal cord and peripheral nerves may, and generally do, share in the disorder, which is of such a nature as to weaken the force of the nervous system without destroying it. If the erratic movements were due to organic disease of the brain or spinal cord, we should not expect much benefit from massage or any other treatment. Rest, massage, and abundance of easily-digested food have proved successful in the early or acute stage; in the decline of the malady, when slight irregular movements still linger, massage, exercise, and calisthenics have done well. Anæmia, chlorosis, rheumatism, endocarditis, etc., should, of course, be met by appropriate remedies. But "there are great difficulties," says Von Ziemssen, "in the way of forming a critical judgment of the activity of remedies in this disease, whose duration is so variable, whose course is always subject to spontaneous remissions, and which so often passes away quickly and easily without any medication." Nevertheless, the medical treatment of chorea is pronounced very satisfactory, and complete cure is the rule in from two to three months. Massage does better, if we may believe the published reports, and they are properly vouched for. In 1847 the staff of the Children's Hospital in Paris appointed Napoleon Laisné to use massage and movements in the treatment of chorea, and the result was reported to the Academy of Medicine by M. Blache, one of the physicians to the hospital. From this report the following is quoted: "One hundred and eight cases have been submitted to treatment by massage. Of these, 100 were in the first attack, at the commencement of the malady, and severely afflicted; 8 were on the decline. These were again divided into two categories—34 cases of medium intensity and 74 in which the agitation was as violent as it could be. The 34 cases of the first class were all cured in an average of twenty-eight days, with eighteen séances. Of the 74 more serious cases, 68 were cured in fifty-five days, with thirty-one massages. There remained 6 cases, which finally got well in one hundred and twenty-two days, with seventy-three séances. . . . After each séance an amendment was observed in the disorder, and calm sleep followed. Conclusions: 1. None of the methods of treatment of St. Vitus's dance has given so many cures as massage, either alone or with sulphur baths. 2. Massage can be employed in almost all cases, without being interrupted by the contra-indications which present themselves to other methods of treatment. 3. Cure is more durable than that obtained from baths, and the sedation shows itself from the first. 4. As the disorder declines, the constitution is ameliorated in a marked manner, and patients are cured not only of the chorea, but also of the anæmia which so often accompanies it. 5. The exercises are in no way dangerous. They are of two kinds: passive, when the will has no power over the muscles; active, when they can be done." One would infer from the report that no medication was used, but M. Blache says that analeptics ought to be employed with the massage.

The London *Lancet* for August 5, 1882, has an article, by Drs. Goodhart and Phillips, on the treatment of acute chorea by massage, and the free administration of nourishment, with rest in bed. Twelve cases were thus treated, and the advantages proved to be: that when the massage was carefully performed, flabby and thin muscles became plump and healthy; the various groups being manipulated in an orderly manner, some influence was undoubtedly exerted toward restoring more equable nerve discharges from the centres which control them, and dis-

pelling a disorderly habit by an orderly one; the supplies were utilized to their utmost and without any call upon the diminished capital of brain-power. Marked improvement was observed in every case in the following particulars: rapid subsidence of all the more violent movements; improved circulation and warmth of the extremities; the pulse fell and became more regular; the patients slept soundly after massage; they also decidedly increased in weight. The temperature, which is usually normal in chorea, Drs Goodhart and Phillips found to fall from 1° to 2° F. after massage. The amount of urea excreted was tested daily, but no increase or decrease could be found to correspond with the increased nitrogenous waste; systolic murmurs and *bruits* disappeared. Massage was given for fifteen minutes twice daily—much more sensible than the séances of an hour each, every three or four days, employed by Laisné.

In other irregular actions of nerves and muscles, massage has been found highly advantageous. Dr, Beyer, in the *Philadelphia Medical News*, April 11, 1885, reports a case of tonic spasm of the spinal accessory nerve, of central origin, manifested by obstinate contracture of the trapezius and sterno-mastoid muscles, that had existed for eighteen months, and resisted all proper treatment—such as nerve-tonics, and sedatives, electricity, and injections of atropia—that was effectually cured in nine weeks by massage and movements.

General massage is said to have given good results in hysterical contractions that have not yielded to any other means (Reibmeyer).

Massage in Neuralgia.—In neuralgia of milder form, and in what seemed to be the incipient stages of more severe attacks, as well as in old cases of neuralgia, where everything under the sun had been exhausted but massage, this has been tried, and it has not been found wanting in favorable results. Used between the paroxysms of severe neuralgic pains, massage generally lengthens the intervals between these attacks, and lessens the severity of them when they come on. Pain arising from disturbance in the central nervous system is frequently relieved by massage—whether this has any effect upon the cause of it or not. In peripheral neuralgia, where the affected nerves can be reached by massage, this ought to be much more effectual. If the view of Anstie be accepted—which would explain every neuralgia arising with or without apparent cause—that it consists in atrophy of the posterior roots of the spinal nerves in which the pain is felt, and of the neighboring central fibres and ganglionic cells, we must conclude that the sedative effect of massage reaches far beyond the region of its application. The opinion of Benedict, that at least all peripheral neuralgiæ are due to slight neuritis, does not necessarily conflict with that of Anstie, Either or both conditions may be present, but slight neuritis would be the more encouraging for the employment of massage. Evidently, the less neuralgia is dependent upon disorder in other organs the better is the prospect of relief from treatment by massage. Disturbances of sensation from too great tension or relaxation of the tissues offer favorable conditions for treatment by manipulation. When neuralgia is not in nerves too deeply situated, and has lasted but a short time, massage is considered by many as the best of all remedies. In well-marked degeneration of nerves, and when neuralgia is dependent upon mechanical pressure that cannot be removed, we would not expect any result. In the early and later stages of neuritis massage is indicated; in the early, it would act as a prophylactic, relieving congestion by causing a free circulation in the surrounding tissues, and by pushing the blood out of the distended vessels; in the later, by promoting absorption of inflammatory products. When the inflammatory process is on the verge of softening and suppuration, manipulation would be questionable. Impalpable disturbances of nutrition, and undue molecular activity or passivity, whether as cause or consequence of neuralgia, would undoubtedly be favorably influenced by massage. The repeated mechanical effect of manipulation and percussion upon old neuralgiæ, benumbs and lessens the sensibility of the nerve-filaments, and gradually decreases it. In other words, nerves that are already in a state of painful excitement may have this reduced by overinciting them, and thus wearing out their irritability. A temporary aggravation of pain is likely to occur at first, especially if light and rapid percussion be used; whereas if heavy, slow blows be given, an obtunding effect will probably set in at once. Massage, if used at all in recent and severe neuralgia, should be by means of gentle stroking, firm pressure, and slow, deep kneading, which will favorably modify the excitations of the painful nerves. Recent cases would seem to require more time for treatment by massage than old ones. Those in which failure from massage usually results, are cases where the constitution is run down and the mind harassed by cares. Neuralgia the result of anæmia and malnutrition, may be successfully treated by tonics, increased nourishment, rest, and massage.

It has long been recognized by Anstie and others, as a diagnostic feature of neuralgia, that, notwithstanding the existence of tenderness at the points of emergence from deeper to more superficial structures of the affected nerves, firm uniform pressure may not only be made here without aggravating the pain, but also very often with the effect of relieving it when rest alone would not, and pressure with the ends of the fingers in an uneven manner would aggravate. The wonder is that this hint has not been more utilized in practice in the way of massage.

Nerve excitation and vibration for the relief of pain and other morbid symptoms, by means of percussion, have recently become of renewed interest and importance, from the scientific and successful experiments of Dr. J. Mortimer Granville, of London. Acute or sharp pain he likens to a high note in music, produced by rapid vibrations; while a dull, heavy, or aching pain is regarded as similar to a low note or tone caused by slow vibrations. A slow rate of mechanical vibration upon the suffering nerve interrupts rapid vibrations of acute pain, while quick vibration arrests the slower ones of dull pain. By thus introducing discord into the rhythm of morbid vibrations, relief or cure in neuralgia is effected. This is accomplished by means of an instrument called a *percuteur*, which is so constructed as to give at will a slow or rapid rate of blows per minute. In a large number of cases, by this means the cerebro-spinal and sympathetic ganglia can be brought under control, torpid centres aroused to action, reflex irritability of subordinate centres subdued, and these centres placed under the control of the higher ones; the vibrations can be propagated along the trunks, and into the branches of the principal nerves from their centres of origin, or called into action reflexly by the afferent nerves connected with those centres. In no instance has this method failed to produce activity of the bowels, even when they had been previously obstinately constipated. It is necessary to determine as precisely as possible the particular nerve-branch in which the pain is located, and to act upon this alone. This treatment is said to fail if healthy or normally vibrating nerves are mechanically vibrated with those which are in a morbid state. The rationale of the process of relief is to overpower the tumultuous vibrations of the nerve-elements within their sheath. Dr. Granville considers the rate of speed of great importance, but admits that it can only be approximated in any given case by trial; for, when the pain of neuralgia is not quickly relieved by vibration, he considers that it is wrong to continue working at the same rate of speed, as it is likely to aggravate the suffering. Others do not consider the rate of speed of much importance.

Up to the year 1878 Johnson had treated by massage seventeen cases of neuralgia. Fourteen were sciatica, and eight of these were cured, four improved, and two unchanged. Three were neuralgia in other nerves, and they recovered. From twenty-seven to fifty-two sittings were required. These were recent cases. Berghmann reports three cases of apparently hopeless neuralgia that were cured by massage, when everything else had failed. One had suffered for five years from neuralgia of the trigeminus, and after ten days under massage the pain ceased entirely. One for four and one-half years from

severe pain in the ulnar nerve, and was cured in six weeks by massage. The other had had coccyodynia for two years, and after eight days' use of massage was well. Similar results are reported by others.

Massage in Affections of the Central Nervous System.—In peripheral paralysis massage will often hasten recovery, even after the affection has been at a standstill for some time. Just what Ross means, in his "Treatise on Diseases of the Nervous System," by saying that massage often succeeds in organic and functional paralysis, is not very clear. The benefits that might result from massage or any other remedial agent in disturbances arising from organic changes in the central or peripheral nervous system, will depend more on the nature of these changes than on the merits of the treatment. So many variations are seen in the course of paralysis of central origin, that the influence of massage in modifying these is difficult to determine, even if it were always judicious to make use of this treatment from the first. When paralysis of central origin has come on suddenly, I prefer to abstain from the use of massage until after the danger from inflammatory reaction has passed and the perturbation in general has subsided. But in the meantime, while thus waiting to spare the nerve-centres any extra commotion, peripheral pathological changes are gaining ground, which can later, in most cases, be only imperfectly overcome. These are, interference with the supply and return of the circulation, owing to the fact that the accelerating influence of muscular contraction and relaxation is absent or diminished—and, as a result of this, variation of temperature, usually below the normal, and passive hyperæmia or ischæmia; hypertrophy of interstitial connective tissue, with, at times, subsequent cicatricial retraction, giving rise to atrophy of muscular fibres and contractions; formation of adipose tissue, or fatty degeneration; in a word, vaso-motor and trophic disturbances. All these are rational indications for the use of massage, either as a preventive of these changes, or as a palliative of them when they have taken place. But if the nerve-centres are impaired beyond recovery, or secondary pathological changes have occurred, the prospect of benefit cannot be encouraging. My experience with massage in a number of cases of paralysis may be briefly stated by saying that, in the absence of severe pain, obstinate contracture, or tonic spasms, this agent has proved useful in improving the circulation, nutrition, and temperature of the affected parts. When, in paralysis of spinal or cerebral origin, recovery follows under treatment, we must conclude that the central disturbance had entirely passed away, and that the force of habit was the main factor that continued the external manifestations of inaction. But even here, when the causative conditions have ceased, paralyzed muscles will not at once resume their former natural condition. Massage and passive and resistive movements restore them to a sense of existence, enable them to recognize their latent power, and educate it to a higher degree. At the same time, such treatment affords the manipulator the only means of judging of the capabilities of the patients, and of telling them how they can be used. Sometimes it will be found that the patient can do better when his movements are resisted than when they are not. This seems to give a sense of support and consciousness of power. Only when there is partial impairment of motion will massage be likely to lead to recovery. This treatment, if used early in the cases referred to, would diminish the evils of inactivity upon the circulation and nutrition, and keep the muscles in a state of readiness for voluntary contraction. Dr. S. G. Webber is of the opinion that, in cases of cerebral hæmorrhage, the nutrition of the muscles would be benefited after a few weeks by massage; and later, after five or six weeks, electricity might be used.

In cases of infantile paralysis (*poliomyelitis anterior*), when there still remains slight voluntary motion, much benefit can be gained by massage and movements, even years after the attack. In such cases a warm bath is a good preparation for massage; friction and deep manipulation should follow; and if there be no motion at all, passive motion should be freely given; when slight motion remains, but not enough to make a complete movement, assistive movements should come into play; when there is more strength of motion than is necessary to move the part to which the affected muscles are attached, resistive motion within their strength should be used; percussion is of service when sensation, motion, and circulation are sluggish, but when there is a sufficient substratum of muscles to strike upon; when, however, there is passive hyperæmia, the less percussion is used the better. Cases are often seen where one group of muscles is paralyzed and atrophied, granting no response to the will, neither to the faradic nor slowly interrupted galvanic current, as, for instance, the anterior tibio-fibular group. Here, cultivating the extensibility of the opponent group with massage and vigorous passive flexion of the foot, together with resistive movements of the whole leg and thigh, made by opposing their extension with the hand or other opposing force at the ball of the foot, will be productive of benefit; for in this manner the posterior tibio-fibular muscles will be relieved from their continual state of contraction or retraction, the weak and elongated muscles will be shortened, and the innervation of both groups will be simultaneously increased. Medical gymnastics for weak, paretic, or paralyzed muscles, are based on the fact that exercise of adjoining intact muscles stimulates the innervation and nutrition of neighboring impaired ones, and skill in directing these efforts consists in finding out what patients are able to do, and in contriving means for their performance. Massage is of more value in the prevention than in the cure of contractures, stiffness, and anchylosis, whether of central or peripheral origin. In conjunction with elastic muscles which supplement the loss of power in paralyzed muscles, and assisted by mechanical contrivances to overcome contractures and to make tissues more amenable to restraint, massage proves useful. After section of muscles, when repair has sufficiently progressed, massage can be used to advantage for the restoration of mobility. Malgaigne has styled massage "the soul of orthopædic surgery."

Cases of locomotor ataxia are benefited by a course of massage from time to time. There is early, frequently after the first massage, improvement in the tone of the muscles, and later, disturbances of sensibility, anæsthesia, and paræsthesia disappear, and patients are but too apt to think that recovery may result. Before cutting down and laying bare a nerve-trunk in order to stretch it for the relief of the pain of locomotor ataxia, or for any purpose whatsoever, massage should be thoroughly tried, as the action of each procedure is somewhat similar to the other—releasing the nerve from the neighboring tissues that compress it, producing changes in its structure and circulation, and lessening its irritability, probably by over-inciting it. Massage makes repeated mild stretching, and might succeed when more violent stretching would fail. After violent stretching by exposing the nerve, Langenbuch makes use of massage in the vicinity of the wound; but it is not stated whether he or anyone else has ever tried massage before resorting to such extreme measures. He has operated in one hundred cases of locomotor ataxia, but no summary of results is given. Six cases out of sixteen are mentioned as being relieved of their pain and disagreeable feelings. The indications for the surgical operation of nerve-stretching are not clear, and evidently it must be done empirically. Langenbuch says: "I have operated in far-advanced cases, which to all appearances were very unfavorable—when the patient had not left the bed for two or three years—and have seen the patient get on his feet again; on the other hand, I have been able to accomplish very little in relatively early cases which had neither much pain nor any symptom of bladder disturbance." Hence the uncertainty of prognosis. Bardeleben disclaims all responsibility for the operation, and only does it when requested. He had obtained no good results "We can never know whether the nuclei of the affected nerves are destroyed, or remain so as to favor restoration of the fibres." Dr. Mortimer Granville has succeeded in relieving the pains of locomotor ataxia and of other affections by means of percussion over the affected nerves, and he thinks this

endeavor to bring about a natural condition ought to be tried before resorting to so formidable an operation as firmly stretching a nerve, which for the time being mechanically disorganizes it.

From a summary of the most recent and comprehensive views, gleaned by Eulenburg, from the experience of the ablest and most trustworthy observers of *progressive muscular atrophy*, we learn that the prognosis of this affection is generally unfavorable, but by no means absolutely hopeless; for the treatment of it has many successes to boast of. But in order to gain these, "*it is necessary to begin as early as possible, and to persevere with untiring patience as long as possible; absolutely nothing is to be expected from internal remedies. The only suitable and really trustworthy remedies are electricity and medical gymnastics.*" Undoubted successes, says Eulenberg, have followed the use of suitably localized gymnastics in this disease, and it is proper to say that we possess, in active and passive movements, remedial measures of especial efficacy for the interstitial changes within the muscles. In one case that had fallen under his observation the process of massage, to all appearances, brought the disease to a stand-still. Dr. S. G. Webber says that massage should be used from the beginning of the malady. In one case that came under my care the progress of the affection was certainly much retarded by the use of massage, for when all power of voluntary motion had ceased it would return after manipulation, and remain for hours.

In *pseudo-hypertrophy* of the muscles, which is considered a modified form of progressive muscular atrophy, inasmuch as the first stage of each consists of a chronic irritative process of the interstitial connective tissue, affecting secondarily the muscular elements, and hence defined by Friedreich, *a chronic myositis accompanied by interstitial hyperplasia of the connective tissue*, massage and hydro-therapeutics have been of value in some cases. In the initial stage of the disease they are of advantage, though at a later period success should not be expected, at least in the restoration of the affected muscles (Eulenburg).

Theory and practice do not quite harmonize in the treatment of locomotor ataxia, as compared with progressive muscular atrophy. In the former, rest is advocated; in the latter, massage and exercise. It seems hardly reasonable to urge on by exercise the degenerating cells of the anterior cornua in progressive muscular atrophy; while one would think that in locomotor ataxia the disease in the posterior columns and their vicinity, would be favorably acted upon by the derivative influence of increased activity of the cord called forth by such means as massage, exercise, passive and resistive movements. On the other hand, if the degenerating nerve-cells in the anterior cornua are benefited by functional activity, and the evidence is that they are, ought we not to expect that cultivation of the co-ordinative power would exercise a like favorable influence upon the co-ordinating tracts presumed to lie within the posterior columns? We are told by Mortimer Granville that, in the case of the blind who become ataxic, the muscular sense is so highly developed that it compensates for the loss of sight, and is not easily impaired even by paralytic disease; and therefore the distinctive symptom of ataxia is often wanting until an advanced stage of the disease. Could we have a greater argument than this in favor of massage and the cultivation of movements which improve faulty muscular sense?

Of the efficacy of external friction in diseases of the spinal cord and its envelopes, Professor Erb believes that he has *quite accidentally* proved to himself the benefits of such procedures, and is, therefore, unwilling to see them abandoned. "Friction with spirituous substances upon the skin," he says, "may excite and enliven the action of the spinal cord, and bring to pass a better functional condition and nutrition in it. The soothing effect upon the peripheral cutaneous nerves produced by inunction with warm oil or narcotic salves, has a soothing action upon the central nervous system, and this contributes to the removal of diseased conditions, and sustains the courage of the patient."

In hyperæmia of the brain and its membranes, whether owing to an increased flow of blood or a hindrance to the return of a normal flow, stroking of the neck, so as to hasten the current in the jugulars, has a rapidly depletory effect, similar to copious blood-letting or compression of the carotids, but without the possibly injurious effects of either of these. The pressure of blood in the cranium can thus be quickly lowered, and it has proved an excellent preparatory measure to the use of other depletory agents, cathartics, etc.

Massage of the Head.—To most people massage of the head is highly delightful; more agreeable, indeed, than on any other part of the body to which it is applicable, and in various disturbances as beneficial as it is pleasant. In order to account in great part for this increased comfortable sensation, we need only remember the acutely sensitive condition of the terminal filaments of the fifth pair of nerves, and that they will show signs of sensibility under circumstances in which no response could be elicited from spinal nerves. But massage of the head is seldom attempted, for manipulators are so accustomed to grasping muscular masses that, when they cannot do this, as on the head, they are apt to think that nothing can be accomplished. When manipulation of the head is attempted, it is usually in a way that would be better described by the word shampooing than by any other. Save when water is used for the purpose of cleanliness, such a procedure had better be omitted; indeed, most people would object to it on account of its "setting their nerves on edge." The soothing influence of gentle stroking is preferable. But the idiosyncrasies that cannot tolerate the following manner of doing massage upon the head are rare: With the patient in a semi-recumbent position in an easy-chair, the head inclined toward the side on which the operator sits or stands, at a suitable distance to give his arms free play, one hand will be placed over the temporal muscle, while the other, if the manipulator be a novice, will be placed on the frontal region to steady the head; then the pressure of the hand on the temporal region should be instinctively graduated to produce the greatest movement of the scalp and underlying tissues between it and the bone, without gliding of the hand and without hindrance to motion. Three or four manipulations will be made in this way and proceeded with step by step, the advance overlapping one-half of the region worked upon, until the occiput is reached, and the whole should be repeated several times. After this the other hand can be trained to make similar manipulations in an opposite direction, proceeding from the superciliary ridges over the top of the head, upon the occipito-frontalis, to the nape of the neck. A good *masseur* ought to be able to keep both hands going on these regions at the same time, one contracting as the other relaxes, without scraping, scuffing, shaking the head, or turning a hair. The manipulator, having done one side of the head and the region bounded by the occipito-frontalis, will find it most convenient to step to the other side of the patient and proceed as before. The back of the head can be more thoroughly *masséed* with the head erect; one hand steadying it on the frontal region, while the other makes manipulations in an oval direction with the long diameter horizontal. At the centre of the upper portion of the back of the head, where the hair sheds off in all directions, a special circular movement with the palm of the hand is agreeable, efficacious, and useful.

Upon tough scalps that cling closely to the skull, massage is very hard work, and all the available motion that can be gained will often be by means of the ends of the fingers, and this only of slight extent, proceeding in the same manner as when longer sweeps can be made. In such cases, when the hair is long and thick, by running the fingers through it close to the scalp additional support will be afforded, and this will secure more effectual manipulation by the palmar surfaces of the fingers. An excellent way to finish massage of the head is to place one hand on each side of it, and make simultaneous manipulations away from the median line, proceeding from before backward. The groove between the occiput and back of the neck should receive special

attention by accurately adapting the palmar surfaces of the fingers to it as far as the median line, first on one side and then on the other, and making upward and forward manipulations. With the thumb over the mastoid process, manipulation in a backward direction proves useful. The head can also be well manipulated while the patient is lying down, and gentle stroking with light percussion can often be added with advantage.

In *masséing* the face of a fat patient, the tissues can only be rolled and stretched under the fingers and palm, away from the corners of the eyes and alæ of the nose toward the angle of the lower jaw; but if the patient be moderately nourished or thin, the cheeks can be grasped between the thumb and fingers, and more thoroughly squeezed and *masséed* in the same direction. The eyelids can be effectually and agreeably manipulated by pinching them up with a rolling grasp by means of the forefinger and thumb, making the seizures at right angles to the orbicularis palpebrarum, and stretching the inclosed fold away from the canthus to which it is nearer. With one thumb closely adapted to the inner portion of the supra-orbital arch, and the middle-finger of the other hand a short distance below it on the upper portion of the nose, useful stretching in opposite directions, and away from the inner angle of the eye, can be made, and should be simultaneous. Moving the thumb one step farther along, so as to include the whole supra-orbital arch, all the tissues upon and immediately beneath this can be advantageously stretched upward and outward, at the same time that the lower lid is pulled down by one or two fingers of the other hand, by carefully graduated pressure upon the lower margin of the orbit. The alæ of the nose, one at a time, can be stretched and manipulated by covering the end of the finger introduced internally with a soft napkin. By putting the index-finger, still covered by a soft cloth, inside the cheeks, these can be squeezed, manipulated, and stretched between the finger and thumb, using care not to lacerate the bridles of mucous membrane.

If it be desirable to manipulate the head in giving general massage, ten minutes will suffice; but if the head and face alone require special massage, twenty to thirty minutes should be occupied. The benefits of massage of the head are as extensive as an injury to the fifth pair of nerves may be injurious. From a supra- or infra-orbital neuralgia, Brown-Séquard has pointed out that no less than eleven different affections of the eyes may originate. The subjective effects of massage of the head are, in general, extreme comfort, with a tendency to go to sleep, which, strange as it may seem, is equally consistent with an increased aptitude for mental work; freedom of respiration through the nostrils, and light, clear feelings take the place of dull, heavy ones. The objective effect is increased supplenesss of the scalp and outer tissues of the head; and this often precedes improvement of more important character, the most immediate and apparent instance of this being relief of congestion of the Schneiderian membrane and the ease of expelling tenacious mucus. The deep lymphatics of the face are derived from the pituitary membrane of the nose, and the fact that these, when they have been obstructed and congested, can be made more permeable by means of massage, will account in great part for the resulting freedom of respiration through the nostrils. Division of the fifth pair causes the nasal mucous membrane to swell, and so disturbs its nutrition as to destroy the power of smell, the passages becoming obstructed by accumulated mucus. Pressure of effete matters would seem to have a similar influence, but to a less degree, and this pressure can be removed to a marked extent by means of massage. Increased circulation in the external tissues of the head will also aid in relieving congestion in more deeply situated parts.

In the incipient stage, and between the attacks, of sick headache, massage proves beneficial. Besides its influence in relieving pain and headache of neuralgic, rheumatic, and sometimes of central origin, the most striking results I have obtained were in the relief of muscular asthenopia. My experience extends to but four cases, one an emmetropic, one a hypermetropic, one a myopic, and the last a myopic and astigmatic patient. They were cases of long standing, all in good health, and not in any way run down, and had had their refraction attended to by the best oculists. Massage of the head, and more especially around the temples, forehead, and eyelids, but not upon the eyes, produced marked and permanent improvement, preceded by returning elasticity of tissues. When these patients were asked to look upward while their lower lids were being pulled downward by pressure on the inferior margin of the orbit, they would make but feeble effort, owing in all probability to stiffness of the tissues beneath the eyeball, and weakness of the muscles above; when asked to look downward while the upper lid was being raised by pressure and extension upward on the superior margin of the orbit, the same feeble effort was observed, the eyes quickly turning upward, unable longer to bear the extension of the tissues above them. Such procedures are diagnostic and therapeutic at one and the same time, and no doubt clearly indicate that the condition of the tissues between the globe and walls of the orbit is similar to the indurated state found externally. By persevering with massage these discomforts and hindrances to motion were overcome, and the manipulation, which at first was disagreeable, became pleasant, restful, and refreshing. Upward and outward movements of the eyes, to relieve the weakened and overstrained internal and inferior recti muscles, were also directed.

European oculists have used massage with favorable results in affections of the eyes, mainly those of a chronic inflammatory nature of the anterior segment. The method employed has been that of Pagenstecher—moving the lids as quickly as possible under slight pressure in a radial direction, starting from the centre of the cornea; and after this by making circular friction by means of pressure upon the upper lid around and upon the sclero-corneal region. This was done for the purpose of removing hindrances to the circulation, by emptying the blood-vessels and lymphatics at the sclero-corneal margin, and thus promoting rapid absorption of exudation around them. Massage is contra-indicated when it is found to cause excessive injection, and especially if there be photophobia and lachrymation; and it must not be employed in the presence of iritis. In some cases it acted as a depletive, lessening the tension of the eye; in others as a stimulant, aiding the formation of new vessels, and thus proving beneficial when nutrition and absorption were torpid. Upon the vaso-motor nerves it exerted a stimulating effect, whereby a better contraction of the vessels resulted, though the immediate effect was that of dilatation; for after massage the eyes were still more injected, but on the day following were less so than before massage. The irritation produced by manipulation should be of moderate degree, and should disappear in half an hour. In such cases massage was used once daily from two to four minutes, and sometimes twice a day when it was well borne. Affections of the conjunctiva, cornea, sclera, and ciliary body were those in which Pagenstecher found massage applicable, namely:

1. Opacities of the cornea resulting from pannous keratitis, scrofulous superficial keratitis, and even parenchymatous keratitis. When, after corneal inflammation has subsided, the opacity remains stationary, massage re-excites a moderate vascularity and promotes removal of the opacity. 2. Chronic pustular conjunctivitis, especially in old people. In forms of chronic conjunctivitis in which there is a hypertrophic thickening of the membrane close to the margin of the cornea, occurring either as an elevated yellowish wall surrounding the cornea, or as one or more thick vascular papules, toward which large veins course from the conjunctiva. A form of conjunctivitis, chiefly caused by external irritation, in which the inflammation occurs in a triangle with its base at the outer, rarely at the inner, margin of the cornea, the membrane being swollen and of a grayish-yellow tinge, and the conjunctival and subconjunctival vessels swollen. 3. Forms of scleritis and episcleritis in which fixed nodules appear in or on the sclera, often accompanied with severe ciliary neuralgia. Constitutional treat

ment is required in addition to massage. Chronic episcleral inflammation, without iritis, leading, after long periods, to alteration in the tissue of the sclera. 4. Circumscribed affections of the ciliary body. In one case thus treated, a localized congestion of long standing in the upper part of the ciliary region, associated with extreme sensitiveness and pain after efforts at accommodation, was cured by massage (*Arch. of Ophthalmology*). The experience of Pagenstecher has been confirmed by other oculists, and among those in favor of this method of treatment in certain cases we find Professor Donders, Professor Mauthner, Professor Junge, and others. Yellow precipitate ointment was used under the lids with the massage in some of the cases.

Gradenigo states that a patient of his, who in the evening required narcotic injections, entirely replaced these by means of massage of the eyes. Diminution of tension resulted, and pain and disturbance of circulation ceased. He also found that decrease of tension occurs in healthy eyes from massage applied to them from two to four minutes (*Centralbl. fr. pr. Augenh.*).

In various forms of glaucoma, when far advanced, Schenkl found that the good effects of massage were only transitory, the diminution of intra-ocular pressure not lasting more than twenty-four hours. Secondary glaucoma was, however, an exception, for in such cases massage produced permanent improvement. He also obtained favorable results in hæmorrhage into the anterior chamber and into the conjunctiva (*Prager Med. Wochenschrift*, 1882). Professor Mauthner is of the opinion that, in the first stage of glaucoma, its dangerous progress may be arrested by means of massage ("Glaucom.," Wiesbaden, 1882). As a means of hastening resorption of the lens after *discisio cataracta*, Junge, Chodin, and Becker testify to the favorable influence of massage (*Centralb. fr. pr. Augenheilk.*, 1880). In blepharospasm massage has frequently proved effectual.

I venture the prediction that, in all probability, the best results will yet be obtained, in affections of the eyes appropriate for massage, by combining its local application with that of the head and face, whereby a much greater influence will be exerted upon the fifth pair, vaso-motor, and sympathetic nerves, and a better revulsive effect obtained than by massage of the eyes and lids alone.

Massage in Affections of the Ear, Nose, Pharynx, and Larynx.—In otology less than in any other branch of medicine, has massage been used. After healing of the incision for the evacuation of the contents of *othæmatomata*, massage has proved serviceable for the removal of the puckering and induration of the auricle, rendering its tissues of natural suppleness and appearance. Meyer says that no other method of treatment can prevent the resulting disfigurement of the auricle. He mentions three cases in which, after the incision had healed, massage and compression restored the auricle to its normal condition and appearance in one week (*Archiv für Ohrenheilkunde*, xvi,, p. 161).

Politzer recommends massage and centripetal stroking over the region of the mastoid process, in front of the ear, and upon the side of the neck, as a means of relieving the pain of *otitis externa* and furuncles of the external auditory canal, especially when other procedures cannot well be used; but incision and local applications should not be neglected. In these massage has a powerful depletive effect, diminishing the redness and swelling of the mucous membrane in the narrow canals of the auditory apparatus. In inflammatory conditions of the Eustachian tube and middle ear, the antiphlogistic effect of centripetal stroking of the neck has proved very efficacious in the hands of Gerst.

In catarrhal affections of the nose, of the pharynx, and of the larynx, Gerst has used centripetal *effleurage* of the exterior surface of the neck, which exerts an aspiratory force here as elsewhere, depleting the veins and lymphatics, and the results have exceeded his expectations. Up to 1879 he had treated in this way 21 cases of acute catarrh of the pharynx; 10 cases of naso-pharyngeal catarrh; 9 cases of catarrh of the larynx; 2 cases of catarrh of the larynx and pharynx in consequence of syphilis; 1 case of catarrh of the nose and of the pharynx, with ulceration of the nasal mucous membrane (*ozæna syphilitica*); 1 case of chronic catarrh and ulceration of the larynx in a patient with phthisis. In all of these cases, except the last one, Gerst's anticipations were "brilliantly fulfilled." In the acute cases, even after a single sitting, improvement was observed in the following particulars: decrease of redness and tumefaction of the mucous membrane of the eyes, nose, and throat; disappearance of feelings of heat and pressure; easier respiration; less burning sensation in the throat in laryngeal catarrh, and voice clearer; dysphagia and sensation of pressure diminished in pharyngeal catarrh; and the symptoms of hyperæmia of the brain, and congestion of the frontal sinuses, were also markedly lessened. Recovery ensued from repeated massage in astonishingly short spaces of time.

Massage in Joint Affections.—In various affections of joints, more than of any other parts of the body, massage has been used successfully. Those joints whose capsules are accessible to the immediate pressure of massage have responded most favorably, while the hip- and shoulder-joints, that are covered by muscles and are not so easily got at, have not yielded so readily. The effects of massage upon joints may be spoken of as local, revulsive, and sympathetic. It may be used to increase the circulation in and around a joint, or to squeeze congestion and exudation out of it with one hand, while the other pushes along the circulation in the veins and lymphatics above the joint; or the joint may be avoided altogether while the muscles above and below are *masséed*, thus making more blood go through them and less to the joint. It would seem as if the vascular and nervous supplies of joints had been prearranged for the favorable influence of massage upon them. With regard to the effect of massage upon the nervous supply of joints, the broad generalization of Dr. John Hilton is here of the greatest importance: "The same trunks of nerves whose branches supply the groups of muscles moving a joint furnish also a distribution of nerves to the skin over the insertion of the same muscles, and the interior of the joint receives its nerves from the same source. This implies an accurate and consentaneous physiological harmony in these various co-operating structures." Still another interesting fact concerns us at the present time, and that is the abundance of Pacinian bodies around joints, whatever significance this may have. When cramp can be localized the pain is mostly felt at the joints, and where pain can be severely felt, in tissues accessible to massage, there massage is most efficacious and agreeable.*

Tender and swollen joints that do not admit of massage being applied directly upon them can be approached by commencing on the healthy tissues above them, nearer the trunk, with gentle stroking in the direction of the returning currents of the circulation, and gradually proceeding downward. The healthy tissues beyond the seat of the malady should also be similarly treated, as the circulation is hindered in getting to and from them. Besides the soothing effect of this, which enables one to gradually encroach upon painful tissues without hurting them, the circulation is pushed along more quickly, so that exudations are carried off more easily. After working for a few minutes in this manner, deep manipulation should be brought into play, proceeding in the same manner as with friction, by beginning above the painful joint, and making the greatest pressure upward while gradually approaching the objective point, the peculiar anæsthetic effect of which is to lessen pain without decreasing ordinary sensation. We approach the joint as near as we can by alternate stroking and kneading, and then make a review on both the proximal and distal sides of it; and by repeated efforts of this kind, in the course of fifteen or twenty minutes we shall usually be able to make gentle, firm pressure upon the sore joint; and this pressure can almost imperceptibly have motion added to it, thus constituting massage properly so-called, by which effusions and exudations are spread over greater

* For experiments demonstrating the more rapid absorption of morbid material from joints under the stimulus of massage, see the Physiological Effects of Massage, page 652.

surface, pressed through the meshes of the areolar tissue as water is out of a sponge, and brought into more numerous points of contact with veins and lymphatics; and these are very materially aided in their resorptive functions by the pressure of massage. It should not be forgotten that, when a light touch is disagreeable, firm pressure affords relief. The folly of commencing massage immediately upon an inflamed region or recently injured joint, as is done by German physicians of otherwise good standing, must be apparent; for it hardly needed the experiments of Glax and Klemensiewicz to teach us that in an inflamed region the lymph-spaces are so choked by effusion poured into them, in consequence of the abnormal activity of the vascular walls, that their outlets become insufficient, the efferent vessels thus compressed, and the circulation impeded; so that pressure, exerted upon an inflamed region already suffering under partial compression of its efferent vessels, may injure more than benefit.

If the feelings of the patient be consulted, they would plainly indicate to us to begin the massage at a comfortable distance from an inflamed region, and gradually approach it, as the pain lessens and the swelling abates through open absorbents.

Recent periarticular effusions can thus be speedily dispersed and absorbed, while superabundance of intra-capsular fluid is pressed into the absorbents, the function of which within the joint is increased by the pressure from without, and by the acceleration of their current from the massage above the joint. In recent sprains and in synovitis this method is rational; it relieves the pain by removing pressure from terminal nerve-filaments; it reduces elevated temperature by hastening absorption, and thus removes the tension which causes lymphatic and venous stasis and exudation, and at the same time it increases the area and speed of the circulation in both occluded and open vessels. The relief to a joint, even after a single sitting of this kind, would hardly be believed unless felt or witnessed. The effect is enhanced by a bandage well applied after the massage; but the pressure of a bandage, though it acts as a support, is at the same time, by its continuous pressure, more or less of a hindrance to the circulation, and will not take the place of massage, which is an intermittent pressure and an aid to the circulation. In recent cases these procedures should be done once or twice a day. Patients are generally ready to recognize improved power of motion, and to make use of it. If they are not, the operator can easily judge, by means of passive and resistive movements, how much or little the joint is capable of, and encourage or restrain motion accordingly. In recent cases it is preferable that the patient manifest the first desire to move the joint, for it is often impossible to tell how severe the affection may be; but if the patient be not of a nervous temperament, sensations and inclinations can generally be trusted. The vast number of sprains of all degrees of severity that have recovered in from seven to nine days under massage, would seem to prove, either that rupture of ligaments, tendons, and laceration of muscles with effusion of blood into the joint, occur much less frequently than is supposed, or else are of much less serious import when treated by massage. After time for repair has elapsed, in order to gradually increase the strength of the muscles, as well as the confidence of the patient to use them, there is nothing better than resistive motion, alternately resisting flexion and extension, or other natural movements of the affected joint, while keeping the resistance less than the strength of the contracting muscles, so that the patient may not recognize any weakness.

When joints are lax and muscles flabby, in the absence of acute symptoms, vigorous, deep manipulation and percussion, with brisk, active, and resistive movements, followed by a tight bandage, are indicated; but passive motion pushed until there is a feeling of resistance should be avoided. With capsular and periarticular thickening, induration, and hyperplasia of an indolent character, kneading with one hand upon the affected structures and stroking with the other above them, will play the most important rôle, while increasing passive motion will be persisted in. In such cases as the latter, the leaving off of a bandage and encouraging active motion can generally be done with safety and advantage. As motion is impaired in all sorts of joint affections, it is well that the muscles on each side of them should be stimulated by massage.

Massage disintegrates newly-formed granulation-tissue, removes the stasis which it has occasioned, and presses the white corpuscles and transuded plasma into the lymph-current; at the same time the newly-formed capillaries that feed this granulation-tissue are ruptured and undergo retrograde metamorphosis, as well as the crushed mass, and thus the formation of connective tissue and the subsequent change of this into cicatricial tissue, which often causes pernicious retraction, is prevented or limited. Hyperplastic tissue firmly organized, solid like india-rubber, and not sensitive to pressure, is probably non-vascular, owing to its pressure upon and obliteration of the capillaries which previously nourished it. Upon such tissue I have seldom been able to accomplish anything with massage, though it is considered by Professor Billroth, Gottlieb, and others, that by vigorous perseverance in manipulation, impervious blood- and lymph-vessels may be reopened and absorption of the adventitious tissue promoted. Certainly the fibrous thickening of the capsule sometimes met with in chronic serous synovitis, which involves the synovial membrane and peri-synovial cellular tissue, must yield but slowly to massage, and still more slowly to time. While in hyperplastic synovitis with connective-tissue thickenings of the capsule, we would use massage with energy, for the same reason that, in trachoma of the conjunctiva, various irritants are used to induce congestion and thereby cause a retrograde metamorphosis of the sclerosed tissue, nevertheless, in more acute sensitive conditions, such as recent sprains and synovitis, massage should be used with great care and gentleness. In the former case it is employed as an irritant, to create a slight inflammation; in the latter as a sedative and antiphlogistic, in the manner already described.

In highly acute arthritis of any kind, massage would not be thought appropriate until the disease had assumed a subacute or chronic form. Then massage might be used with benefit, provided there were no solution of continuity, no true anchylosis, and no risk of hastening absorption of inflammatory products pernicious to the system. In disease of bone or cartilage, massage would be useless.

In 1877 I published an article in the New York *Medical Record*, giving the results of massage in three hundred and eight cases of sprains, joint contusions, and distortions, by seven independent operators—French, German, and Scandinavian surgeons—besides a few cases of my own to illustrate certain advantages of my method of treatment, already described, and which differed from that of the others. In these cases, which seemed to be of all degrees of severity, the average length of time for recovery was found to be 9.1 days, and this time would have been much less if the thirty-nine cases had been omitted in which massage was not begun until from ten days to three months after the injury. In many of the latter it is stated that other methods of treatment had failed, and these required, on the average, three weeks of massage before recovery resulted. A study of fifty-five cases treated in the usual manner, showed the average time of recovery to be 26.16 days, almost three times as long as similar cases treated by massage. The earlier after the injury manipulation was employed, the sooner recovery followed. The advantages of massage in such cases are more speedy relief from pain and swelling, and earlier and more perfect use of the injured joints than have been obtained by any other method. Dr. Beranger-Feraud, an old army surgeon, has given an account of four hundred sprains which he treated successfully by means of massage (*L'Union Médicale du Canada; Phila. Med. Times*, November, 1880). These are classified as slight, medium, intense, and complicated. The conclusion is that the nearer to the time of the accident massage is used, the sooner recovery takes place. A sitting ought to last

until all feelings of pain and distress have disappeared. Similar results have been obtained from the use of massage in sprains and synovitis by Gerst, Wagner, Zabludowsky, Faye, Starke, Körner, Huillier, Fontaine, Witt, Estlander, Norström, and others. In *Virchow and Hirsch's Jahresbericht*, Bd. i., Abth. 2, 1878, Johnson reports having obtained recovery by massage in five cases of acute serous synovitis; in 43 cases of chronic synovitis he obtained recovery in 34, and improvement in 9; in 89 cases of hyperplastic synovitis, 55 were cured, 30 improved, and 4 unchanged. In 15 cases of relaxation of joint-capsules, recovery resulted from massage in 14, and improvement in 1; in 3 cases of acute inflammation of the sheaths of tendons recovery took place, and in 6 chronic cases cure was also obtained by massage.

Heat and cold have each been used with good results in recent and old joint affections, sprains, and synovitis. Moderate heat causes a fluxion to the parts to which it is applied, dilates the vessels bringing the blood, as well as those returning it. If long continued, it causes undue relaxation; if of high temperature, it acts like cold in causing contraction of the vessels and counteracting vaso-motor paralysis. Hence the plan of immersing a sprain in water at the temperature of 70° F., and gradually increasing it to the extreme point of toleration, is excellent as far as it goes. But this is only a slight imitation of what massage does, for the intermittent, momentary compression of stroking and kneading causes a mechanical contraction and dilatation of the vessels (arterial, capillary, venous, and lymphatic) every time it is applied, from sixty times a minute and upward; and this is certainly sixty times oftener than could be caused by the variations of caloric in the same time. Moreover, the aid to the returning circulation by being pushed along by massage is much greater than that caused by heat, which tends rather to enlarge the area of stasis; besides, the pressure of the hand over effusions disperses them more rapidly than heat can.

If cold be used in the treatment of a sprain or synovitis, it is well so far as the reduction of heat, pain, and swelling are concerned; but in place of the seat of the injury being flushed and the returning currents hastened, as by massage, the flow of blood is lessened, and the outlets to effused products by veins and lymphatics are also rendered more impermeable in consequence of their contraction with all the other tissues that are cooled. Cold applications are not without danger, for they may convert inflammation into gangrene, and a less evil is that they may suspend nutritive action and hinder the process of repair to which moderate inflammation is necessary. In the *Journal de Médecine*, Bruxelles, for February, March, and April, 1877, Moeller has given us the result of Baudin's treatment of five hundred sprains by means of cold water. The average time for recovery was found to be twenty-eight and one-half days, or more than three times as long as that under massage.

Massage often proves useful in chronic effusions into the joints, whether painless or painful, whether dependent upon increased secretion or lessened absorption. In these cases there is generally thickening of the capsule. Barwell calls attention to the fact, and Billroth expresses himself in like manner, that frequent applications of blisters and stimulating embrocations often relax and injure the skin, producing therein a state of congestion, a passive hyperæmia, and thickening similar to the diseased condition they are intended to combat, but which they frequently aggravate, and that issues and moxas may inflict similar injury. After acute synovitis, and after lingering inflammation has been subdued, Barwell says that massage and passive motion should be resorted to in order to promote absorption of new-growths. He regards it as very valuable for superficial joints, as it often restores flexibility and perfect shape more rapidly than any other means with which he is acquainted.

Only from such a careful and distinguished author as Barwell is an opinion like the following, on strumous synovitis, of value: "We may only be called upon after the patient has suffered for some time; has been kept in bed with perhaps an issue that has been open for six or eight weeks, or possibly with no treatment at all. The joint will probably be found shapeless, swollen, pulpy, and perhaps painful; probably, particularly if the knee be in question, it will be a good deal flexed. Now, we shall in nearly all such cases find on examination, unless the disease has gone too far, that the whole joint may be manipulated without producing pain; that pressure upon the choice seat of tenderness will cause no expression of suffering, and that no startings or any acute pains disturb the patient's sleep. Even in such a case as this, we may in all likelihood cure the patient by first applying strong pressure, manipulations, rubbing, and passive motion. The condition into which the new tissue has fallen is simply a passive one; the material exists, but there is no action in it; perhaps there may have been an abscess which has left a sinus, but the suppuration is very sluggish; the rest of the tissue is doing nothing. If the granulations be allowed to remain in this passivity, they may, after some years, contract and consolidate even *in spite of such treatment;* but their more general course is to take on a retrograde action, gradually to yield to suppuration, and to involve the textures of the joint which they inclose. Our object should be, taking advantage of the passive state, to produce absorption of the jelly-like tissue. The painless condition upon pressure, and particularly of that spot which is the chosen seat of tenderness, is the proof that we may employ not merely pressure and massage, but passive motion; and we can, in a great number of instances, even after abscesses have formed, produce absorption of a large portion of the false tissue and consolidation of the rest. I desire to lay powerful stress upon this point of enforcing passive motion as soon as actual inflammation is checked, and mere vegetative cell-growth is the only action going on. Bonnet, the first writer who attempted to show the value of such means, has not limited its use sufficiently to the cases of which we are now treating. The contra-indications to this treatment are an active condition of the swelling, evidenced by pain and tenderness, any considerable amount of degeneration or suppuration, starting pains, and tenderness of the joint-surfaces" ("Diseases of Joints," pp. 150, 151). Billroth also recommends massage in torpid cases of *tumor albus*.

Periarthritis of the shoulder-joint, a subacute or chronic inflammation of the subacromial bursa and of the loose areolar tissue under the deltoid, with thickening and the formation of adhesions entangling nerves and tendons, hindering motion, and setting up neuritis, while the articular surfaces are in a normal condition, is a very stubborn affection, and worthy of the attention and study which it has recently received. Surgeons in large practice have expressed to me the opinion that it seems to be on the increase of late years. This would seem to indicate an increasing constitutional predisposition to the affection, besides the immediate causes, injury, rheumatism, catching cold, or prolonged immobility. The main impediment to motion apparently is the thickening of the walls of the subacromial bursa, which prevents the gliding of the superior extremity of the humerus under the acromion. Besides the muscles being atrophied from disuse, one fact, I think, has been overlooked, viz., that they are frequently in the state known as myositis—tender, sore, and indurated. It is generally agreed that the let-alone treatment of these cases allows them to get worse, and favors anchylosis. The most rational plan of treatment consists in the use of massage, passive motion, electricity, and douching. Massage and passive motion prevent the formation of adhesions, and loosen those that have already formed; therefore, in the early stage of this affection they may be both preventive and suffice to bring about recovery. After firm, deep adhesions have been broken up under anæsthesia, their renewed formation will be, in part or wholly, prevented by means of massage, and the immediate soreness of the tissues around the joint diminished, as in the case of a sprain; for this is really what the healthy tissues have to suffer while the adhesions are being ruptured. This will be more apparent when we call to mind that, with limited motion, growth has been going on in the tissues that are healthy,

so that some of them are shorter than natural. The full extent of motion and exercise compatible with firm adhesions can only be ascertained and cultivated by means of massage and passive motion, followed by active motion. For this reason, a course of this sort, preliminary to the operation of breaking up adhesions under anæsthesia, would seem to be commendable, so that muscular fibres that are glued together by lymph might be set free and so much relaxation gained. While using passive motion without anæsthesia, I have usually found that the muscles can be better relaxed and more strain put upon them and the adhesions, and these gradually stretched, by proceeding gently and tentatively, than by sudden and brisk jerking and pumping, which only makes the muscles contract all the more stubbornly in order to protect the parts from pain. In general, the result from treatment in these cases is far from satisfactory. The mobility of the scapula makes up in great part for the lack of success in restoring motion to the shoulder-joint, and this compensatory mobility can be increased by massage and movements. Cases of traumatic origin do the best under treatment.

Cases of joint trouble that give the least response to massage are those where no objective points can be found, though I have had good results from this treatment in neuralgia of the joints after all other methods had been tried with little or no benefit. Patients suffering in this manner will quickly place more confidence in the physician and his abilities, than he does in himself, if they can only see that he understands their cases; and he should make the most of his influence in encouraging gradually increased exercise, a most valuable preliminary and concomitant of which is massage. Rubbing by an automaton in such cases is useless, intelligence and will must direct and accompany it.

Bone-setting, So-called.— A patient with an old joint malady often goes to a *bone-setter*, as he is popularly called. No matter whether the joint be stiff or lax, enlarged or of normal size, the diagnosis is at once made that a bone is out. The patient looks sceptical, but the bone-setter does not care whether the patient believes him or not—he is confident that he can cure the joint all the same. Allowed to proceed, a sudden movement or two, accompanied by a snap, convinces the patient that the bone-setter was right, who tells him that was the noise of the bone going back into its place. He is told to use the limb and leave off his supports. This is attempted, and, if it is successful, then it appears as if a miracle had been performed, and the patient lets everybody he can know of it; but if not successful, or if the joint has been made worse, which is often the case, then be sure said patient keeps very silent on the subject.

A sudden movement of any joint, healthy or diseased, will usually cause it to snap; and if there be old adhesions, this is an excellent procedure. But the noise of adhesions breaking is different from that caused by a bone slipping in or out of place. Dr. Wharton P. Hood, of London, has well described the method of bone-setters in his book "On Bone-setting, So-called." But he himself makes these procedures applicable to too great a variety of cases. He states that the cases which bone-setters benefit by breaking adhesions, are those of joints in which there is a slight degree of mobility checked by pain, a spot tender on pressure, and an absence of acute disease. Now, these symptoms are also found in joints where there are no adhesions. An increased involuntary tension of the muscles occurs in joints that are injured or diseased, and the force of habit often causes this to continue after the joint itself is well. This involuntary tension keeps the joint in an irritable condition and limits passive motion, and hence the above symptoms. In some cases it may be sufficient to explain to them that they may relax their muscles by repeated voluntary effort; in others massage with gentle, persuasive, passive motion will greatly aid recovery. Later, in order to strengthen the muscles and to teach the patient how to use them, gradually increasing resistive motion is of value. It is a mistake to suppose that violent rubbing is of use in such cases; it begets reflex contraction of the muscles, and thus increases the evil it is intended to remedy; and it causes an intense hyperæmia and hyperæsthesia of the skin, besides chafing it. To avoid the last objection, and to conceal the ignorance of the manipulator, oily substances are made use of. Hood to the contrary, violent passive motion would not be appropriate for recent sprains, and seldom for rheumatic and gouty joints.

It is but a few years since the Italian peasant woman Dal Cin visited this country, and by reducing dislocations that never existed, made a great reputation among those who know nothing about such matters. One physician went so far as to give her credit for doing massage well, but neither he nor she have ever given the slightest proof that they knew anything about massage. In a letter from Dr. Chadwick in the *Boston Med. and Surg. Journal* of February 1, 1872, we learn that Dal Cin had for some time been astonishing the inhabitants of Vienna by her reputed vast number of wonderful cures of dislocation of the hip-joint. A committee of physicians was appointed to investigate her claims, and in every case seen by them there was no dislocation of the hip-joint, notwithstanding it had been pronounced a dislocation by her; and she proceeded to reduce it by placing one limb so as to appear shorter than the other, and after several indefinite, painless movements, by which she was supposed to be reducing the dislocation, she would place the limbs so that they would seem to be of equal length. The committee decided that she had not the most superficial conception of a dislocation, and that her manœuvres were done with the object of deceiving as to the comparative length of the limbs; and so she was obliged to go and practise elsewhere.

Reference to the surgical uses of massage would hardly be complete without mentioning that, in incomplete or "soft union" of fractures, when a fixed dressing alone has not brought about consolidation in due time, it is considered good practice to resort to friction of the fractured ends against each other, either by allowing the patient to walk about or by deliberate manipulation by the surgeon. This induces a condition similar to that which occurs at first in an ordinary fracture, and success will be more likely to accompany the renewed application of a fixed dressing. But when this and other methods, such as subcutaneous puncture, injections of irritating fluids, wiring the ends together, etc., fail or are objectionable because the fracture is in the vicinity of a joint, percussion over the fracture has been employed with brilliant results. This method has proved to be both safe and efficacious. It is done with a metallic mallet faced with india-rubber, for five or ten minutes at a time, every forty-eight hours or so, until pain, heat, and swelling show that active hyperæmia and a renewal of the reparative process have been set up. It is considered applicable only to cases of fibrous union where absorption and attenuation of the ends of the fragments, or eburnation, has not occurred, and where there is no constitutional dyscrasia.

In fractures near, and into, joints Dr. Championnière finds that immobilization is accompanied with decided dangers; whereas massage properly used acts well from the first, reducing the length of treatment materially. It can be used with other means. It relieves pain, favors repair, and prevents stiffness (*Revue de Thérapeutique Med. Chir.*, No. 15).

Massage in Rheumatic Gout.—It is to be regretted that our success in the treatment of this obstinate affection is not equal to our knowledge of its pathology. An ounce of relief, or an extra inch of motion is worth infinitely more to a patient than pages of information to the effect that the disease is a panarthritis involving cartilage, bone, and synovial membrane, ligaments, tendons, and bursæ, with thickening of the articular lamellæ, and thinning and alteration of the cartilages. Professor Senator, of Berlin, states emphatically that, "it is important in all forms of this disease to maintain the functional activity of the affected joints, as far as possible, by means of active and passive movements. Absolute rest promotes stiffness of the joints, fixes the limbs, and atrophies the muscles." In using massage

and passive motion in these cases, long and frequent visits and arduous work are necessary, but, in my experience, amply repay both patient and physician for time and trouble expended. Led on by gradual improvement from the use of massage in five out of six cases of well-marked rheumatic gout, I kept up this treatment until unlooked-for results were obtained, so that four of these cases regained tolerable use of the affected limbs, and in one recovery seemed to take place. Professor Gussenbauer, of Prague, reports one case, Berghman and Helleday report three cases, Cronfield one case, and Balfour, of Edinburgh, two cases of rheumatic gout treated by massage and movements, with results similar to those I have obtained; and only one of these had a disappointing relapse. The mode of procedure, in my cases, was deep manipulation without friction or inunction, passive motion as far as pain would allow, and sometimes farther, and resistive motion as soon as it could be done. If pain disappears soon after it is caused by any of these operations, it may be disregarded; if it lasts for several hours and increases after subsequent efforts, they must be suspended. Kneading with one hand, so as to break up indurations or disperse effusions, while the other hand pushes along the circulation in the veins and lymphatics above the joints, is often a good procedure, and quickly leads to the absorption of products not too firmly organized. Blisters and powerful derivatives in the neighborhood of joints affected with rheumatoid arthritis are considered more likely to promote than to retard the affection, according to Senator and others. Massage of the adjacent skin and muscles acts as a physiological derivative, and raises nutrition to a high degree by a rapid interchange of materials, owing to the area and speed of the circulation being increased, and obstructed lymphatics and capillaries made permeable. In this manner the soft structures may be made to adapt themselves to nodosities and deformities that cannot be removed. When the disease is very active, or the muscles fattily degenerated, the tendons frayed out and thinned, and loose cartilages in the folds of the fibrous membrane, or when bony anchylosis has taken place, we would not expect anything from massage. All of my cases had been well-nigh rubbed to death in the ordinary way, besides having exhausted the resources of the materia medica, baths, mineral springs, and electricity, before coming to me for massage.

Chronic articular rheumatism has also given like favorable results to massage.

Massage in Muscular Rheumatism.—The symptoms usually designated by the somewhat vague and unsatisfactory expression, *muscular rheumatism*, whether occurring in those who are rheumatic and suffer more or less from rheumatism, or occasioned by injury, sudden or violent strain, excessive fatigue, or catching cold, almost always disappear in a very satisfactory manner under treatment by massage, when the affected muscles and fasciæ are accessible to touch and pressure. The term myositis would be more appropriate for the majority of these cases, and would be in harmony with what we know of somewhat similar disturbances affecting involuntary muscles, as myocarditis and chronic metritis; and at the same time it would indicate more clearly the nature of the malady and the treatment required. In recent cases of myositis massage acts directly, by squeezing the congestion out of the affected tissues and promoting absorption of exudation, thus removing hindrance to the circulation and pressure upon terminal nerve-filaments. It also sets free muscular fasciculi from minute adhesions, which are the cause of partial, irregular, and painful contractions. Indeed, all the local requirements are met by massage, and not infrequently at a single sitting. M. Martin, a surgeon of Lyons, cured his confrère, M. Petit, of an acute lumbago at a single sitting of massage, and he says that he has collected over a hundred cases of this kind, but recommends that massage be repeated in order to confirm the cure (Estradère, "Du Massage").

In chronic cases of muscular rheumatism or myositis, where proliferation and induration of the connective tissue have taken place, with secondary atrophy of muscular fibres and consequent interference with motion, circulation, and innervation, massage will naturally take longer time; but the result, in promoting absorption and bringing about a natural state of nutrition and elasticity of the affected muscles, is no less satisfactory than in recent cases. The feeling of the affected muscles in old cases, where they can be reached by manipulation, is peculiar. It is neither the semi-solid condition of relaxation nor the elastic hardness of contraction, but like strands of whip-cord, with here and there hard nodules, sensitive to pressure. Pressure of the affected parts of the muscles upon adjacent nerves may cause more pain in the distribution of these nerves than is complained of at the seat of the myositis. Indeed, the same pathological conditions may also affect nerves and their sheaths. But alteration of consistency cannot always be detected, even in muscles that can be easily felt; and the same subjective symptoms may be complained of in muscles that are weak, lax, and flabby, probably owing to neuralgia of the intra-muscular terminations of sensitive nerves from lack of nutrition. Here it would only be a question of improving nutrition, which may be done by massage and exercise. In either case, a natural consistency of the tissues can be again brought about by manipulation and movements.

Of thirty-three cases of myositis, of spontaneous and traumatic origin, treated with massage by Johnson (*Virchow and Hirsch's Jahresbericht*, 1878), eighteen recovered, fourteen improved, and one was without result.

Dupuytren's finger contraction, consisting of hyperplasia and induration of the palmar fascia, the result of slight injury and reflex nervous irritation, has, in some instances, been successfully treated by means of massage. Dr. Sayre says that by this means alone he has secured excellent results in two cases, without resorting to any operative procedure whatever. In one recent case of elephantiasis that fell into my hands, recovery resulted under the use of massage, elevation of the limb, and tight bandaging. Professor Von Mosengeil, of Bonn, has had similar experience with two cases of elephantiasis. The duration of treatment in these cases was from five to six weeks.

The œdema and superabundance of callus sometimes met with after the union of fractures, can both be speedily lessened or removed by the use of massage, at the same time that the circulation is improved and the muscles restored to activity. But when œdema is dependent upon disease of the heart, liver, or kidneys, or an altered condition of the blood, massage will not prove curative, though it may afford temporary relief.

Massage in Scoliosis.—In lateral curvature of the spine, due to weak muscles—habitual scoliosis—Dr. A. Landerer, of Leipzig, has obtained unexpectedly favorable results from manipulation, percussion, and remedial movements, without spinal supports. In the *Deutsche Zeitschrift für Chirurgie*, Bd. 23, 1886, he has reported the results of this treatment in twenty cases. Most of these were in the early stage and recovery was obtained within two months. Later, when the spine had become fixed, the aches and pains disappeared speedily under massage. In the discussion which followed the reading of the report, Herr König, of Göttingen, admitted that this method was better than that which he employed; yet he would not entirely give up the use of the corset. He would limit the support of the latter to the time that the children are in school. It was conceded that the rapid improvement of degenerated muscles in these cases was due to vigorous percussion.

Massage of Internal Organs.—Though internal organs are not so accessible to the influence of massage, yet good results have been gained from its use in hastening the absorption of pleuritic effusions, in lessening hyperæmia of the liver, in relieving atony of the stomach and intestines, in the removal of intestinal obstruction, and also in atonic and hyperæmic conditions of the uterus, as well as in the removal of indurations and adhesions around this organ. In the *Allgemeine Med. Central-Zeitung*, No. 20, 1885, Dr. Emil Schlegel has reported several cases of pleuritic effusion where the absorp-

tion of the fluid was accelerated by percussion upon the chest-walls. For this purpose the ulnar border of the hand was used, striking at the rate of two blows a second, or six hundred in five minutes. Two sittings were given daily. Schlegel believes that percussion might be quite as useful in promoting absorption in other portions of the body, such as the intra-cranial cavity, spinal canal, etc., which are not directly accessible to manipulation.

While in health, natural movements and ordinary exercise suffice to keep the liver in good condition; yet, when this organ becomes hyperæmic, these are of necessity lessened and inefficient. At every meal there is an increased flow of blood to the liver, and from over-feeding there may be too great a determination of blood to this organ, the portal vein being too much filled and all the digestive organs overtaxed. When this state of affairs has been too long continued without anything to counteract it, there may result hepatic engorgement, the treatment of which by the douche and massage has been successfully carried out by Dr. Durand-Fardel, Director of Vichy. Simple engorgement of the liver is susceptible of resolution after long duration, though its persistence may lead to the belief that hypertrophy or induration has replaced it. Of 133 cases noted by Dr. Fardel, 43 were said to have followed upon acute attacks resembling hepatic colic; 72 developed gradually, and 18 in a latent manner, their advent being masked by dyspeptic symptoms. The time-honored treatment at Vichy has comprised simply baths with the internal use of the waters. Fardel has added to these massage and douches over the hepatic region. The abdomen is first kneaded altogether, after which the hand is gently passed over the hepatic region, the skin of which is first squeezed and afterward the deeper parts worked, and this is alternated with percussion by the palmar surfaces of the fingers, and finally the liver itself is kneaded, its lower edge being raised and seized by the hand. The operation takes from five to twenty minutes, and is repeated every other day. Buoyant feelings result, and the massage is agreeable while being done. Intercostal neuralgia is not a contra-indication for massage as it is for the douche. By massage the liver is emptied of its fluids as water is squeezed out of a sponge, the circulation is favorably acted upon, and absorption hastened. In most cases this treatment is satisfactory, the general condition of the patient improves, and the dyspeptic symptoms disappear. The entire treatment of these cases may last for several years, but what is gained at each visit of a month or so is retained, and the majority of the cases ultimately recover.

In poorly nourished people who gain flesh under massage and feeding, no small part of their improvement is doubtless due to the influence of massage over the region of the liver by which its functions are stimulated; for the bile aids the gastric juice in emulsionizing fats and preparing them for digestion; besides, its presence in the intestines excites their peristaltic action, as do the immediate and remote effects of massage. Obstruction of the excretory gall-ducts from catarrhal swelling, or collection of mucus, might sometimes be relieved by means of massage squeezing out the contents of a distended gall-bladder, and thus pushing the obstruction before it. In the disappearance of icterus and the sudden improvement that sometimes follows examinations of the liver, this is probably what has occurred.

As a preliminary to the solution of biliary calculi, fracture of the crystals must occur. Nature ordinarily effects this by the movements of the chest-walls and of the abdominal muscles causing more or less attrition and breaking of the corners and edges of the crystals, and thus permitting more readily the solvent action of the bile. This object may be aided by manipulation of the gall-bladder through the walls of the abdomen. Faradization has been used for this purpose, but massage carefully used would act much more directly. For attempting the disintegration of an impacted biliary calculus, Professor Bartholow recommends that firm friction be made with the fingers along the inferior margin of the ribs toward the epigastrium and umbilicus, while the opposite side, posteriorly, is supported by the other hand spread out and firmly applied.

Atony of the muscular coat of the stomach or intestines, with deficient peristaltic action and consequent disturbance of digestion, accompanied with distention from flatus or solid contents, is usually benefited to a marked degree by means of massage, after ordinary exercise and other measures have failed. When the alimentary canal is distended by gas or overburdened by solid contents, the nutrition of its walls must suffer from languid circulation, as any muscular organ would that was continually stretched and inactive. Here massage increases the circulation and, at the same time, pushes along the contents of accessible portions of the stomach and intestines, besides directly stimulating the muscular fibres to contraction and reacting on the nerve-centres, thus improving function and organization. That benefit is more likely to result from repeated treatments than as an immediate effect, would show that the nerve-centres that preside over these functions have undergone a nutritive change which has taken time to produce, and hence that the improvement would most likely be lasting, as it usually is.

It is customary to dismiss the subject of massage in intestinal obstruction by saying that it does no good and only wastes time, without bringing forward any evidence in support of the same. If all accounts be true, and they are properly vouched for, massage in such cases has often had the effect of rendering unnecessary a grave surgical operation, the propriety of which is always doubtful in view of the great uncertainty of success in thus endeavoring to relieve cases of intestinal obstruction. At a meeting of the Royal Medical and Chirurgical Society, which was reported in the London *Lancet* for December 18, 1875, Dr. Brinton pointed out that, of six hundred cases of intestinal obstruction, forty-three per cent. were due to intussusception, and that of these from thirty to forty per cent. terminated favorably. Dr. Brinton stated that the operation of gastrotomy for the relief of these cases is only of value in the earlier stages of the affection, when the condition is one of obstruction and not of enteritis. In the London *Lancet* for July 27, 1872, is given "a full account of a case of intestinal obstruction of five days' duration, cured by kneading after injection per rectum." To the right of the umbilicus and above it, there was distinct hardness, which gave the impression that a transverse coil of the bowel could be felt above, bending upon a vertical one below. The vomited matters were brown, with flocculi of a darker color, but not stercoraceous. Anodynes, hot fomentations, and injections had been thoroughly used, but no relief was obtained until the abdomen was kneaded by Surgeon Brookhouse; and the report further says that "it can hardly be doubted that the life of the patient was saved by the kneading of the belly; and so satisfactory an issue may well encourage other surgeons to adopt a similar procedure."

Dr. C. P. Putnam has reported a case of intussusception of the large intestine in a child five months old, successfully treated by injections and massage. Massage was applied to the tumor to lessen the hyperæmia and œdema, and under this treatment the tumor became softer and shorter (*Boston Med. and Surg. Journal*, April 21, 1881). Buch has used massage successfully in four cases of intussusception, the patients recovering. One was a case of strangulation at the ileo-cæcal valve. The other three were invaginations. It is impossible to fix the seat of strangulation, unless the tumor formed by the arrested matters can be felt. Then massage is used, so as to push the fæcal mass past the constriction, and afterward stretching is made so as to remove the invagination. It is always advantageous to displace the fæcal mass and remove it to another part of the intestine. By this means it is broken up into small fragments, so that purgatives can succeed better in expelling them, and it is for this reason that it is not a contra-indication for the use of massage when the seat of constriction cannot be located (*Berliner Klin. Woch.*, October 11, 1880).

Bitterlin, in *L'Union Médicale* of March 18, 1882, re-

ports two cases of intestinal obstruction with vomiting of fæcal matter, in which massage was used and the patients recovered. This author says that "these cases show that in obstruction of the intestines, massage of the abdominal region can bring about quite unlooked-for results when other means have failed. Before having recourse to such extreme measures as puncture of the intestines, enterotomy, or gastrotomy, it is important to try massage."

Scerbsky and Krönlein have also reported like favorable results in cases where massage formed a prominent part of the treatment. Dr. Kriviakin, in the *London Medical Record,* August 15, 1885, warmly recommends deep massage of the abdomen as a powerful curative in cases of intestinal obstruction. He considers that it is indicated in intestinal obstruction of every kind. He has given the details of four cases, in three of which massage was effectual in bringing about profuse defecation, the patients recovering. The fourth case was hopeless. It was that of a weak, decrepit man, with constipation of twelve days' duration, filiform pulse, fetid eructations and vomiting, cold, viscid perspiration, and in a semi-comatose state. After the administration of two grains of camphor, and an effervescent enema, massage was tried, and half an hour after this a free discharge of hard fæcal lumps, suspended in fluid, ensued. But the collapse became worse, and five hours later the man died. No autopsy was allowed.

None of these observers has clearly defined the manner in which massage should be used to relieve intestinal obstruction. It should not be employed if there are any suspicions of enteritis or sloughing. It is only in the early stage of this affection that massage or surgical interference has proved effectual. The milder procedure should be tried first. When the case is one of intussusception with an impacted mass of fæces, there are special indications for the use of massage; for what mechanical agency can be more likely to pull out a portion of invaginated intestine, disperse a mass of fæces, and push it through a constricted opening than massage properly applied? The manner of doing massage here that would most commend itself would be by gentle stroking and kneading at a short distance beyond the distal or rectal end of the mass, in the course of the intestine toward the anus, continuing to work in the same direction and in the same manner, gradually proceeding backward upon and beyond the tumor. Massage has been effectual in every instance that we have heard of. It may have failed in many more that we have not heard of. The weight of surgical opinion is against it.

A case of induration of the cellular tissue around the kidney, the result of perinephritis, the pressure of which upon the nerves in its vicinity caused rebellious neuralgia and wasting of the muscles of the leg and hip, was cured by massage at the hands of Dr. Winiwarter. Dr. Weissenberg reports the case of a military surgeon who had three attacks of peritonitis in three years. For three years after the last attack pain was continuous and aggravated by motion, with a feeling of heaviness. These symptoms were accounted for by a hard tumor, the size of a goose's egg, in the ileo-cæcal region. Under massage this old inflammatory exudation from the peritoneum disappeared, and the patient recovered. This case illustrates the increased capacity for absorption by the peritoneum under the stimulus of massage. This agent exerts a similar influence upon indurations and exudations wherever they can be reached by it, whether around intestine, kidney, uterus, or in other places.

Taxis, for the reduction of hernia, is a sort of external massage requiring skill, tact, and care; and the dilatation of strictures is an internal massage, of late improved on by combining it with external massage where the stricture is accessible to this. Each method has had its advocates; thus Bardinet made use of internal massage alone by the repeated introduction and withdrawal of a sound, while Professor Antal employed external massage alone, with success, in impermeable strictures with peri urethral indurations. Professor Antal gave daily *séances* of eight or ten minutes, and good results were gained in from three to eight days, the callous tissue disappearing and the constricted urethra admitting of the passage of sounds. Internal massage acts only upon the thin layer of tissue immediately surrounding the urethra; the external causes the absorption of the entire hyperplasia, and in many cases can be used in preference to urethrotomy. The method of Professor Antal is of the utmost value in those cases in which the urethra will not admit of the passage of a bougie (*Centralblatt für die gesammte Therapie,* July, 1884).

For many years physicians have practised massage of the uterus, through the medium of the abdominal walls, as a means of overcoming inertia of this organ during labor, and when its contractions are partial or irregular; also when there is post-partum hæmorrhage or danger of the same; and, with modified position and pressure, to correct malpositions of the fœtus, as well as for the expression of the placenta. Within the past twelve years massage has been gradually growing in favor for other abnormal conditions than those attending the parturient state—principally in enlargement of the uterus from subinvolution or areolar hyperplasia, and for the removal of adhesions and exudations in its neighborhood. Credit has been given to the Swede, Major Brandt, for having been the first to use massage, in 1874, for the local treatment of uterine affections; but eight years before this Dr. A. D. Sinclair, of Boston, employed massage of the uterus and its surroundings, with the patient in the genu-pectoral position, for the correction of retroversions and retroflexions. The next to interest himself in this was Dr. Gustaf Norström, of Stockholm (*Le Mouvement Médical,* July 8, 1876). He found massage especially successful in chronic metritis that had not arrived at the period of induration, and after this in hæmorrhagic metritis. He also obtained good results in prolapse of the vagina, and in chronic inflammations of the ovary. The catamenia, acute and subacute affections, and pregnancy are contra-indications. In his report of 1876 is given his experience, which had then extended over two years and a half, and which shows that in 138 cases of chronic metritis, he obtained 43 complete cures, and more than 70 nearly complete; 9 cases of hæmorrhagic metritis were cured, and in 7 cases of sterility, complicating chronic metritis, there occurred conception in 2 soon after the cure. In the course of his operations, he has never had a fatal termination nor the supervention of general peritonitis.

The method consists in introducing an index-finger into the *cul-de-sac* behind the cervix, so that the posterior surface of the uterus is reached. This is then raised as high as possible, while the fingers of the other hand grasp and knead the uterus through the abdominal walls. Sometimes the uterus is pressed against the lateral walls of the pelvis, sometimes against the posterior surface of the symphysis pubis. Massage acts in these cases by removing and preventing inflammatory stasis, by producing resorption of leucocytes and elements which have migrated into the surrounding tissue, and by restoring tonicity.

Jackson, Bunge, Orum, and others have also used massage in similar cases with favorable results. Each has contributed something, either in the improvement of the method, or in more clearly defining the nature of appropriate cases; so that massage has now found a recognized place in gynecology, though other means, such as hot water, and mechanical compression or extension, may be used for the same purpose. Dr. Jackson, of Chicago, points out that all cases of uterine enlargement obstruct the return of the venous circulation. The indications are to lessen the undue and partially stagnant supply of blood, to overcome the stasis, and to promote resorption of the excess of tissue. All the remedies generally employed act by lessening vascular fulness, but massage has proved more efficient in doing this in the hands of Dr. Jackson than any other single means that he has used. Not every case of uterine enlargement is amenable to squeezing and kneading; in some it might be injurious. It is available in the first stage, when the uterus is low in the pelvis, enlarged, tender, and spongy,

having a doughy elasticity, its sinuses gorged with blood, and newly-formed connective tissue in its walls. When the organ has become firm and indurated like cartilage, massage and all other remedies will be useless. Jackson is of the opinion that the pains and discomfort accompanying enlargement of the uterus, though usually referred to this organ, are really seated in the walls of the abdomen. These are first subjected to gentle and superficial, then to more deep and vigorous massage, until sensitiveness decreases sufficiently to allow the uterus to be kneaded. If this cannot be done effectually through the abdominal walls, two fingers are introduced into the vagina and the uterus is by turns pushed forward, backward, and upward, and subjected to momentary squeezings between the hand on the outside and the fingers on the inside.

When the hyperplasia is dependent upon some local condition outside of the uterus, such as inflammatory exudations in the pelvic cellular tissue, and when spots of tenderness and indurated fibrous bands are found fixing the uterus in some abnormal position, the enlargement will remain so long as these continue, owing to the disturbance of the circulation which passes through the cellular tissue in going to, and coming from, the uterus. The removal of these conditions, external to the uterus, must be secured before any diminution can be obtained in its size. For this purpose Dr. Otto Bunge, of Berlin (*Berlin. Klin. Wochen.*, June 19, 1882), has used massage to get rid of the sequelæ of peri-uterine cellulitis and pelvic peritonitis which had not yielded to the customary methods of treatment. When engorgement of the uterus was also present, as in subinvolution and retroflexion, he found this method excellent. As his object was the loosening of adhesions and the dispersion of indurations, the manipulations were directed toward the liberation of these, working around the uterus and pushing, pulling, or raising it in such ways as would detach the adhesions. The good effects of this treatment showed themselves by the dispersion of the pathological products, by furthering the circulation, and by exciting contraction of the uterus. One patient declared that while being *masséed*, she felt real after-pains, although four years had elapsed since her last confinement. Cases were successfully treated, in which the uterus was so closely fixed to one or another part of the pelvic walls by adhesions, that at first it was not possible to penetrate between them. Precaution, tact, and skill were necessary. Injections of warm water preceded the use of massage. It acts in the same manner, but not so effectually. When there are inflammatory products in the *cul-de-sac* of Douglas, or in the perivaginal tissue, Bunge is of the opinion that less benefit proceeds from the customary local medication than from the mechanical pressure made in applying it by the speculum. When purulent or sanious products are present or suspected, massage is contra-indicated. Dr. H. P. Orum and Professor Howitz have found massage efficacious in removing the after-effects of peri-uterine cellulitis when other means had failed. Under its influence the infiltration of the connective tissue, after parametritis, was speedily absorbed in the majority of cases.

Dr. Prochownik, of Hamburg, has used massage in 103 gynecological cases (*Journal de Médecine*, January 3, 1886). Sixteen of these could not go on with the treatment on account of the pain it produced, due to the inexperience of the operator. Five of the remainder were small intra-ligamentary tumors, and 2 of these disappeared under massage and did not return. Of 13 cases of prolapsus uteri only 1 was cured, and 2 improved. Of 10 cases of chronic metritis 4 were cured and 3 improved. Of 18 cases of exudation (including 5 cases of hæmatocele) 8 recovered, 2 improved, and 3 were slightly benefited. The most suitable cases were those of old cicatricial, contracted remnants of exudation, and of 40 of these 24 were cured, and 10 greatly improved. In 10 cases undoubted latent gonorrhœa was followed by painful joint affections associated with slight fever, so that Prochownik was led to regard this as a contra-indication for the use of massage. In addition to manipulation with the hands and the fingers in the region of the uterus, he also employed in some cases passive massage. For this purpose a series of vulcanite cylinders were employed to gradually dilate the parts contracted by cicatrix or spasm. Massage of the uterus and its surroundings should only be employed after having exhausted every other means, for it is tedious and painful. It ought always to be done by the physician himself.

According to Bartholow, electricity is of value in uterine disorders only when there is no hyperplasia of the connective tissue. According to the various observers mentioned, massage is of great value when there is hyperplasia of the connective tissue.

But general massage alone, without any local treatment whatsoever, has produced favorable results in cases similar to those under consideration. In 1876 Dr. Henry B. Stoddard and I published several cases thus treated with marked benefit after the apparent failure of other means. Improvement in the local and general condition resulted, with better sleep and digestion. Weir Mitchell's plan of rest and excessive feeding made possible by massage and electricity (already referred to under the head of Massage in Affections of the Nervous System, at page 655), is undoubtedly the best for many of these cases. Dr. Asp has also obtained favorable results by means of general massage and medical gymnastics, without any local manipulation. Up to the year 1877, he had treated in this way 72 cases of uterine affections. Of these 35 were called cases of chronic inflammation of the uterus; 15 of these recovered, 13 were much improved, and 7 remained as before treatment. The average length of time of treatment for those who recovered was 8.6 weeks for single women, and 15.4 weeks for married. Eleven cases of anteflexion and one of retroflexion were also treated in this general way. During the treatment the subjective symptoms disappeared and the patients felt perfectly well, the flexions remaining unchanged. Four of the cases were chronic inflammation of the surroundings of the uterus, and 3 of these improved much in from four to twelve weeks. In one case of myoma and another of fibroma of the walls of the uterus, the general condition of the patients improved, but not the local (*Virchow and Hirsch's Jahresbericht*, vol. ii., p. 570, 1878).

I have so often observed an increase in the quantity of the catamenia, and an earlier appearance than usual, in women who are to all intents and purposes well, and who have had massage of the back or general massage for some slight ailments, that I have finally come to regard this as one of the physiological effects of massage. Even massage of a leg for a joint or muscular affection is frequently followed by an earlier appearance and a longer stay of the monthly visitor.

In amenorrhœa and dysmenorrhœa, where neither local treatment nor operative procedure is indicated, general massage is a good means to employ, especially in atony of the nervous or vascular system, and when no abnormal state of the blood exists, but rather a condition of torpor of the pelvic organs. In such conditions massage may be employed with advantage during the catamenial periods, as well as in the intervals; but when the flow is superabundant, massage should be omitted, not only during the period, but also for a day or two before and after.

Douglas Graham.

MASSANETTA SPRINGS. *Location,* Rockingham County, Va.; *Post-office,* Harrisonburg, Rockingham County, Va.

Access.—By Baltimore & Ohio Railroad to Harrisonburg, thence by stage, four miles to the Springs.

Therapeutic Properties.—This water acts as a diuretic and as a tonic. Its chief claim relates to the cure of chronic malaria, to which many responsible persons testify.

The springs are situated in the Shenandoah Valley, near the Massanetta Mountain. The hotel at the Springs accommodates seventy.

The water, both still and carbonated, is bottled, and is exported to various points.

ANALYSIS—(Professor J. W. Mallet).—One imperial gallon contains :

	Grains.
Calcium carbonate	14.778
Magnesium carbonate	6.949
Iron (ferrous) carbonate	0.375
Manganese carbonate	0.052
Sodium carbonate	1.128
Lithium	trace
Ammonium chloride	0.012
Potassium chloride	0.163
Potassium sulphate	0.113
Calcium sulphate	0.419
Alumina	0.161
Arsenious oxide (in salt)	trace
Phosphoric acid	trace
Silica	1.134
Organic matter	0.480
Carbonic anhydride united to carbonates as above to form acid carbonates	10.576
Total	36.343
Gases.	Cubic in.
Nitrogen	86.67
Oxygen	8.44
Carbonic anhydride	2.64
Marsh gas	2.25
Total	100.00
Temperature	50.7°

G. B. F.

MASSENA SPRINGS. *Location and Post-office,* St. Lawrence County, N. Y.

ACCESS.—By stage from Norwood, a station on the Rome, Watertown & Ogdensburg, and Ogdensburg & Lake Champlain Railroads.

ANALYSIS—(Professor Ferd. F. Meyer).—One pint contains :

	Grains.
Carbonate of iron	0.045
Carbonate of lime	0.422
Chloride of potassium	0.063
Chloride of sodium	9.961
Chloride of magnesium	3.741
Sulphate of soda	0.437
Sulphate of lime	7.616
Hyposulphite of soda	0.526
Phosphate of soda	0.165
Bromide of magnesium	0.084
Sulphuret of sodium	0.176
Silicate of soda and organic compounds	1.397
Total	24.633
Gas.	Cubic in.
Sulphuretted hydrogen	0.663

THERAPEUTIC PROPERTIES.—These are well-known salt-sulphur waters of a mild, though efficient, class, and enjoy an excellent reputation for their effects in diseases of the skin, rheumatism, etc. Hot baths are provided.

These springs are located on the banks of the Racquette River, in the northern portion of New York State, on the western border of the Adirondack region. The scenery is beautiful, and there are attractive drives and good fishing. *G. B. F.*

MASTERWORT (*Rhizoma Imperatoriæ,* Ph. G.; *Impératoire,* Codex Med.). The root of *Imperatoria Ostruthium* Linn. (*Peucedanum Ostruthium* Koch); order *Umbelliferæ.*

The use of this root is a relic of ancient medicine, in which it was much employed for many diseases. It is a stimulant stomachic, of the musk-root and angelica type, and may well be replaced by them, or even omitted without any substitute. It contains *oil, resin, peucedanin,* etc.

ALLIED PLANTS, ETC.—See ANISE. *W. P. Bolles.*

MASTIC, Codex Med. (*Mastiche,* U. S. Ph.; Br. Ph.). The resin of *Pistacia Lentiscus* Linn., the Lentisk: Order, *Anacardiaceæ,* a graceful little tree with slender, brownish-gray branches, and evergreen pinnate leaves. Its flowers are very small, diœcious, in erect axillary spikes; its fruit consists of little, dry, red berries, about as large as cubebs. Large resin-canals exist just beneath the surface of the thin bark, from which a certain amount of turpentine exudes spontaneously. The Lentisk is a native of numerous countries bordering upon the Mediterranean, Syria, Greece, Italy, Spain, and parts of Africa. It is also abundant upon the Mediterranean islands, of which one, Scio (*Chio*), has always been famous for it. It is on this one only that the resin is collected to any important extent.

Mastic is a drug of venerable antiquity, being mentioned by the early Greek and Latin writers upon medicine and natural history two thousand years, or so, ago. It has kept in use ever since, and several hundred years ago entered into the formation of numerous medicines and plasters, and was highly prized. It is now fast becoming obsolete, so far as medicine is concerned.

It is collected in the northern part of Scio, whose political fate for centuries depended upon its importance, from cultivated (male) trees planted for the purpose, by making light incisions in the bark, through which it flows in little rounded tears, and on which it slowly hardens in the same shape. Two or three weeks after the tapping the collectors revisit the trees and collect the little tears from the bark, and from the ground, to which some of them have fallen. This product is afterward sorted, according to whiteness, cleanness, and shape, into several grades, and so sold. The best of that which reaches us is in pale yellow tears, of the size of a large pea and smaller, with dusty, opaque surfaces, and perfectly clear and glassy fracture. Odor and taste pleasantly terebinthinous; texture, brittle, but softening in the mouth. Mastic contains a very little *essential oil,* about ninety per cent. of *resin,* soluble in alcohol, and ten of another *resin* soluble in ether, but not in alcohol.

The medicinal action of mastic is exactly that of other turpentines, although, perhaps, on a sightly milder scale than the most active of them, that is, a local and renal stimulant. It has been, and still is, in the East, employed as a sort of dentifrice, and as a temporary filling for carious and aching teeth. It has figured in numerous old mixtures and plasters, but is now nearly obsolete in European and American medicine. Out of respect to old tradition it is still used in the *Pilulæ Aloës et Mastiches* of the Pharmacopœia, which are one-sixth mastic.

ALLIED PLANTS.—The genus is a small one of resin-bearing trees and shrubs, mostly European and Asiatic, of which several are sources of commercial products (resins). *P. Terebinthinus* Linn., furnishes, from the same island, another famous product, Chian Turpentine, which, after having been employed for centuries, became wholly obsolete in the present one, until revived about seven or eight years ago, on account of its supposed efficacy in internal cancers. It has nearly passed into forgetfulness again. Cashew Trees, the various Sumachs, and Pistachia Nuts are also furnished by the order.

ALLIED DRUGS.—See TURPENTINE. *W. P. Bolles.*

MASTOID OPERATIONS. Under this title are included two fundamentally different operative procedures: the so-called *Wilde's incision*—a mere cutting of the soft integuments over the mastoid process down to the surface of the bone,—and perforation of the bone itself, either by means of chisels and gouges, or by means of some form of drill.

WILDE'S INCISION.—This procedure was first suggested by Sir William Wilde, of Dublin, in 1853, for the purpose of relieving deep-seated pain in the mastoid region, dependent upon acute inflammation of the middle ear and communicating bone-cells. Experience has shown that this operation, which, when properly performed, is perfectly free from danger, is one of the most effective means at our command for arresting the progress of an acute inflammation of the middle ear. The steps of the operation are, in brief, as follows: The operator should ascertain with the forefinger of the left hand the location of the tip of the mastoid process; the latter serving as a guide in determining the lower limit of the incision, and also in a measure the direction in which it should be made. He should then introduce the point of a sharp-pointed bistouri into the skin at a distance of an inch or an inch and a half above the tip of the process, and not less than

half an inch from the angle where the skin over the mastoid process is reflected outward upon the auricle. The incision should be carried down to the tip of the process and through the periosteal covering of the bone. If the patient has sufficient nerve it will not be necessary to administer a general anæsthetic, as the pain is of but short duration. Dr. J. West Roosevelt, of this city, has found that by injecting a two per cent. solution of hydrochlorate of cocaine into the deeper layers of the skin along the line of the proposed incision, the patient experiences almost no pain during the subsequent operation. After the incision has been made, everything should be done to favor free bleeding and oozing of serum from the cut surfaces. With this object in view, the wound should at first be sponged with tepid water, or with a tepid, weak solution (1 to 2,000 or 3,000) of bichloride of mercury. When the bleeding has ceased, a small piece of linen, wet with the bichloride solution, should be laid over the wound, and, over this, flaxseed-meal poultices should be applied, at intervals of say half an hour, for three or four hours consecutively. In very many cases this simple operation, especially if associated with paracentesis of the membrana tympani, and with the frequent use of the warm douche in the external auditory canal, will arrest the further progress of an otitis media acuta, which, without such vigorous interference, would be very likely to assume serious proportions.

In some cases in which the inflammation of the middle ear had been going on for so long a period, and in such a severe manner, that the more fundamental operation of perforating the bone seemed rather to be called for, I have succeeded in effecting a cure by means of the following procedure, which may be spoken of as *a modification of Wilde's incision.* It consists in stuffing the wound, after all the bleeding has ceased, with a pledget of lint or prepared oakum to which a strong thread has been firmly attached, and allowing it to remain in the wound until a process of suppuration has been well established—say for from two to three or four days. After the wound has been stuffed in the manner described, an occasional series of poultices will be found useful in hastening the desired development of suppuration. As soon as this has been effected, the plug may be pulled out from the wound, which should then be syringed with a weak bichloride solution two or three times a day, and dressed with simple dressings, as in the case of any ordinary open wound. This procedure is sometimes accompanied by extensive œdematous infiltration of the entire side of the head, and even occasionally by a decided periostitis, with accumulation of pus between the periosteum and the bone, above the ear. Painful and alarming as these manifestations may be,—and on one occasion, I remember how they deceived me into advising perforation of the mastoid process,—they undoubtedly contribute largely toward the ultimate cure of the deeper-lying ear disease. The principle of counter-irritation unquestionably explains the great potency of this modified Wilde's incision, if I may so term this operation, in those cases which have got beyond the reach of the curative effects of a simple Wilde's incision, but have not yet reached the stage in which nothing short of free drainage through an opening in the bone can afford relief. Without an examination of my records I cannot recall more than four or five cases in which this procedure has proved entirely successful. On the other hand, I can recall several instances in which it failed to afford the desired relief. In these, however, the time had passed when we could reasonably expect counter-irritation, no matter how violent, to do more than temporarily arrest the deeper-lying disease. It is too soon, therefore, to express any positive opinion in regard to this plan of treatment, but there is sufficient evidence to justify me in urging others to try it in suitable cases.

I have said that if the operation of incising the mastoid integuments be properly performed, there is no serious danger connected with it aside from erysipelas, which, of course, may develop after the simplest wound made in any part of the body. I know of but two dangers that may happen as a result of this operation, and they are scarcely worthy of being designated as serious. They are as follows: If the incision be made too far forward, that is, in too close proximity to the auricle, arterial hæmorrhage of a somewhat vigorous character may be encountered; and if the knife happens simply to have nicked a piece out of the artery, a troublesome false aneurism may develop, despite any pressure that we may bring to bear by means of suitable dressings, and that the patient will be able to tolerate. As it is not an easy matter to apply a ligature to a bleeding vessel lying deep down in a fleshy pit, the sides of which are very unyielding, it is better, in the event of this accident, to stuff the wound and apply moderate pressure. The stuffing is to be allowed to remain in the wound until suppuration takes place.

Perforation of the Bone Itself.—Schwartze, of Halle, in Prussia, who has probably had a larger experience in operations upon the mastoid process than any other surgeon living, lays down the following rules in regard to the indications which call for perforation of this bone. I quote them as they are given by Dr. J. Orne Green in a preceding volume of the Handbook:

"1. In acute inflammation of the cells, with retention of pus, if œdematous swelling, pain, and fever do not subside after antiphlogosis and free incision. 2. In chronic inflammation of the mastoid process with subacute (periosteal) abscesses, or fistulæ in the mastoid. 3. With a sound cortex of the mastoid, on account of cholesteatomata or purulent retention in the middle ear, which cannot otherwise escape, and with which symptoms arise showing that the life of the patient is in danger; or when a congestive abscess has formed in the upper posterior wall of the meatus. 4. When the mastoid appears healthy and there is no pus in the middle ear, but when the mastoid is the seat of long-continued and unendurable pain which other means fail to relieve.

"The operation is of *doubtful* utility in old, incurable middle-ear secretion, when no symptoms of inflammation of the mastoid nor of purulent retention in the middle ear exist. It is contra-indicated when there are positive symptoms of already existing metastatic pyæmia, or of secondary meningitis, or of cerebral abscess."

My own experience leads me to express my entire approval of Schwartze's rules, with the exception, perhaps, of that relating to cases in which meningitis or metastatic pyæmia has developed. Farther on, I will refer to this point more particularly. However, when we come to apply any fixed set of rules, at least in private practice, we shall find that all sorts of circumstances will compel us to modify them somewhat. Among cases of ear disease in which the mastoid process is more or less involved, there are such great differences that one may correctly say that no two cases are ever exactly alike. This circumstance renders it exceedingly difficult to formulate rules which are likely to be of much use to one who sees mastoid disease rarely. By aid of the history of the case, of the condition of the drum-membrane, or rather of the visible parts in the immediate vicinity of the drum-cavity,—and here I have reference especially to the upper and posterior part of the cutaneous lining of the auditory canal in close proximity to the drum-membrane (*i.e.*, the skin covering that portion of bone which constitutes the bony floor of the antrum);—by aid, furthermore, of the condition of the skin covering the mastoid process itself (redness, swelling, tenderness); by aid, to a slight degree, of the thermometer; by a consideration of the time which has elapsed since the onset of acute symptoms; in a word, by the aid of all these things we must endeavor to answer this question, Has the inflammation of the middle ear, antrum, and communicating bone-cavities progressed so far, and acquired such a momentum of virulence that we may feel reasonably confident that none of the simpler therapeutic measures — such as leeching, poulticing Wilde's incision (or the modification suggested above), or the free use of the knife on the drum-membrane—will suffice to arrest the progress of the disease, to ward off the dangers which at this late stage are associated with it, and to restore the parts to health. Some years ago I for-

mulated what I thought were very simple and practical rules for guidance in the matter of operating on the mastoid process. Further experience has taught me that, while in the main these rules will be found useful, in not a few exceptional cases they will not be found to be adequate. These rules, which had reference only to cases of comparatively recent origin, are as follows:

"In the early stage of the disease, when there is persistent and rather severe deep-seated pain, perhaps involving the entire side of the head as well as the parts immediately surrounding the ear, and when there is tenderness on pressure over the mastoid process, and possibly also a little redness of the skin, we should apply to this region from four to eight leeches, according to the age and vigor of the patient. If the loss of blood has not produced any decided depressing effect upon his strength, the after-bleeding may be allowed to continue for half an hour or one hour. Warm fomentations should then be kept applied to the mastoid region for several consecutive hours. If these measures fail to afford the desired relief, or if, after the lapse of say twenty-four hours, the pain is found to be as active as it was before the leeching, a Wilde's incision should then be made without further delay. Finally, if this procedure also fails to relieve the pain, or if it relieves this symptom only temporarily, an opening should as soon as possible be established in the mastoid process."

The question might be raised by some physicians, whether they should interpret this rule as meaning that, in the event of their failing to alleviate the pain by the other measures enumerated, they ought to perforate the mastoid process as early as on the fifth or sixth day after it has shown signs of being inflamed. As a matter of course, the rule is not to be followed blindly, nor without due consideration of all the facts connected with the case. Circumstances undoubtedly may exist which would render it desirable to modify the rule. For instance, the condition of the external auditory canal or drum-membrane, on the fifth or sixth day, may be such as to render it advisable that we should then devote special attention to this region before we adopt the conclusion that the mastoid process should be perforated. But if no such valid contra-indicating reasons exist, I believe that the sooner the operation is performed, the better it will be for the patient. In actual practice, it will rarely happen that, in following the rule which I have laid down, and which is essentially the same as that which I published in 1873, we shall find ourselves called upon to perforate the bone as early as on the fifth or sixth day. The vigorous employment of leeches is usually followed by a remission of the pain for from one to two or three days; and a still more protracted lull is apt to follow Wilde's incision. In this way the question of an operation upon the bone does not usually present itself for serious consideration before, say, the tenth day, at the earliest.

In all cases of comparatively recent origin we must not forget one well-established fact, namely, that the majority of them will, in one way or another, get well without the aid of perforation of the bone. In some, recovery will take place after weeks or even months of suffering; in others, it will take place through the establishment of a fistula behind the ear, and this in turn may persist for many months; again, in others, recovery indeed follows, but only after irreparable damage has been done to the hearing; finally, in a few individuals, who are blessed with unusually large mastoid pneumatic cells, which communicate freely with each other and with the antrum (see Fig. 2196), and are separated from the outer periosteum and integuments by only a very thin lamina of bone, a spontaneous recovery (through softening of this outer shell of bone and escape of the pus by way of a fistulous channel in the skin behind the auricle) will take place promptly and without permanent damage to the hearing. As there are no statistics at hand which give the exact proportion of deaths to recoveries among the cases of acute mastoid disease not treated by the operative method, it is not possible to show, by the statistical method, exactly how urgent is the need for operative interference.

If delirium, drowsiness, or limited paralysis develop in a case in which, judging from its history and from the conditions observed in the ear, we have already concluded that perforation of the mastoid process would be a useful procedure, we shall certainly be justified, in the presence of these new symptoms, in placing the urgency of operative interference in a much stronger light; that is, we may now unhesitatingly state that without the operation the chances of recovery are likely to be very small. We shall also be justified in advising the operation with the same degree of urgency in a similar case in which pyæmic symptoms have developed, even though coma, delirium, and paralysis may be lacking. Schwartze, it will be remembered, says that the operation is "contra-indicated when there are positive symptoms of already existing metastatic pyæmia, or of secondary meningitis, or of cerebral abscess." If the symptoms of any of these conditions are really positive and well-defined, in a case that in other respects seems to require operative interference, I should certainly feel that the time had gone by when a useful purpose would be subserved by boring into the mastoid process. On the other hand, successful results have followed mastoid operations in individuals in whom the symptoms of meningitis or of pyæmia were fairly well marked. It is therefore important carefully to weigh the circumstances of each case, and not lightly to reject an operation which may save life.

Finally, I believe that the operation should be urged as indispensable to life and health in those cases of chronic discharge from the ear which have been characterized by frequently recurring and severe attacks of pain on the same side of the head, and in which our examination leads us to believe that ulcerative action, with insufficient outlet for the pus toward the middle ear or the external auditory canal, is going on unchecked. In cases of chronic discharge from the ear, however, the question of when perforation of the mastoid bone should be resorted to, is far more difficult to answer than in the acute cases. The tenderness on pressure behind the ear, and the redness and œdema of the skin in this region, are very often, if not generally, lacking. In these cases, therefore, we are obliged to fall back upon the previous history, upon the appearances presented by the drum-membrane and neighboring parts, and upon the presence, never wanting, of deep-seated pain.

Here, then, are three classes of cases, some of them of acute origin and others of a chronic nature, in which I believe that all good surgeons would be of one mind in regarding the operation as advisable and more or less urgent. But there are other cases in which Schwartze and other surgeons—among whom I should wish myself to be included—would also urge the necessity of an operation; not because they believe that without it the patient cannot recover, but simply because they believe that it offers the speediest and the most effective means of putting him out of danger, of relieving him from his suffering, of preserving the hearing of the affected ear, and of restoring him to health. In consultations I have, a number of times, been overruled in regard to this point, and have sometimes seen the patient get well under the employment of less radical therapeutic procedures. In most of these cases, however, the recovery has been tedious and the patient has suffered, as it seemed to me, a great deal of unnecessary pain which the operation would have prevented. At one time, after two or three experiences of this kind, which occurred within a comparatively short period of time, I made up my mind that I would adopt a policy of delay, and not operate until it was reasonably clear that nothing but the perforation of the bone would put the patient out of danger. Shortly after this I was called to see a young man who had been suffering with severe pain in the ear for a period of nearly four weeks. There was pus in the middle ear, but the drum-membrane, owing to the toughness of its textures, had not ruptured, and consequently there had been no visible discharge from the ear. There was marked tenderness and redness of the mastoid integuments, and marked redness and swelling of the posterior and upper cutaneous wall of the auditory canal in the vicinity of the drum-membrane. Taking into consideration the long duration and the severity of the pain, and the local evi-

dences of inflammation involving the mastoid cells, I made up my mind that the only proper course to pursue was to make an opening down to the antrum, thereby relieving the parts of all tension, establishing a free and more direct route for drainage from the inflamed region, and so giving my patient, as I thought, the best chance of recovering his health and his hearing. My courage, however, had been so weakened by the recent rebuffs which I had experienced, that I simply advised paracentesis of the drum-membrane, a Wilde's incision, and poulticing. These measures were carried out and the patient speedily improved. In fact, ten days after this date I found him feeling so well that I discontinued my visits. Five days later, however, I was sent for in haste, and found that the patient, after a dancing party, had been seized with severe pain in the affected ear and throughout the entire side of the head. He had passed a night of suffering, his temperature was high, and there was a little tenderness over the mastoid process. This time I unhesitatingly urged the desirability of an operation, and it was performed on the same day. To my great surprise, I found that the entire mastoid process, which was one of unusually large size, was converted into an abscess cavity, all traces of mastoid cells having already disappeared. From this time forward the patient made a rapid recovery, but during the years which have since elapsed he has in many ways acted so strangely, and so unlike his former self, as to lead to the belief that the brain must have experienced some slight damage during the weeks while this abscess was developing in its immediate vicinity.

The case just narrated is not the only one in which I have been surprised to find a great disparity between the outward manifestations of mastoid disease, and those found after an opening had been made in the bone. In fact, on two occasions, in cases of quite recent origin, I found no redness of the skin behind the ear, no tenderness on pressure, and no demonstrable swelling of the parts, and yet, on perforating the bone, I found it to be in the condition which I have just described.

In the light of all these facts, I am convinced that it is not practicable at the present time, nor is it ever likely to be practicable, to formulate a rule by means of which we shall always be sure when the proper time has arrived for operating upon the mastoid bone. Every surgeon will have to decide for himself, in each individual case, whether or not the operation in question is called for. If he must err either way, it is far better that he should err in the direction of occasionally operating when, perhaps, an operation might be dispensed with; for to err in the opposite direction means the loss of a life that probably might have been saved, or at least the infliction of a chronic and disagreeable affection of the ear.

Steps of the Operation.—*The External Incision.*—This should be made in the line of the vertical axis of the head, and should extend from a point at least two inches above the tip of the mastoid process down to the latter. Sufficient pressure should be made with the point of the knife to divide the periosteum throughout the full extent of the incision. So far as the operation on the bone itself is concerned, a somewhat curved incision, running forward to a vertical line which passes through the external auditory canal, would be found decidedly more advantageous than the straight incision. By such an incision we obtain a flap which may be dissected up from the bone, thereby freely exposing the surface of the latter throughout the entire area upon which we desire to carry on our operative procedures. It is an easy matter, where we are dealing with such a flap, to ligate the bleeding posterior auricular artery, and furthermore, the most liberal space is afforded for the use of our instruments. These advantages, however, are offset by the very serious disadvantage that some deformity is sure to remain when the wound subsequently heals; the tendency of the anterior flap to fall forward and downward is so great, that stitches cannot be used in approximating the edges of the outer wound, nor can any dressings be devised that can successfully retain the flap in an absolutely normal position until perfect and strong union shall have taken place between the opposing edges of the wound. As a consequence of this, the auricle of the side operated upon will be found dislocated downward to a slight extent after the parts have healed. In the case of a straight incision, not less than two inches in length—and even three, if there is much swelling of the soft parts—our minds may be at rest as regards any subsequent deformity; and if the drill be used instead of the bone chisels or gouges, all the room will be gained that is necessary. When there is considerable inflammation of the mastoid integuments at the time of the operation, we may expect to encounter some annoyance from the copiousness of the bleeding. The blood wells up so actively that it is almost impossible to see exactly what we are doing. To obviate the difficulty it is well to have a vessel near at hand filled with water as hot as the hand will bear. By filling a sponge with this hot water and wringing it out over the wound, the bleeding may generally be controlled so promptly, that we need not resort to the use of ligatures, which are more or less objectionable in this operation. Thus, for example, if the long ends of these are allowed to lie outside of the wound, they are very apt to get in the way and so prove troublesome; and yet, if we cut them off short, they may be overlooked and be left behind in the wound after it has fairly healed, thus causing discomfort to the patient until, after the formation of a small abscess near the surface, they are finally expelled. If practicable, therefore, it is better to avoid ligatures altogether, and to trust to the slower method of applying hot water and pressure.

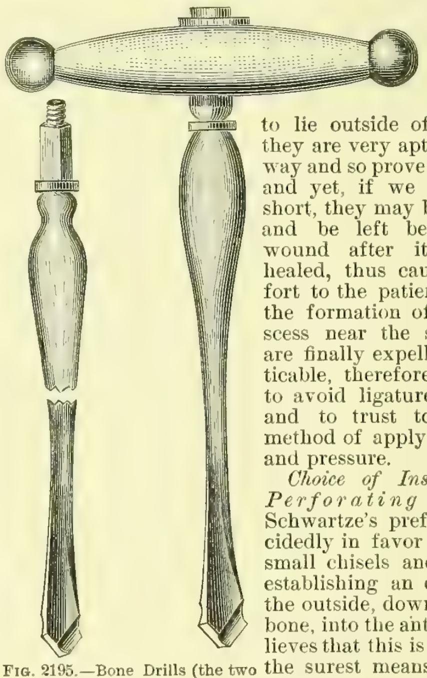
Fig. 2195.—Bone Drills (the two larger sizes).

Choice of Instruments for Perforating the Bone.—Schwartze's preference is decidedly in favor of the use of small chisels and gouges for establishing an opening from the outside, down through the bone, into the antrum. He believes that this is the safest and the surest means of attaining the desired object. My own preference is in favor of the drill, and my reasons for this preference are these: In the first place, the preliminary wound need not be curved or rectangular, and hence the resulting deformity, when the process of healing is completed, is limited to the presence of a mere linear scar which may readily pass unobserved. If the chisels be used, not only will there be a depressed scar, showing plainly the loss of bone-substance, but there will also, in all probability, be a certain amount of displacement of the auricle itself, as mentioned above. These disadvantages, I must admit, should be considered as trivial if, in other respects, the chiselling method be decidedly superior to that by means of the drill. It is claimed, for instance, that in chiselling we can see exactly what we are doing at every step of the process. This is certainly an advantage, and, so far as I can see, the only advantage connected with the chiselling method. Its advocates further say that by this method the danger is avoided of suddenly plunging the drill into some cavity or region where it will inflict serious injury. This danger is largely an imaginary one, at least so far as it relates to the pattern of drills (see Fig. 2195) which I have been in the habit of using during the past fifteen years. I have never made any such plunge as the advocates of the chiselling method

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would lead one to anticipate; nor do I believe that, in the hands of a reasonably careful person, will any such plunge ever be made. In the first place, the rules governing the perforation of the mastoid bone are now so well known that no person has any business to direct his instrument toward any place where he can inflict serious damage, should his instrument make such a plunge as is theoretically anticipated. In the second place, all those who have used the pattern of drill to which I have made reference,

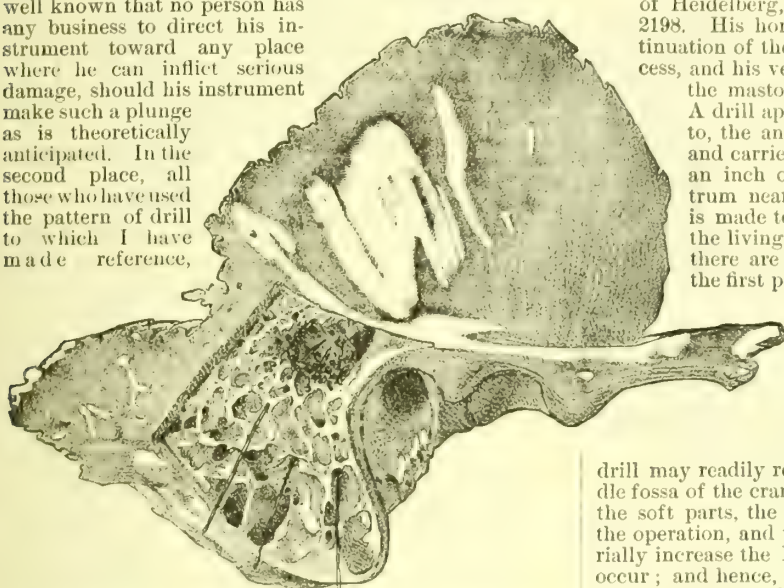

FIG. 2196.—Dissection (by chiselling) of the Mastoid Process, for the purpose of showing the free communication which exists between the pneumatic cells in the body of the process, and the antrum. The upper ends of the bristles may be seen projecting into the cavity of the antrum. The specimen also shows in a satisfactory manner the relative position of the latter. (Nuhn.)

will bear me out in the statement that, by reason of the peculiar shape of the cutting part of the drill, ample warning is conveyed to the fingers or hand of the operator when the sharp point of the instrument is beginning to enter a cavity. When this sensation is felt, the surgeon resorts to the use of the probe, and soon determines whether the warning is one which he should heed, or whether he may disregard it and proceed to a greater depth. It is possible that the statement occasionally made in reports of cases, that after a few turns of the drill had been made, the instrument suddenly plunged into an abscess cavity, is responsible in a measure for the fears expressed above. It is not unlikely that I may have used some such expression myself in reporting some of my cases. If I have, it was certainly not my intention to convey the idea that the resistance to the drill suddenly ceased, and that the instrument actually made a plunge into the cavity in the bone. No such experience has ever happened to me. The expression was used, undoubtedly, in a careless manner, to convey the idea that a well-defined abscess cavity had been reached.

Operation with the Drill.—After the preliminary incision through the soft parts has been made, and after at least the excessive bleeding has been checked, we should proceed to separate the periosteum from the underlying bone until the latter is laid bare as far forward as where the bone curves round to form the entrance to the auditory canal. As a matter of course, if the bone shows any signs of softening it should be broken down with any convenient instrument at the point of softening. To accomplish this the drill is certainly not the appropriate instrument; a small bone-chisel or gouge is unquestionably preferable for this purpose. But if, as will generally be found to be the case, the bone seems to be perfectly natural in appearance, we should proceed at once to determine the exact spot where the drill is to be applied. If we were dealing with the uncovered skull, it would be very easy to formulate a rule for the accurate application of the point of this instrument. This is what Nuhn, the distinguished anatomist of Heidelberg, has evidently intended to do in Fig. 2198. His horizontal black line is apparently a continuation of the upper border of the zygomatic process, and his vertical line, one drawn from the tip of the mastoid process at right angles to the first. A drill applied to the bone in front of, and close to, the angle made by these intersecting lines, and carried directly inward to a depth of half an inch or more, would probably enter the antrum near its very centre. But if the attempt is made to apply such a rule in operating upon the living subject, we shall soon discover that there are certain objections to its adoption. In the first place, the zygomatic process, covered as it is with soft parts, is very ill-defined in many persons, and consequently cannot be depended upon as a guide. The same remark applies to the linea temporalis. In the next place, the spot indicated by Nuhn is situated so high up that a slight error in the direction given to the penetrating drill may readily result in its being carried into the middle fossa of the cranial cavity. The swollen condition of the soft parts, the position of the patient's head during the operation, and various other disturbing factors, materially increase the likelihood that such slight errors will occur; and hence, a spot should be selected where the drill may with safety depart a little from a direction straight inward.

A better plan, as it seems to me, is to apply the drill a short distance directly below the spot indicated in Nuhn's drawing. To find this spot on the living subject is probably the most important step in the operation, and if a rule is to be formulated which may serve as an aid to the surgeon in correctly locating it, this rule must be

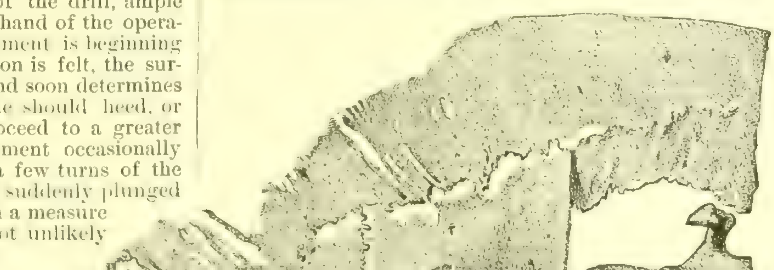

FIG. 2197.—Dissection of a Mastoid Process, in which the Pneumatic Cells are less well developed than in the preceding figure. Slightly enlarged. (Nuhn.)

based upon landmarks which are available in every case. There are two such fixed landmarks, viz., the bony external auditory canal (as exposed to view by the preliminary dissection), and a vertical line running through the tip of the mastoid process (in other words, the line of the

incision). As regards the first of these, we can scarcely mistake the curving of the bone forward and inward at the entrance of the external auditory canal, and the expression "vertical" has reference to the head in the erect posture. The rule, then, formulated in words, may be stated as follows: A vertical incision having been made through the skin, and the periosteum and superjacent soft parts

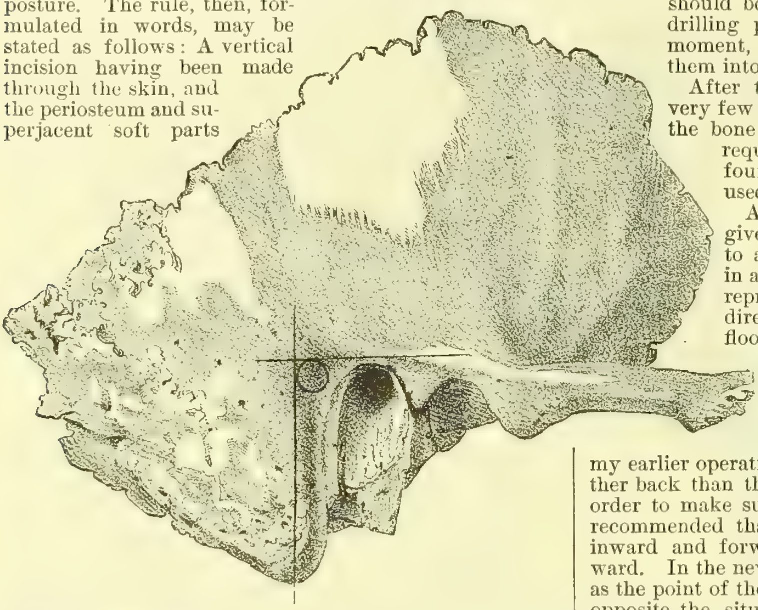

FIG. 2198.—Representation of an Adult Temporal Bone, with superposed intersecting horizontal and vertical lines showing where, according to Nuhn, the drill should be applied, in order to reach the Antrum. (Nuhn.)

having been pushed forward sufficiently to expose the posterior and upper boundary of the bony external auditory canal, run an imaginary line through the upper limit of the meatus at right angles to the line of the incision and place the point of the drill against the bone immediately beneath this horizontal line, and as close to the meatus as the shelving condition of the bone will permit. This rule, if expressed in the form of a diagram, would be like that represented in Fig. 2199.

As regards the proper size of drill to be used, I may say that I now always use the largest drill first, and do not exchange it for one of smaller size until I find, by the sensation conveyed to my hand, that the point of the instrument is engaged between septa of mastoid cells—or, rather, between septa which are too strong to be broken down under the employment of a very moderate degree of force. When the instrument reaches this point it ceases to gnaw away bone-substance, and begins to act as a lever to break down the thin bony partitions. It has always seemed to me that, with the larger instrument, this leverage-power might sometimes be great enough to cause a split in the bone. Perhaps in this view I am mistaken; but whether I am or not, I have followed the rule of substituting the next smaller drill for the large one on reaching distinct cell-structure, the walls of which I could not readily break down; and besides, on reaching this depth, I am in the habit of applying very much less force in my manipulations. As another precaution, I resort frequently to the use of the probe, and to measurements of the depth to which the drill has already gone. Finally, I have never carried the drill to a greater depth than a scant three-fourths of an inch; and, in cases of sclerosis of the mastoid process, I have always reached the antrum at a depth not exceeding three-fifths of an inch. In the latter class of cases, and also in those in which the mastoid cells are small, with firm intervening septa, I have found it necessary to make the final break into the autrum by means of the smallest or the middle-sized drill. As stated above, the fear of cracking the bone has led me to adopt this practice. The process of cleaning away the chips, if I may be permitted to use such an expression, should be carried on at frequent intervals, as the drilling progresses, and not be left to the last moment, when there may be danger of pushing them into the antrum.

After the drilling has once been begun but very few minutes will be required to perforate the bone to the required depth; the time thus required being very much less than will be found necessary if chisels or gouges are used.

As regards the direction which should be given to the drill, perhaps the best rule is to aim at penetrating as nearly as possible in a direction at right angles to the plane represented by the side of the skull. This direction will carry the drill down to the floor or lower part of the antrum, and will allow an ample margin for error in almost any direction. After I have penetrated to a depth of say nearly a fourth of an inch, I direct the instrument a little upward and forward. In my earlier operations the drill was placed at a point farther back than that now advocated, and accordingly, in order to make sure of not entering the lateral sinus, I recommended that the drill should be pointed obliquely inward and forward, and at the same time a little upward. In the new situation this is no longer necessary, as the point of the drill is to be applied almost directly opposite the situation of the antrum, at a point from which, by direct boring inward, it is scarcely possible, under any conceivable circumstances, to touch the lateral sinus.

A word or two with regard to the antrum end of the canal made by the drill. The minimum diameter of this should not be less than three millimetres; but one of four or five millimetres will afford the most ample outlet for thorough drainage.

If, after we have withdrawn the drill, the soft parts be left to themselves, it will be found that the anterior flap.

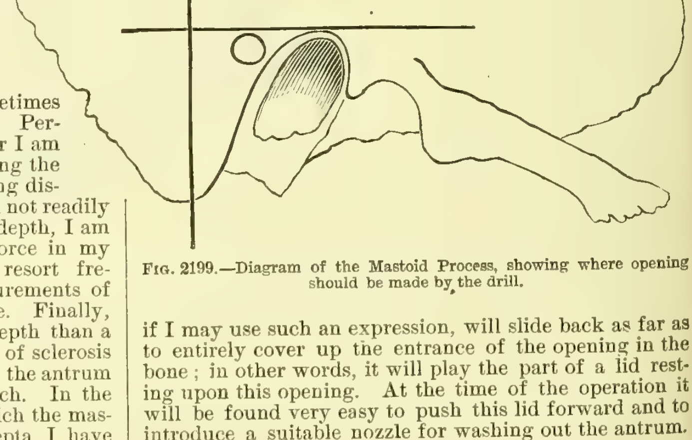

FIG. 2199.—Diagram of the Mastoid Process, showing where opening should be made by the drill.

if I may use such an expression, will slide back as far as to entirely cover up the entrance of the opening in the bone; in other words, it will play the part of a lid resting upon this opening. At the time of the operation it will be found very easy to push this lid forward and to introduce a suitable nozzle for washing out the antrum. On the second day, however, when the soft parts are

swollen by inflammation, it will be found quite difficult to accomplish this; and furthermore, the pain to which the patient will thereby be subjected will be found to be quite severe. As we can readily imagine, the spontaneous drainage from a bony canal thus covered with soft parts at its entrance, will not be very effective. To obviate this I formerly tried the plan of inserting a drainage-tube; but this, I found, was not altogether a comfort to the patient, nor was I satisfied that it really materially increased the facility of drainage. My present plan, which I have found to work admirably, is to chisel out a shelving channel or gully in the outer surface of the bone, from the bottom of the external wound to the artificial channel in the bone leading to the antrum. This supplies a collateral drainage-channel through which all the discharges can find a ready outlet, and through which at the same time, by means of a suitably curved nozzle (see Fig. 2200), the washing of the wound in the bone and of the antrum can be effected with very little discomfort to the patient.

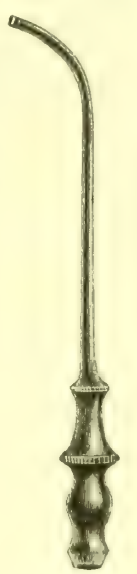

Fig. 2200.—Curved Hard Rubber Nozzle, for Use in Washing out the Mastoid Antrum. (Natural size.) The soft-rubber tubing of a Davidson's syringe, or a fountain douche, may be slipped over the lower end.

After this collateral drainage-channel has been completed, a warm solution of bichloride of mercury (1 part in 2,000 or 3,000) should be injected into the antrum until it escapes from the wound in a perfectly clear condition. In performing this step of the operation, it is advisable to use quite a slender tube, in order that ample room may be left for the return current of the fluid injected. Even with this precaution, it will sometimes happen that the bichloride solution will travel down through the Eustachian tube into the pharynx, in sufficient quantity to cause the patient considerable distress. In some cases the fluid injected will escape freely from the external auditory canal, but no effort should be made to force it out by way of this channel.

Operation with Chisels or Gouges.—Very little additional need be said on this topic, as much of what properly belongs in this section has been discussed in previous sections. As already stated, the preliminary incision in this operation must almost necessarily be either curved or angular. A straight vertical incision affords scarcely space enough for the satisfactory manipulation of chisels; while one that begins at the tip of the mastoid process, and curves gradually upward and forward until it reaches a point directly above the orifice of the auditory canal, and about half an inch distant from the angle where the skin is reflected from the side of the head upon the auricle, will freely expose all that part of the bone on which the chiselling must be done. Such a curved incision necessarily involves division of the posterior auricular artery. This vessel is of such a size, that we cannot trust to the free use of hot water as a means of arresting the consequent hæmorrhage, and a ligature will, therefore, have to be placed around the proximal end of the divided artery.

In this connection I may mention a circumstance which has attracted my attention. I refer to the rapid development of a very marked difference in thickness between the opposite edges of the wound—the anterior lip or flap attaining almost twice the thickness of the posterior one, in the course of an hour or two. This phenomenon is probably to be attributed to the cutting off of the blood-supply to the posterior flap. In the course of a few days there is developed a sufficient collateral blood-supply, and the difference in thickness then disappears.

The accompanying cut (Fig. 2201) shows sufficiently well the general shape and character of the instruments which should be used for this purpose. Instead of a wooden mallet it is better to use one having a head of thin steel filled with lead, and provided with a slightly flexible shank interposed between the head and the handle. Another form of mallet, the head of which is made of compressed leather, is very highly spoken of by some surgeons.

In cutting away the bone Schwartze very properly recommends that the chief part of the work should be done by blows directed from behind forward, and from above downward; his idea being that in this way all possibility of driving the chisel into the lateral sinus will be avoided. Aside from this danger, it is preferable to aim the blows of the mallet in a direction approximately tangential to the skull, as thereby the force of the shock communicated to the contents of the cranial cavity will be reduced to a minimum. In adhering to Schwartze's rule, the operator will find it necessary to remove a considerable area of bone from the outer surface of the mastoid process; for in no other manner can he make the sides of the excavation leading into the antrum sufficiently shelving. On the side toward the meatus, however, he will find himself almost necessarily obliged to disregard the rule in large measure; the sides of the excavation at this point will be much less shelving than elsewhere. After the antrum has been reached, the steps of the operation will be essentially the same as those described in the next section.

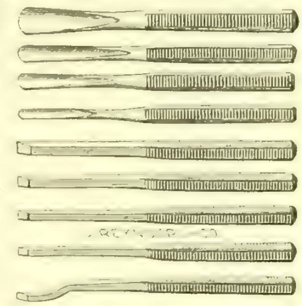

Fig. 2201.—Schwartze's Bone Chisels and Gouges. (About one-third natural size.)

After-treatment.—As regards the final dressings, these, it seems to me, should be as simple as possible. After the antrum has been carefully washed, and as soon as the bleeding has entirely ceased, a small piece of sheet-lint, soaked in a weak solution of bichloride of mercury, should be laid over the wound, and flaxseed-meal poultices should be applied over this at frequent intervals until suppuration has been established. Afterward, a mass of borated cotton or of prepared oakum ("marine lint") should be substituted for the poultices, and a cap of mosquito-netting should be tied under the patient's chin to hold the dressings in position. Such a gauze-cap can be thrown away and a fresh one put in its place, if necessary, at each change of the dressings. During the first four or five days after the operation, I believe that it is a good plan to wash out the antrum at least once a day with the weak solution of mercury; but if by that time no symptoms of blood-poisoning have shown themselves, I think that the injections may be stopped altogether. My idea in regard to this point is this: immediately after the operation there are, undoubtedly, a number of small blood-vessels left gaping in the substance of the bone. So long as they remain in this condition there is, of course, danger that poisonous materials may enter through them into the general circulation. Hence the desirability of employing antiseptic irrigation. But when the processes of suppuration and granulation are fairly well established, we may assume that these vessels are all closed, and that the danger of septic poisoning no longer exists. Of what use, then, is it to go on distressing our patients with this procedure, which always causes more or less pain? If it be said that the risk of blood-poisoning continues for a much longer period, I can only reply that I have followed this practice in at least a score of cases, and have seen no reason yet to change my belief that the plan advocated is a safe one to follow—*always provided that unobstructed drainage exists.*

The subsequent progress of the healing process is uneventful. It is generally necessary to excise and suppress exuberant granulations, and now and then a small sinus persists for weeks, or even months, before the final healing takes place. Sometimes, again, after perfect healing has apparently taken place, the painful symptoms return, a small abscess forms, and a fragment of bone is

discharged. Then the parts quickly heal again, and no further trouble is experienced. Finally, in other cases, with every fresh cold in the head involving the middle ear of the affected side, evidences of inflammation show themselves in the mastoid integuments, and even in some cases there is a discharge of pus from the old cicatrix before the parts again return to a quiet state.

If we except those cases in which a small fistulous opening remains for an indefinite period, we may expect the wound behind the ear to be fully healed in from thirty to forty days. I have known the wound to heal in the course of a fortnight. The patient, even in the most favorable cases, should not leave his bed before the fourth or fifth day after the operation.

Albert H. Buck.

MATÉ (*Thé du Paraguay*), Codex Med. Paraguay Tea is the leaves of *Ilex paraguensis* Lamb., a shrub or small tree in the Holly family, *Aquifoliaceæ*, growing both wild and cultivated in the country for which it is named, and in other parts of South America. The leaves are evergreen, lanceolate or oblong, blunt, and sparsely serrate. For use they are collected, dried, and generally broken into fine fragments.

Maté seldom appears in this market, there being no demand for it, but it is consumed to the extent of several million pounds a year in South America. It is in small fragments of a grayish-green leaf, of agreeable herby odor and a bitter taste. It is remarkable as one of the few plants containing *caffeine*, of which it has about one per cent. Like the other caffeine-containing plants it also has a very large (ten to fifteen per cent.) proportion of *tannic acid.*

Allied Plants.—See Alder, Black.

Allied Drugs.—See Coffee and Tea. *W. P. Bolles.*

MATICO, U. S. Ph.; Codex Med. (*Maticæ Folia*, Br. Ph.); *Artanthe elongata* Miq. (*Piper angustifolium*, Ruiz and Pavon); Order, *Piperaceæ*, is a South American shrub with downy, round, or slightly quadrangular, prominently articulated branches, and long, narrow, acutely-pointed, lanceolate-cordate leaves. These latter, which are the officinal part, are short-petioled, unequal at the base, finely tessellated above, and conspicuously reticulated and downy beneath. They have an aromatic odor and a spicy, bitter taste.

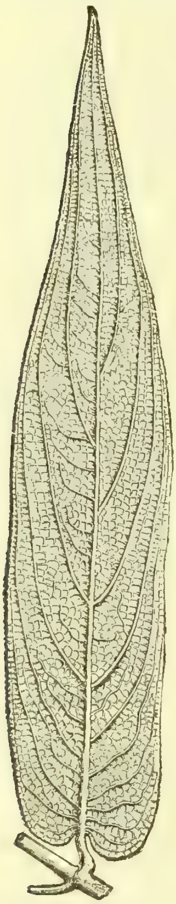

Fig. 2202.—Leaf of Matico Plant. (Baillon.)

The use of matico was introduced from South America some fifty years ago, and since this time it has so completely fallen out of favor that its remaining officinal seems wholly unnecessary.

It contains two or three per cent. of *essential oil*, of which a portion is a stearoptene, some *resin*, and a crystalline, acid substance, *artanthic acid*, neither of which throws much light upon its supposed qualities. The first and principal use of matico has been as a hæmostatic, applied locally as a cataplasm or in infusion; it is also given internally for internal hæmorrhages, bronchitis, catarrh of the bladder, etc. A fluid extract and tincture are officinal.

Allied Plants.—See Pepper. *W. P. Bolles.*

MEADOW SWEET (*Ulmaire ou Reine des prés*, Codex Med.), *Filipendula Ulmaria* Chis. (*Spiræa Ulmaria* Linn.); Order, *Rosaceæ* (*spiræœ*), often called in the country, where it is occasionally cultivated for ornament, Queen of the Meadow, is a perennial herb with interruptedly-pinnate leaves, and a compact, large, cloud-like terminal panicle of fine creamy-white flowers. The herb and flowers have been employed in infusion as an astringent, and as a remedy in vesical catarrh. Meadow Sweet contains an *essential oil* of peculiar properties, consisting largely of salicylous acid in conjunction with an indifferent oil, and perhaps a stearoptene. To this, with its possibility of decomposition into salicylic acid, it is rational to attribute whatever activity it has.

Dose.—It may be given *ad libitum* in infusion.

Allied Plants.—See Roses.

Allied Drugs.—Buchu, Uva Ursi, etc.

W. P. Bolles.

MEASLES. Synonyms.—Morbilli, Rubeola; Ger., *Masern, Flecken*; Fr., *Rougeole*; It., *Rosalia*; Sp., *Sarampion.*

Definition.—Measles is an eruptive contagious fever. It is characterized by a period of incubation, of invasion, of eruption, and of decline. Its peculiar symptoms are manifested upon the skin and mucous membranes. It is highly contagious and, as a rule, attacks an individual but once.

History.—There is no evidence that measles was recognized as a distinct disease before the time of Rhazes (A.D. 900). Although this writer described measles and small-pox together, he probably appreciated their differences. Late in the tenth century, Avicenna described measles, but it was not until the close of the seventeenth century that this malady and scarlatina were definitely determined to be separate affections, when Sydenham and Morton (1670–74) declared the latter to be a disease *sui generis.* Thenceforth descriptions of measles became more clearly defined, and to-day its literature is very voluminous. The origin of measles is buried in obscurity. At present its distribution is almost world-wide; only the remotest corners of the earth have remained exempt from its ravages. It appeared in America soon after the arrival of the first settlers, and advanced steadily with the pioneers of civilization. It did not reach Oregon until 1829, nor California and Hudson's Bay Territory until 1846. Greenland, as late as 1864, had not been invaded by it.[1]

Clinical History.—*Typical Course.*—Stage of Incubation. Although it has been asserted by Vogel and others that for several days after infection the contagious principle remains absolutely quiescent, it must be concluded that an attack of measles begins at the moment when its specific influence is brought to bear upon the body of its recipient. Though not demonstrable and, certainly, so far as our present methods of research enable us to determine, quite without immediate appreciable results, this influence continues and grows until it acquires a force capable of upsetting the equilibrium of the economy and of initiating characteristic symptoms. The interval included between the date of infection and that of the outbreak of symptoms is called the *period* or *stage of incubation.* This period varies between seven and twenty-one days; very rarely it may be more brief than seven days, or prolonged beyond twenty-one days. Panum, whose opportunities for observation, during an epidemic of measles in the Faroe Islands, were unusually good, determined that the eruption occurred thirteen or fourteen days after infection. This would give a period of incubation of from nine to ten days. Girard,[2] in one hundred and eight cases of measles, determined that the exanthem appeared in from thirteen to sixteen days, never earlier, never later; in only three cases was it as late as the sixteenth day. This would correspond to an incubative period of from nine to twelve days. Chomel taught that the eruption may appear as early as seven days after infection, and in many cases may not appear until after fifteen days. The results of inoculation of unprotected individuals, with the tears and catarrhal secretions of persons affected with measles, are, as might be supposed, somewhat different. The inoculations practised at Edinburgh, in 1758, by Home, with the blood of infected persons, have been repeated with blood, tears, mucus, epidermic scales,

etc., by different experimenters, with varying results. Katona failed in only seven per cent. of eleven hundred and twenty-two inoculations.[3] Prodromal symptoms began in his cases on the seventh day. The difficulty of discovering the exact time of infection necessarily renders the determination of the duration of the stage of incubation very uncertain. Many instances of apparently protracted incubation are to be explained by the fact that the individual only became infected after repeated exposures. It may be concluded that most cases develop prodromal symptoms on the ninth or tenth day after infection. These will rarely appear on the seventh or eighth day, somewhat more frequently on the eleventh or twelfth day, and only exceptionally, after more prolonged intervals or earlier than the seventh day.

Stage of Invasion.—This stage may begin abruptly with fever, or it may be ushered in by gradually developing evidences of disturbed nutrition. Anorexia, nausea, headache, general malaise, shiverings may accompany or follow symptoms of conjunctival, nasal, and bronchial catarrh, during which the fever will become manifest. Although it has often been claimed that vague signs of disorder accompany the incubative stage, it is usual for the invasion to be marked by a sudden onset of fever, in which, during the first day, a temperature of from 39.1° C. to 40° C. (102° to 104° F.) will be attained. Wunderlich has shown that this preliminary elevation of temperature "allows us to forecast the subsequently occurring elevations with very great probability, since these, on an average, are wont to exceed the height of the initial rise by about 0.8° C. to 1° C. (1.5° F. to 1.8° F.), and only exceed this a trifle even when most extreme."[4] Catarrhal symptoms develop almost immediately; indeed, the implication of the mucous membranes is the characteristic feature of this stage. The mucous membranes of the eyes, nose, throat, bronchial tubes, and of the larynx, trachea, and sometimes of the digestive organs, become almost simultaneously affected. The conjunctivæ are injected and reddened, a free discharge of tears follows, shortly succeeded by a scanty muco-purulent formation about the tarsal borders, which is more free in scrofulous persons. More or less photophobia will be developed. Monti has drawn attention to the small red spots visible along the ciliary border. The eyelids become somewhat reddened and swollen. Köningsten has declared the conjunctival hyperæmia to be a specific effect of the measles contagium, and not simply catarrhal. Sneezing and snuffling, which are often the first symptoms observed, indicate hyperæmia and inflammation of the nasal mucous membrane. A thin watery discharge from the nose is also present. After a day or two this becomes muco-purulent. The membrane is seen to be reddened, and inspired air excites a painful, burning sensation. Cough denotes the involvement of the respiratory tract, and is intense, usually, in proportion to the severity of the attack. It is at first dry and troublesome, but afterwards becomes associated with secretion. Croupy cough and respiration sometimes occur and denote swelling of the tracheal and laryngeal mucous membrane. Rarely œdema of the glottis may suddenly develop and threaten life, or call for tracheotomy. Nausea, vomiting, and total loss of appetite indicate perturbation of the gastric mucous membrane, and the frequent appearance of diarrhœa denotes the occurrence of intestinal catarrh. The buccal cavity does not usually show pronounced alterations. The tongue quickly becomes coated with a thin whitish fur, through which the papillæ penetrate. From the first there is often pain and difficulty of swallowing, and the faucial mucous membrane assumes a more vivid coloring; and by the end of the second day careful inspection will detect small blotches of irregular outline and deepened color upon the hard and soft palate. Girard asserts that a punctate redness is visible on the palate from four to six days before the eruption. Due attention has only of late been given to the condition of the mucous membrane in this stage. The posterior wall of the pharynx is more intensely reddened than the arch of the palate. From twelve to twenty-four hours before the appearance of the cutaneous eruption, an eruption invades the palatal mucous membrane. The efflorescences are irregular, varying in size from that of a pin-head to that of a hemp-seed or a lentil, and are isolated or confluent. They are sometimes papular. These lesions grow pale after from twelve to twenty-four hours. The buccal mucous membrane is sometimes similarly affected; that of the tongue, however, is never invaded.[5] While the eruption is most copious upon the soft palate and uvula, it has been observed upon the general visible surface of the respiratory and digestive tracts, and its existence at this time justifies the opinion expressed by Hardaway and others, that it would be better to designate the period of its development as the stage of the "exanthem of the mucous membrane." The throat is felt by the patient to be dry, and the cough, which constantly grows in intensity, may have a metallic ring and may be accompanied by decided hoarseness. Sibilant and sonorous, and, occasionally, subcrepitant râles, may already betray bronchitis. Not infrequently the symptoms become complicated with epistaxis, which rarely becomes alarming. Nervous agitation may now be extreme, or the child may remain dull, inattentive, or somnolent. Convulsions not very rarely appear, but, when observed thus early in the disease, are not often of grave augury.

The fever, which may have developed with the symptoms described, or may have preceded them, becomes in a few hours quite intense, in severe cases attaining a temperature of from 39° to 40° C. (102.4° to 104° F.). Vomiting and severe frontal headache often accompany it. The child will be fretful and peevish, or may remain drowsy and apathetic. All the symptoms enumerated may be of an exceedingly mild character, may even escape observation, or they may rapidly develop a high degree of intensity. Once developed, they continue unabated until the end of the second or beginning of the third day, when in most cases there will be a sudden amelioration. Indeed, fever may quite disappear, and delusive hopes of an immediate recovery may be entertained. The child will regain some of its gaiety of manner and will play about the room at times. The catarrhal symptoms, however, will in most cases persist, though with diminished vigor. This period of apparent improvement is very deceptive, but by careful consideration of all concomitant phenomena, the experienced attendant will learn to avoid error. During the third day the fever will increase and remain unabated, while the appearance of the cutaneous eruption will usher in the next stage. The high temperature of the stage of invasion is not again equalled until the acme of the disease, which occurs toward the close of the second day of the eruption. Careful consideration of the symptoms, of the course of the fever, of the development of the catarrh, the coughing and sneezing, the lachrymation, the injection of the conjunctivæ, and especially of the efflorescences upon the faucial mucous membrane, will often justify a very confident surmise as to the true nature of the disorder before the cutaneous eruption appears.

Stage of Eruption.—It rarely happens that the eruption is discovered on one in whom premonitory symptoms have not been observed. In such cases inquiry will often elicit the fact that, for some days previously, the child had not been in his accustomed health, though attracting no special attention. A slight cough, a mild coryza, a conjunctival irritation can be recollected.

In the great majority of cases the eruption begins to appear on the fourth day of the disease, when the fever and general catarrhal symptoms are approaching their height. It is first seen on the forehead, temples, and cheeks as pale red spots, appreciable to the eye, but not to the touch. These spots rapidly increase in number and in intensity of color, and include the face, head, neck, breast, shoulders, and trunk. By the fifth day, or second day of the eruption, in ordinary cases, the face becomes swollen and more or less covered with an eruption that has now acquired a raspberry-red color, and a configuration and distribution of peculiar character. The spots are now quite perceptible to the finger and sometimes decidedly papular, so that, at times, the hard, shotty papules of beginning small-pox eruption are sim-

ulated. This resemblance quickly disappears and the papule becomes surrounded by a red areola of small size, the whole spot not exceeding the size of a flake of bran. These spots tend to group themselves into crescentic shapes, or segments of circles, the general distribution of which varies considerably in intensity. At other times the spots will present a soft, almost uniformly elevated surface that may not suggest a papular eruption. They have an irregular outline and are surrounded by normal, unaltered skin, except where the eruption becomes confluent, as upon the cheeks in ordinary cases, or over more diffused areas in severe ones, or at the site of some pre-existing hyperæmia, as that from the irritation of a sinapism or other stimulating application. When confluent the eruption shows a dusky red surface, elevated, and more or less infiltrated.

During the fifth day the eruption extends along the trunk and upper extremities, but does not develop upon the legs until the sixth day. Here it is usually not nearly so intense either in extent or coloration. The groups of macules are much less numerous, and their color is paler. The general symptoms will have continued with unabated vigor. If diarrhœa have not already been present during the prodromal stage, it is now very apt to occur, and may prove very annoying. The temperature remains unabated, reaching its acme at the height of the eruption. The catarrhal symptoms persist, the secretions often becoming muco-purulent. At this period vesicles the size of a hemp-seed may appear at the mucous follicles of the buccal cavity, in the middle of a macule or papule. Sibilant, sonorous, and subcrepitant râles indicate the extent of bronchitis present. The maximal temperature is attained from the end of the fourth to the sixth day of the disorder (earlier in mild cases than in severe ones), and continues for from one and a half to two days, when there is a sudden diminution of fever and a rapid mitigation of all the symptoms.

At the height of the eruption, the finger pressed upon a spot causes the redness to disappear and to be replaced by a pale yellow color, which rapidly gives place to the returning hyperæmia. With the reduction of temperature the eruption begins to pale, and by the eighth day will have become quite indistinct, and the swelling of the face and neck will have, in great part, disappeared. With defervescence, which usually begins in the night, the eruption rapidly fades, first in those parts first invaded, so that by the ninth day the only traces to be found are pale-yellow spots, which will not entirely disappear upon pressure. Occasionally, when the eruption is at its height, a number of tiny, pin-point vesicles may develop more or less abundantly. They are not of importance, and commonly depend upon excessive temperature of the room or too heavy bed-clothing. At other times the eruption becomes hæmorrhagic and assumes a petechial character, strongly suggestive of the exanthem of typhus fever. This condition is usually seen upon the extremities, but may involve the eruption over the whole body. The spots assume a more livid coloration, and are not affected by pressure. No especial significance is to be attached to this form of eruption, the course being favorable, though for many days after the active symptoms of the disease have ended, the surface remains mottled with the dark spots. As the intensity of the eruption is usually proportionate to the severity of the fever, in milder cases the cutaneous lesions are more scattered and of less vivid coloration ; and in the mildest cases fever, catarrh, and exanthem may be hardly appreciable, the eruption especially being pale, scattered, and limited almost entirely to the face, neck, and superior portion of the trunk.

Throughout the attack the tongue remains moist and thinly coated with a whitish fur. This coating is not stripped off as in scarlet fever, nor does the tongue become dry and brownish, and cracked as in typhoid fever, unless complications of grave character supervene. After defervescence, it soon reacquires its normal appearance. Even at the height of the eruption, the tongue usually remains red at its borders. General enlargements of the lymphatic glands are often observed. The submaxillary and anterior cervical glands are most markedly swollen. The urine is reduced in quantity, is strongly acid, and of high specific gravity. Occasionally, and especially early during the prodromal stage, retention of urine may be noted. At other times there is great irritability of the bladder, with frequent micturition and pain. Albuminuria will rarely occur, but may almost always be attributed to the febrile condition, and not to specific influence.

The eruption is most characteristic in those of fair complexion, though it always retains its peculiar features even in the darker individuals of the white races. In dark-skinned races, however, it becomes much modified, principally, of course, in its coloring. In negroes and those of mixed African descent, the characteristic color disappears in proportion to the intensity of the normal cutaneous pigmentation. The eruption, in losing its vividness, seems to acquire a more pronounced papular character, and the summits of the tiny papules often appear, by contrast, of a whitish, translucent color, from the exudation into them. Through the black skin the hyperæmic redness will be obscurely visible. The true nature of the eruption will usually be recognized without difficulty by its distribution, the œdema of the face, the concomitant fever and catarrhal symptoms, and the eruption upon the mucous membrane.

Stage of Decline.—Though the fever and eruption rapidly disappear, it is not until after several days that the catarrhal symptoms subside. As these become less urgent the appetite gradually returns, the various functions become restored, the strength and spirits increase, and the patient, though feeble, enters upon convalescence. This *stage of decline* terminates with a scanty desquamation. This begins about the tenth or eleventh day, and after mild cases may be almost imperceptible. Usually it appears, especially about the forehead and cheeks, as an exfoliation of fine, branny, epidermic scales, quite unlike the desquamation of scarlatina. After a few days it is completed, and health becomes re-established. Careful search is often necessary to detect this desquamation upon the body and limbs.

Atypical Course.—Very many cases depart from the typical course, as described, in one or more respects ; indeed, the general characters of the malady may be irregular. The initiatory symptoms of the stage of invasion may be so insignificant as to entirely escape observation, when it may appear that the eruption abruptly ushers in the disease. Cases of this kind are not very uncommon. On the other hand, the stage of invasion may be prolonged until the sixth or seventh day. Here, however, appearances are apt to be misleading, as in cases where the specific process develops during an attack of simple coryza or bronchitis. The eruption may be very long delayed by pre-existing internal disorders of more or less gravity —pulmonary phthisis, acute or chronic visceral inflammations, etc.—when the whole course of the disease is apt to be irregular. The stage of eruption may even be wanting. In such cases, a correct diagnosis depends rather upon etiological considerations than upon specificity of symptoms ; occurring sporadically, these cannot be identified. But it occasionally happens, in families, boarding-schools, asylums, etc., where measles prevails, that children unprotected by a previous attack and exposed to the contagion, in due time develop all the symptoms of measles except the eruption, and upon recovery remain protected from future attacks. Such forms are designated as *morbilli sine exanthemate.* When, on the other hand, the eruption occurs without a well-marked or recognized catarrhal stage, and without the development of catarrhal symptoms during its course, similar diagnostic difficulties arise, and one is only justified in recognizing *morbilli sine catarrho* in the presence of unquestionable conditions. Indeed, there are those who claim that unless catarrhal symptoms are present, a diagnosis of measles cannot be maintained. In these forms the course is usually mild. Rarely, a very interesting departure from a typical course is the appearance of a rash almost simultaneously with the outbreak of the stage of invasion. This is usually observed, upon the morning of the second day, upon the cheeks, forehead, temples, neck, etc. At

first it is like the ordinary measles rash in shape and distribution, but in color it is pale. With the mitigation of symptoms that occurs by the close of the second day, it ceases to develop, and may even recede partially and remain as pale, pinkish blotches, until the regular rash appears and supplants it. Such cases present generally no other abnormality of course. Irregular distribution of the rash is not very infrequently met with. It may invade the trunk alone, or may spare the lower extremities, or it may not appear in the order described. These are unimportant modifications and, of themselves, add no gravity to the prognosis.

As in mild cases the rash may be pale, scanty, and not well developed, so in severe ones it may be confluent, brilliant, and abundant; at times it may be livid, and the patches may coalesce into more or less extensive areas of eruption over the trunk and limbs, as well as upon the face. These patches feel elevated and infiltrated. Here and there tracts of unaltered skin will be sharply circumscribed by them. Pressure upon these dark, livid patches will generally cause them to grow pale; but there may be occasionally observed evidences of hæmorrhagic exudation in the increased lividity of the patches, and in the fact that they are uninfluenced by pressure. The eruption may assume a petechial character strongly suggestive of the exanthem of typhus fever. The hæmorrhagic spots often correspond closely to the eruptive lesions in configuration and extent, and remain for many days after the activity of the malady is passed. This condition is developed early, and may involve the entire area of eruption. It cannot be assigned to any recognizable cause, and, indeed, is not of serious augury. During convalescence these hæmorrhagic spots slowly undergo the changes of extravasated blood-pigment, and disappear within a week or two. This variety should not be confounded with that severe and extremely fatal form of measles known as "black measles," or "malignant hæmorrhagic measles," which is fortunately very rare, and which more especially attacks persons with bad hygienic surroundings, such as soldiers in camps, convicts, children crowded into badly constructed asylums, etc.; also those exhausted by intemperance, want, exposure, and similar influences. Here all the symptoms differ from those of the form just described, in which, although the petechial character of the eruption is marked, there is always the corresponding, associated intra-vascular hyperæmia of the eruptive lesion. These differ altogether from the purplish and blackish ecchymoses of malignant measles. It has even been asserted that the pigmentation in them is not due to extravasated blood, but to the decomposition of red blood-cells exuded in a purely inflammatory process. In malignant or "black measles," the symptoms of profound systemic intoxication are associated with the irregularly distributed rash, which is never perfectly developed. At first appearing possibly in the regular way, its abnormal course is soon declared. The eruption ceases to develop, and the lesions already present fade away or change into ecchymotic spots, which may correspond to the size of the primary lesion or assume linear or irregular shapes, and involve larger tracts of skin. These ecchymoses are most abundant and largest upon the trunk and on its most dependent parts, though they may appear anywhere. Signs of failure of circulation, quick and feeble pulse, coldness and lividity of the extremities, delirium, stupor, and subsultus tendinum develop. Hæmorrhages may occur into and upon mucous and serous membranes, and death follow early from profound toxæmia. Malignant measles may run a very rapid course, as is especially the case in some epidemics.[6] Convalescence, however, may be established, but will usually prove tedious.

The course of measles may be made abnormal by the existence of acute or chronic disease at the time of infection. Here much alteration in the features of the exanthem may be noted. The prodromal stage may be unusually protracted, or the eruption may be imperfectly developed, both as to intensity and in distribution; or the mucous membrane may have to bear the brunt of the attack; at other times the attack seems to receive a sudden check. The eruption fades, and is succeeded by great pallor. Such sudden arrest is usually due to an intercurrent malady, and will be more suitably considered with the complications of measles. It has already been said that convulsions occurring at the outset of the disease are not especially ominous. If, however, they occur repeatedly, or during the later stages of the disease, they are of grave augury, and often precede or accompany complications that may lead to a fatal issue. In rare instances the eruption is unduly prolonged; it has been known to persist as late as the tenth day.

Diagnosis.—Although the nature of the disease may very often be conjectured during the prodromal stage, it is only during the eruptive stage that the diagnosis of measles can be definitely determined. In typical cases the combination of fever, eruption, and catarrh of the mucous surfaces, affords characteristic and easily recognizable features, when considered along with the history and course of the malady. During the prodromal stage the symptoms may be mistaken for those of simple coryza or of bronchial catarrh. Indeed, they are often identical with these, and to this extent can cause no confusion. They may be suspected to depend upon the contagion of measles, if they develop in one who is known to have been exposed to it, or if during the second or third day the eruption upon the soft palate is observed. If, however, the fever and catarrh persist after the fourth day without an eruption, measles may be excluded nearly always. Upon the appearance of the eruption, measles may be confounded with Rötheln or German measles, scarlatina, typhus fever, and in its earliest stages with varicella and variola. It will also be necessary to exclude drug eruptions, such as those from copaiba, quinine, etc. The diagnosis between measles and Rötheln presents many difficulties. It is true that recent writers describe Rötheln as having well-marked characteristics; but it must be observed that many do not agree as to the exact history and symptomatology of this affection. This want of agreement makes it difficult to determine the standard of Rötheln for comparison. The diagnosis must rest upon a general consideration of all the symptoms. In Rötheln the prodromal stage only exceptionally exceeds twenty-four hours; it often is less than twelve hours. In many cases Rötheln is afebrile throughout, and in most cases it is barely febrile. Upon this point, however, there is no consensus of opinion, some authors describing epidemics of Rötheln in which fever of great intensity prevailed.[7] Cheadle even claims as a distinguishing mark of it, "a higher range of temperature and its longer persistence" than in ordinary measles.[8] The catarrhal symptoms in both affections differ only in intensity. The faucial mucous membrane in Rötheln shows a diffused redness rather than the flecked eruption of measles. Enlargement of the cervical glands has been noted as of constant occurrence in Rötheln, but it is likewise very often observed in measles. The eruption of Rötheln is pale red, rather than dark red, as in measles, while the patches are more circular and less discrete, and with less irregular borders. It is also more rapid in its course, and is but rarely followed by desquamation. It should be remembered, however, that upon no symptoms of Rötheln, as distinct from those of measles, have writers agreed, and that no case of Rötheln presents features sharply defined from those of measles. Up to the present time, therefore, one is not justified in diagnosticating Rötheln in any isolated case, unless the patient has already had measles or has been exposed to the influence of a prevailing epidemic of the former disease.

Of the other eruptive fevers, scarlatina is most like measles. Usually, however, the diagnosis is easily made. In scarlet fever the eruption appears by the second day. The fever is accompanied by sore throat, more or less severe, with intense redness of the faucial mucous membrane. The eruption is of a bright-scarlet color, and more regularly diffused; the papules are much finer. In well-marked cases there is a universal redness. In measles the eruption is of a dusky-red and arranged in circumscribed patches with intervening healthy surfaces. At times the measles eruption becomes almost univer-

sally confluent. The darker coloration is, however, still maintained, and the surface is distinctly infiltrated and elevated, giving to the hand a sensation of roughness. Moreover, there will always be areas of less intense eruption, where the characteristic arrangement may be recognized. Rarely scarlatina develops a discrete eruption closely simulating that of measles. The patches will then be of larger superficial area, of a brighter color, and less infiltrated. There will nearly always be present concomitant symptoms that should dissipate doubt. After the first few days the tongue, in scarlatina, develops the characteristic strawberry appearance, whereas in measles the tongue remains coated throughout. The eruption of scarlatina is accompanied by a more or less intense itching, that is usually absent in measles. The fever of scarlatina persists for some days after the eruption has attained its height, while in measles the completion of the eruption is marked by almost immediate defervescence. The desquamation of scarlet fever is composed of large, sometimes of enormous, flakes of epidermis, while that of measles is branny and not abundant. In scarlatina the faucial mucous membrane is inflamed, sometimes diphtheritic ; in measles there is catarrh of the whole respiratory tract. Finally, measles is not followed by dropsy and nephritis, which are so often observed after scarlatina.

During the first twenty-four hours the small-pox eruption may resemble that of measles, but its papular, shotty character soon reveals it. Varicella may also at first resemble measles, but its vesicular eruption quickly develops. The eruption of typhus fever is often perplexingly like that of measles. Doubt, however, is only apt to arise when the former affection is known to prevail, or where the conditions favorable to its development are present. The typhus eruption is especially like that of measles where the distribution is normal, but where extravasation gives a petechial character. Such cases of measles can be recognized through their concomitant symptoms. Bronchial catarrh is present in both. In typhus the nasal catarrh is absent, as is also the conjunctivitis, though the eyes may be injected. The eruption on the face is also absent or scanty. The course of the fever is also different in the two affections, the typhus exanthema not appearing until the seventh day.

A peculiar eruption following the ingestion of copaiba offers points of great similarity with that of measles, though at times it equally resembles that of small-pox. The resemblance is heightened by the catarrh of the conjunctival, nasal, faucial, and bronchial mucous membrane, and by the existence of fever. In the copaiba eruption the incubative period is lacking, and the rash, brighter red from the first, while exhibiting many patches indistinguishable from those of measles, develops many lenticular papules, totally dissimilar. At scattered points vesicles will almost always be observed. Simple roseola is less intensely colored and is more fugacious than measles ; it is without prodromal stage or catarrhal symptoms, and is usually afebrile. Moreover, many cases of what was formerly called roseola must now be relegated to the domain of Rötheln. Erythematous eruptions from quinine and other drugs somewhat resemble the measles rash ; but they differ widely in most other respects. Erythema papulatum may also resemble measles, but its seats of election, the face, the forearms, the dorsal surfaces of the hands and of the feet, along with its afebrile course and general history, will serve to distinguish it.

COMPLICATIONS.—The course of measles may be made irregular by complications ; or, occurring in persons already suffering from other diseases, measles may itself become the complicating affection. Disorders complicating measles may be simply the results of intensification of morbid processes characteristic of the disease, or they may be intercurrent. By far the most important are those involving the mucous membranes. " A high grade of purulent conjunctivitis may develop, and even false membranes may form upon the lids. True diphtheritic inflammation is not unknown. Purulent infiltration of the cornea and keratomalacia may be observed, but iritis occurs only secondarily." [9] Thomas has reported, as a sequela of measles, paresis of accommodation and, in consequence of this, strabismus. Rarely the nasal mucous membrane may undergo excessive inflammation. Stomatitis is more often developed, and may range from ordinary catarrh to ulcerative and even gangrenous inflammation. True *cancrum oris* or *noma* is more apt to occur as a sequela. In stomatitis the mucous membrane becomes highly injected. The tongue is thickly coated with a whitish fur, and has a sodden look. The gums are spongy and swollen, and often bleeding at their borders. Superficial ulcerations appear upon the buccal mucous membrane, and aphthous deposits accumulate. Saliva is copiously discharged, and fetor of the breath becomes pronounced. The sublingual and submaxillary glands often become greatly enlarged and tender. Much distress is often experienced, and mastication becomes almost impossible. The stomatitis usually outlasts the measles and subsides in a week or ten days. More profound and gangrenous ulcerations form extreme degrees of these inflammations. The more severe grades of pharyngitis only rarely complicate measles. *Diphtheritis faucium*, however, is not very uncommon. It usually leads to a fatal termination. Laryngeal and tracheal symptoms may at times acquire undue prominence, usually from catarrhal inflammation of a high grade. In such cases the voice, cough, and respiration become "croupy." Œdema of the glottis has been known to occur, and rarely may be so severe as to terminate life by asphyxia. True laryngeal diphtheria is also a recognized and very fatal complication of measles.

Bronchitis can only be considered a complication when it assumes a rôle more important than the essential disease. Severe bronchitis is quite common, and very often persists for some time after the eruption has disappeared. Serious results are not apt to ensue, but occasionally it may become grave more or less rapidly, or become suddenly intensified in badly nourished children, or in those not properly looked after. In such cases the fever is unduly prolonged, and the symptoms become those of ordinary acute bronchitis. A much more formidable complication is capillary bronchitis. Usually occurring during the decline of measles, it protracts the febrile movement while the eruption pursues its regular course, or, as more frequently occurs, prematurely fades with more or less abruptness ; the life of the patient being thrown into imminent peril. This affection is most dangerous, both from its own intensity and from its tendency to develop atelectasis pulmonum and catarrhal or lobular pneumonia. Whether arising in this manner or not, lobular pneumonia is the most common of the graver complications of measles, and is responsible for the greater number of deaths from the disease.* It occurs mostly in badly-nourished, delicate children, and in those who have been unduly exposed during the attack. Nevertheless, pneumonia often develops, in consequence of some individual predisposition, in those whose hygienic surroundings are perfect ; and it cannot be denied that the contagious principle at times exerts a special morbific influence upon the pulmonary parenchyma, as is shown in the greater prevalence of complicating pneumonia in some epidemics than in others. Catarrhal pneumonia may appear at any stage of measles, in patients of any age, and at any period of an epidemic. It is more apt to occur, however, in those under five years of age, in children of poor parents, and at the height of an epidemic. Catarrhal pneumonia, complicating measles, does not necessarily greatly increase the gravity of the attack. It is probably, in more or less restricted extent, a very common concomitant of measles, and in many cases where fever is protracted beyond the usual period, with persistence of symptoms of bronchitis, limited areas of lobular inflammation are present. The severity of the attack will be proportionate to the severity and extent of the pneumonia, which usually invades both lungs irregularly, beginning at the bases. There will always be present bronchitis, the symptoms of which are so prom-

* Pott reported as causes of death in 24 cases : pneumonia, 17 times ; capillary bronchitis, 4 times ; croup, 3 times (Jahrb. f. Heilk., vol. xiv., p. 331).

inent that the pneumonic symptoms may be very obscure. Crepitant râles, with slight dulness and bronchial breathing, may nearly always be detected during the attack. Dyspnœa is often decided, and there is greater tendency toward cyanosis than in lobar pneumonia. The sputa are generally catarrhal in character. The inflammation tends, in favorable cases, to terminate slowly, by lysis, possibly only after several weeks. When catarrhal pneumonia is the only complication, most cases end in recovery, but where it is but one of a number of complications, or occurs during a severe and abnormal attack of measles, the result is much more often fatal. Many cases of pulmonary tuberculosis after measles develop from an unresolved catarrhal pneumonia.

Lobar or croupous pneumonia is also a recognized complication of measles, but is of less grave import than the catarrhal form. It occurs abruptly, is not necessarily associated with extensive catarrh, and presents the characteristic symptoms. By many writers acute tuberculosis is described as a complication of measles. It should be classed among its sequelæ, though it doubtless very often dates back to the beginning of the attack. The intestinal catarrh that often becomes developed during measles sometimes becomes intensified, and to the diarrhœa there are added the symptoms of a more or less severe enteritis. Bloody, mucous stools, voided with tenesmus and the other signs of colitis, will at times be observed. These cases, however, usually end in recovery. Acute nephritis may also be a direct consequence of measles.[10] When convulsions appear during the course of measles after the development of the rash, they generally mark the supervention of some grave complication, and are thus of very evil augury. They may accompany pneumonia, enteritis, even meningitis. Inflammation of the middle ear of a catarrhal character, extending from the pharynx along the Eustachian tube, may occasion temporary deafness; or, it may be intense, with severe pain, and followed by perforation of the tympanum. Permanent deafness may, but usually does not, result from this. Occasional and rare complications are gangrene of various parts, dropsy, various inflammations, hæmorrhages, etc.

A much controverted question is that of the coexistence of measles with other eruptive fevers. Although Hebra denied the simultaneous presence of two of the exanthemata, many writers make positive assertions to the contrary. Thomas[11] says "measles can appear during the course of variola, scarlet fever, and varicella, and *vice versa*," and quotes Laverani as claiming that mumps attacked by preference patients suffering with measles, and Kesteren, who saw a girl attacked by measles while suffering from typhoid fever. Barthez and Rilliet also assert that two specific eruptive fevers may coexist. Blacke,[12] Steiner, Monti, Körber[13] report observations of the simultaneous existence of measles and other eruptive fevers, viz., scarlet fever, variola, and varicella. Traube,[14] Fischl,[15] Stiller, Trechmeister, and others report similar cases. There is, indeed, no reason why two specific morbid principles may not exert their peculiar pathogenic influences at the same time upon an individual. An abnormal course of different exanthemata, however, may be characterized by features of anomalous nature, and various lesions due to simple cutaneous irritation may complicate the eruptions. Erythematous, papular, vesicular, and pustular lesions may accompany any of these fevers, and may lead to errors of diagnosis. It is, therefore, not asking too much to insist that, before such coexistences can be definitely accepted, the evidence should include a sufficient number of cases of persons previously unaffected by either of the fevers in question, who have remained free from infection after subsequent exposure. Examples of one specific eruptive fever following another in near succession are sometimes observed; thus, Prior had a patient who developed scarlet fever November 18th, varicella December 2d, and measles December 13th.

SEQUELÆ.—These are either complications persisting after the subsidence of the exanthem, or they develop in consequence of some predisposition intensified or evoked by it. The power of resistance of the system is diminished by measles, and, under these circumstances, certain external influences may provoke morbid actions which, under more favorable conditions, they cannot. Thus, any affection attacking one lately recovered from measles must, strictly speaking, be called a sequela. As far as possible, however, it is better to restrict the term to those disorders where the parts implicated are especially involved in measles, and which can be definitely attributed to its effects. In this sense, nearly all sequelæ of measles may be said to originate in the mucous membrane. Not infrequently, more or less severe chronic conjunctivitis, with obstinate blepharitis and hordeoli, follows measles. Keratitis and even keratomalacia, and other alterations in the orbit, may be occasionally observed. Catarrh of the middle and external ear, with sometimes persistent otorrhœa, is not very uncommon. These catarrhal inflammations may result in changes that produce more or less complete permanent deafness. Catarrhal and aphthous, even gangrenous, stomatitis, sometimes follows measles. Whether by extension of these forms, or by spontaneous development, that, fortunately, rare buccal affection, *cancrum oris*, or *noma*, or gangrene of the mouth, has measles for its most frequent exciting cause (except, perhaps, mercurial ptyalism). Its course is usually a fatal one. Pharyngeal and laryngeal catarrh very commonly follow in the wake of measles. Usually, they are of brief duration. Ulcerative inflammations of these parts sometimes occur, and in the larynx may accompany or precede pulmonary phthisis. Bronchitis is the most common sequela of measles, carried over from the height of the attack. Its course is for the most part in the direction of health, but it too often becomes protracted, and leads to broncho-pneumonia and pulmonary phthisis. Broncho-pneumonia may develop after the effects of the measles seem to have disappeared, a slight cause serving to upset the balance of the lung, enfeebled by the antecedent attack. Croupous pneumonia may be similarly developed. Acute miliary tuberculosis may follow one of the affections just mentioned, or developing at once, may pursue a rapidly fatal course. It is resulting pneumonia, catarrhal and croupous, and pulmonary phthisis, that make measles so formidable a disease, and a high death-rate in this disease is usually to be referred to one or other of these complications, or sequelæ. Tuberculous disease in the bronchial and mesenteric glands may indirectly become sequelæ of measles, the latter following tuberculosis of the bowels. Entero-colitis, of very severe character, may sap the powers of life or greatly retard convalescence.

Measles may itself complicate other diseases, modifying and being modified by them. The coexistence of the acute eruptive fevers, and the influence of a pre-existing disease upon the course of measles, have already been considered. On the other hand, measles undoubtedly modifies the course of other diseases upon which it has become engrafted. Barthez and Rilliet have shown that a noxious influence is principally exerted over affections that are most frequently met with as true complications of measles. This disorder occurring during an attack of bronchitis, of lobular or lobar pneumonia, or of pulmonary tuberculosis, will almost invariably intensify them, yielding inflammation will be rekindled, and new areas will become involved. Recrudescence of tubercle will pretty surely occur in tuberculous patients, and mucous inflammations will be made more active. Some other affections, however, seem to become ameliorated upon the supervention of measles. This may be real or only apparent. In the latter case the original disease will fade away during the attack, to return in full vigor after its disappearance. Examples of this may be seen in various cutaneous disorders, such as eczema, seborrhœa, psoriasis, etc., and affections of different parts. It has been asserted, again, that a number of diseases may be radically and permanently removed by a complicating attack of measles. Barthez and Rilliet have seen chorea, epilepsy, incontinence of urine, etc., disappear after an attack of measles.[16] Thomas has also had a similar experience.

Relapses and Reinfections.—There may be very rarely observed in persons who have entirely recovered from measles, the sudden outbreak of an eruption exactly like that of measles in configuration, though hardly ever attaining more than a pale red coloration, and not accompanied by œdema of the skin or attaining a very wide distribution. Simultaneously there will be very slight fever and catarrhal symptoms, not exceeding slight conjunctival hyperæmia and redness of the upper air-passages. There may even be no fever at all. The appetite may not be affected, and the sense of well-being in no wise modified. The eruption is most abundant about the face, neck, and trunk, but may invade the general surface. It is exceedingly fugacious, hardly lasting more than twenty-four hours. These attacks usually occur within a few weeks after the original seizure,* and correspond closely to the descriptions of Rötheln, as given by certain writers. It is difficult to regard such attacks as other than relapses of measles. True reinfections, however, certainly do occur not so very rarely. Trujawsky [17] noted 14 cases of recurrent measles in 200 cases observed by himself. Six of these were children less than ten years old; 6 were children more than ten years old; 2 were adults. The intervals between the attacks were from six months to seven years, the average being three years. Kassowitz has also reported cases of reinfection in which the attacks closely resembled Rötheln. They, however, could be traced to exposure to the contagion of measles, and themselves communicated measles to others. The failure to appreciate the frequency of relapses and recurrences of measles is undoubtedly a fruitful cause of error and discord among writers.

Etiology.—Measles is an epidemic, contagious disease. All races of men are liable to it. The sexes are affected in almost equal proportion.† Although it nearly always attacks young persons, those of advanced age have no immunity beyond that conferred by infection in earlier life. Infants of tender age possess an immunity. This is not absolute, however, and a number of writers have reported observations of measles in new-born children. Beyond the first half-year of life this insusceptibility rapidly disappears, and after the second year nearly all who are exposed to the contagion contract the disease. It is remarkable, however, that a few persons preserve an absolute immunity under any degree of exposure, and that numbers enjoy a temporary immunity, escaping many exposures unscathed, finally yielding to the infectious influence. There is no reason to suppose that measles ever arises spontaneously. It is essentially contagious and is usually communicated by direct exposure to the emanations of a person sick of the disease, or through actual contact. The danger of contagion is proportionate to the propinquity of the contaminating influence, being greatest in the sick-room. It cannot be denied that measles may be spread by mediate contagion. In such cases the clothing probably becomes the disseminating agent. Such articles as have been used by the patient, the bed-linen, even those things that have been used in the sick-room, very frequently communicate the disease. The discharges from the patients are not above suspicion in this regard. Except small-pox, measles is probably the most contagious of the exanthemata, and is communicable from the early prodromal stage until desquamation is completed. The infectious properties are probably most active during the prodromal stage. The great difficulty of identifying measles during this stage in great measure explains the rapid dissemination of the disease in schools, asylums, etc. The contagious properties continue throughout the stage of eruption, but speedily diminish with it, and probably become extinct during desquamation. Girard declares that quarantine is of no use after the eleventh day of the disease.‡ On the other hand, there are those who consider infection possible for several weeks after the disease has spent itself.

The contagion of measles exists in the blood [18] and in tears, in expired air, in nasal secretions, in sputa, and in epithelial and epidermic structures. Many efforts have been made to determine its exact nature. Its power of indefinite increase from the smallest possible beginnings seems to preclude a gaseous or liquid origin, and all probabilities favor the conception of a living organic substance, a *contagium vivum*, as the essential cause of measles. In 1862 Salisbury [19] declared that a peculiar fungus found in straw is the true measles-germ and claimed to have produced the disease by inoculating unprotected persons with this fungus. His researches, though important as among the first in the now widely worked field of parasitic pathogenesis, have never been confirmed. Coze and Feltz [20] and Keating [21] found micrococci in the blood, and Ransome, Braidwood, and Vacher, in the breath of patients with measles. In the sputa of patients with measles Eklund detected an organism 1.5 μ in diameter, united in numbers of two, three, five, to eight, or more, to form chaplets. These he also found in blood from the eruptive lesions and in the urine. He named this organism *torula morbillorum.*[22] A bacillus has also been found in the urine in measles by Le Bel. These observations have differed too widely in their results to justify, at present, any conclusions regarding the specific nature of the contagious principle of measles.

Though measles may be communicated through inoculation of blood, tears, saliva, etc., ordinary infection probably always occurs through the mucous membrane and its products, particularly that of the respiratory tract, the epithelia serving as contagium bearers.

In larger cities measles is probably endemic. In small towns and in rural districts, there are often long intervals during which it is not observed. It displays a pronounced tendency to prevail epidemically; indeed, epidemics recur with such apparent regularity, that a definite periodicity has been attributed to its recurrences. Closer observation, however, shows that no such periodicity exists, and that the extension of the disease depends upon two factors, "the time of importation of the morbid poison, and the number of persons susceptible to it." [23] Epidemics appear to be of greater severity in proportion to the infrequency of their occurrence. Localities where the disease does not prevail during prolonged intervals, are said to experience its most intense types. A high rate of mortality is observed in races of men among whom measles prevails for the first time. This tendency has been supposed to be due to the action of the contagious virus operating upon the bodies of those who have not inherited through generations some capacity for resistance to its influence. There can be no doubt that different epidemics exhibit different types of severity or tendencies toward certain modifications or complications. The causes of this variability remain undiscovered. There is reason to believe that the great mortality following measles that prevails in a community for the first time, is in large measure due to the ignorance of the proper methods of treatment and general management of those affected. Just as bad hygienic conditions surely increase the mortality from measles, so will they the more readily under the circumstances now referred to. Accumulated evidence shows that even where the death-rate is at the highest, the disease is still very amenable to proper treatment. Masterman writes: "At the beginning of the Brazilio-Paraguayan war, an epidemic of measles swept off nearly a fifth of the national army in three months, not from the severity of the disease, for I treated about fifty cases in private practice without losing one, but from want of shelter and of proper food." [24] Identical results were obtained under similar conditions in the Hudson's Bay Territory, the Fiji Islands, and elsewhere. No season exhibits any special influence upon the type of the epidemic. The mortality of winter and summer is about the same, but the disease is undoubtedly more prevalent during the colder than during the warmer months (Hirsch). In warm climates measles pursues a course equally favorable as in temperate re-

* Trujawsky records six such cases, in which the intermission was from six to fourteen days, with a medium duration of eleven and five-eighths days. In these cases, however, the second attack was of equal or greater severity than the first one.

† Of 276 cases noted by Pott, 147 were girls, and 129 were boys.

‡ Hebra and Mayr and Munro assert that epidermis shed during the stadium desquamationis cannot communicate measles by inoculation.

gions, though there is a greater tendency toward intestinal complications. Local conditions of soil exert no influence in the etiology of the disease. The existence in an individual of chronic disease, especially of the respiratory mucous membrane, as bronchitis, pertussis, or tuberculosis, is said to predispose toward attacks of measles (Mayr).

MORBID ANATOMY.—In fatal cases of measles the blood, after death, is of a bluish or brownish-red color, and is seldom completely coagulated. "It is sometimes thick and tarry, sometimes thin and of a cherry-red color" (Mayr). According to Mayr, the eruption of measles is characterized by the pouring out of exudation about the mouths of the hair-sacs or sebaceous glands. On the other hand, G. Simon found no change in the hair-sacs or sebaceous glands, nor even in the cutaneous papillæ. He found the epidermis not separated from the corium, but slightly swollen over the papillæ.[25] Neumann[26] concludes that the pathological changes in the skin are almost limited to the glands and vessels. In the superficial vascular area there is round-cell proliferation of the vessel-walls, and especially in the papillary loops. The vessels themselves are dilated and hyperæmic. The sebaceous and sweat-follicles are infiltrated with round cells. Cell-infiltration of the *arrectores pilorum* is also observed. The cutis proper and the epidermis are almost unaffected. The changes in the mucous membranes are mostly those of ordinary catarrh. Traube has described a condition of the lungs observed by him in a number of children, who died during an epidemic of measles, which he calls "catarrhal interstitial pneumonia." In these the changes were very similar to those of the phthisis of adults, though the lower lobes were principally affected, and the process was, at most, only eight weeks old. In addition to evidences of catarrhal pneumonia, though the density of the lung could not be attributed to filling of the alveoli, many capillaries were empty. This condition was caused by a cell accumulation between the capillary wall and the lung epithelia. Traube thought that these cells were from the bronchial mucous glands, and that the entire process was an adenitis of these glands.

PROGNOSIS.—Under favorable conditions a fatal termination of uncomplicated measles is most rare. Indeed, except in cases of malignant or "black" measles, it may be said never to occur. Meigs and Pepper reported not one death in two hundred and fifty-seven cases. The complications of measles are, however, so many, and of such frequent occurrence, that what would ordinarily otherwise be quite a trivial malady, becomes frequently a source of great danger, and is often followed by death. It is thus that measles presents quite a formidable death-rate, death occurring most often during the second week—that is, after the course of normal measles would have been completed. The rate of mortality varies within wide limits. Ranke, in Munich, records a rate of 1.7 per cent. Of 844 cases Pott noted a mortality of 24, or three per cent. In St. Joseph's Children's Hospital, in Vienna, observations, extending over twenty years, showed a mortality from the disease of eight per cent. In an epidemic in Sydney, reported by Caroll, in which there was a tendency toward malignancy, 54 of 900 measles cases perished. Fleischmann records 162 deaths in 740 cases; the minimum annual mortality was 2.3 per cent., the maximum rate was thirty-one per cent. His cases were classified as follows: Under one year, 35 cases, 18 deaths, fifty-one per cent.; from one to four years, 355 cases, 123 deaths, thirty-four per cent.; from five to eight years, 350 cases, 21 deaths, six per cent. Under five years there were 390 cases with 141 deaths, or thirty-six per cent. Every fifth child had pneumonia. Of these, sixty-six per cent. died. This high rate of mortality is due to the bad hygienic surroundings of children previous to their admission to hospital—conditions favoring the development of fatal inflammations. In malignant epidemics a much higher death-rate may be attained. At Lippe, in Hungary, in 1856, fifty per cent. of those attacked succumbed. In some epidemics there is developed a greater tendency toward dangerous complications than in others. The prognosis is always incomparably more favorable in patients whose surroundings accord with the best hygienic conditions. It has already been shown that the high death-rate in certain races and localities is mostly attributable to want, exposure, foolhardiness, and not to especial malignity of the epidemic. The great mortality from measles in camps results from the necessarily exposed life of the victims. Under nearly all conditions the prognosis will depend upon the presence or absence of complications. Of these pneumonia most often destroys life. Croupous pneumonia, it is true, most often runs a favorable course, but catarrhal pneumonia is of much greater gravity, both immediately and remotely, as serving to initiate the processes leading to pulmonary phthisis. The extent and intensity of the pulmonary inflammation will serve as an index to the gravity of the case. Catarrhal croup is usually of not great importance, unless accompanied by œdema and spasm of the glottis, in which event death may ensue at once. Diphtheria, whether attacking the laryngeal and tracheal and pharyngeal mucous membrane, or any other portion of the respiratory or general mucous surface, is not very uncommon, and usually leads to a fatal issue. Convulsions occurring at the outset of the attack add but little gravity to the case, but occurring during the eruptive stage, or that of decline, they are most ominous, as denoting the occurrence of dangerous complications that commonly end in death. The development of gangrene or of tuberculosis augurs unfavorably for the patient, the first usually, the latter always. In certain cases, and in certain epidemics, there is a tendency toward inflammation of the bowels. This may develop into severe complications, and may prove fatal. The persistence of high fever beyond the usual period, the occurrence of delirium, great rapidity and difficulty of respiration, of uncontrollable diarrhœa, of convulsions, the sudden, premature recession of the rash, copious and repeated epistaxis; all increase the gravity of the situation. Measles occurring in a person already suffering from a serious disorder is very apt to terminate unfavorably. In delicate and feeble children, especially those whose respiratory organs are feeble; in persons exhausted and broken down by exposure, hunger, insufficient nourishment, prolonged marching, etc., measles may form a most dangerous malady. Children of less than two years stand in more danger, when attacked, than those of greater age. Adults are more liable to fatal complications only when their conditions of life are especially unfavorable. Pregnancy is said to add greatly to the dangers of measles, and abortion may ensue. This statement is true only in a limited sense, and cannot be made of general application.

TREATMENT.—There is no specific treatment for measles. Its management will depend upon the type and the intensity of the attack, the nature and character of various symptoms and complications, the condition and surroundings of the patient. Very little need be done for a case of simple, uncomplicated measles. Most cases will do very well without any medicinal treatment whatever. Upon the appearance of prodromal symptoms, the child should be confined in a comfortable, well-ventilated room, free from draughts and dampness, at a temperature ranging from 69° to 70° F. during the colder months. Until the increasing severity of the symptoms destroys the desire to be up and about, he need not be kept in bed. As the stage of eruption approaches, the little patient will usually become so uncomfortable that he makes no objection to confinement in bed. During this period, a warm bath may allay the highly irritable condition of the nervous system so often observed. It also certainly favors the evolution of the eruption, if given toward the end of the third, or during the fourth day. As the eruption develops most copiously about a locality where active hyperæmia has been artificially induced, as by a sinapism, so the general cutaneous hyperæmia induced by a hot bath will facilitate the evolution of the general eruption. The child may be immersed in a bath of from 90° to 100° F. for from three to five minutes, and when removed should be immediately wrapped in blankets, when, without the use of towels, it will soon become dry

enough to be dressed in its night-dress. Warm drinks are, in the writer's opinion, a very useful agent in inducing gentle diaphoresis and in promoting the normal development of the eruption. Of these, hot lemonade and flaxseed-tea are probably the most satisfactory. Though the temperature during the prodromal stage may already reach a high degree, it will very infrequently be necessary to employ cold bathing or other active antipyretic treatment at this period, or, indeed, at any period of normal measles. In ordinary cases the use of cold water externally, while probably not harmful, does not offer any especial advantages, in view of the usual natural tendency toward recovery. Although cold bathing is recommended by Thomas and others, with cold compresses and packs, whenever the temperature reaches 103° F., its employment can only be considered important in pronounced hyperpyrexia, a rare condition in measles. Should there be insomnia, restlessness, or premonitions of convulsions, one of the bromides will prove invaluable.

As the eruption begins to appear, all active medication may in most cases be neglected. Ordinary vigilance in controlling the movements and behavior of the patient, the administration of proper food, the maintenance of proper ventilation and temperature, will be all that is required in many cases. Very often, however, certain symptoms become unduly prominent and call for alleviation. The catarrhal symptoms, for example, may be distressing. Bronchitis may be severe and associated with more or less troublesome cough, and even with the signs of spasmodic croup. An expectorant, with or without a bromide, will here prove of great assistance. Tartar emetic, which might otherwise be most serviceable, is here inadmissible on account of the diarrhœa so frequently present, which it might tend to aggravate. Squill, ipecac, senega, in various combination, in the ordinary popular cough-syrups, may be given with or without small doses of opium. The vomiting, which is sometimes very annoying, may often be relieved by drop-doses of dilute hydrocyanic acid, by crushed ice, by small quantities of brandy or champagne, or by any of the agents usually employed to control nausea and vomiting; or it will often quickly subside spontaneously, if the stomach be allowed to remain at rest until the desire for food has returned. The use of purgatives should be avoided, if possible, as, from the habitual tendency toward diarrhœa in measles, this may be suddenly aroused and become troublesome. When decided constipation is present, it is better to use enemata or the milder laxatives and purgatives, such as castor-oil, rhubarb, or magnesia. When the eruption prematurely recedes, as from the occurrence of grave complications, it is useless to attempt to effect relief by efforts to recall it. Attention should be concentrated upon the intercurrent malady. Epistaxis is not apt to produce alarming consequences. The application of ice to the nose under these circumstances is not advisable. Compression of the facial and nasal arteries will often control the hæmorrhage. Remedies ordinarily influencing epistaxis—ergot, turpentine, sulphuric acid, and the various appropriate external applications—must be employed. The diet should be of the simplest character. Indeed, during the first few days, anorexia is so complete that all nourishment is refused. Since the course of the disease covers only a few days, this is of small importance, and the patient may be spared the importunities of over-anxious mothers and nurses. Milk, alone or with lime-water, will often be acceptable, and may be given to the exclusion of everything else. Malignant measles will require the energetic administration of alcohol, carbonate of ammonia, and other stimulants. Under the use of such remedies a not insignificant proportion of these cases will recover.

Complications originating in the respiratory apparatus call for special treatment. Croup, whether catarrhal or diphtheritic, requires the same treatment as when primary. Capillary bronchitis, catarrhal and croupous pneumonia, should be treated in the ordinary manner, but with especial reference to their debilitating consequences as complications. Counter-irritation and warmth must be applied to the chest. The oiled-silk jacket here serves an excellent purpose. Poultices, when properly applied over the affected lung, serve admirably, but the dangers from improper management, the tendency to dampen the clothing and chill the surface when unskilfully used, may well deter one from their use. Expectorants containing the chloride and carbonate of ammonia, quinine, and such agents should now be employed, and especial attention paid to the diet, since the illness will now be protracted beyond the usual period. Diarrhœa does not often call for interference, as it will nearly always spontaneously cease after a day or two. A dose or two of opium, with subnitrate of bismuth, or a few grains of Dover's powder, or some drops of camphorated tincture of opium, will, in nearly all cases, prove effective. Catarrhal affections of the eye and ear require some attention. For most cases the simple exclusion of light, or an eye-wash of tepid water or milk, is all that is required. More severe inflammation requires especial treatment in accordance with its intensity. If the eyelids adhere, they must be separated by bathing in warm water and anointing with cold cream. The more severe disorders of the eye demand more energetic and special treatment. Aural inflammations spread from the buccal and nasal cavities, and often excite violent earache, which must be combated with warm opiated instillations through the external auditory canal. Atropia frequently acts charmingly in this condition, administered in two- or three-drop instillations of a two or four per cent. solution. Hyperpyrexia will not occur in uncomplicated measles. When it occurs it should be treated upon general principles. Great relief is often afforded patients affected with measles by inunctions of camphorated oil, cold cream, or other fatty substance. Milton has highly extolled this method of treatment.

The patient should be kept in bed until all fever has subsided, and should not be permitted to leave his room until the disappearance of all symptoms, normal or abnormal. During convalescence appropriate tonics, ferruginous and otherwise, will prove valuable. Cod-liver oil should be administered to weakly persons, or those who continue to have weak lungs after the attack.

Prophylaxis.—Measles is so intensely contagious that nearly all persons are attacked by it before adolescence. Unfortunate results so often follow it, however, that no one is justified in not placing unprotected persons beyond its influence. With measles the difficulty of accomplishing this is especially great, since it is already intensely contagious during the prodromal stage, when accurate diagnosis is often impossible. A person with measles should be separated from those who are unprotected, in a room into which only the attendants should be allowed to enter. Communication with the rest of the household should be as restricted as possible. All soiled linen should be soaked in disinfecting watery solutions and boiled separately. During the eruptive period the contagion will be much less disseminated if the whole surface of the body be systematically oiled once or twice daily. Isolation must be practised until all symptoms have subsided. Recent investigations make it very doubtful whether the disease can be communicated during desquamation. Some writers assert that a month should elapse before the patient be permitted to mingle with unprotected persons. Others (Girard) claim that quarantine is not necessary after the eleventh day of the disease. A hot bath administered at this time will remove nearly all desquamated epidermis, and along with it the contagious principle. Inoculation with the contagion-bearing particles from patients with measles has heretofore always educed unmodified measles, but it is not impossible that procedures may ultimately be discovered whereby prophylactic measures similar to those employed against small-pox, by inoculation, may be made available.

I. E. Atkinson.

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MECONIUM is the name applied to the contents of the intestine of the fœtus, and is the first matter to be defæcated after birth, as a nearly black moist viscous mass. It consists largely of fragments of the epidermis and sebaceous secretions (vernix caseosa) swallowed by the embryo, and mixed with and colored by the biliary fluids. Meconium appears by the beginning of the fifth month (Hennig) and is at first yellowish, but gradually turns dark green or black. By the seventh month it fills the whole of the large intestine. The term is of Greek origin and is said to have been used by Aristotle. Meconium is interesting to the physiologist because it proves the early activity of the liver and the early occurrence of intestinal peristalsis.

From its double origin meconium may exist in two forms, one in which the parts derived from the amniotic fluid predominate, and another in which the gall products predominate; between these extremes every variety occurs. By swallowing the amniotic fluid (*cf. Amnion*, vol. i., p. 140) the fœtus takes in epidermal scales, woolly hairs, and bits of the vernix; the two former are found again in meconium, but little altered; the latter supplies some fats, which may wholly or partly be changed into fatty acids. The intestine supplies some mucus and also epithelial cells.[1] The gall supplies the characteristic and essential parts of meconium, cholesterin, biliverdin and bilirubin, taurocholic, and other biliary acids. In normal meconium there are no putrefaction products.[2-9] When the development is abnormal, so that the passages to the stomach are occluded, the epidermal contingent, of course, does not appear in the meconium. At the time of birth meconium contains about 80 per cent. water, 1 per cent. ash, 0.77 per cent. fat, and 0.8 per cent. cholesterin. Zweifel's analysis[11] of the ash gave ferric phosphate 3.41, sulphuric acid 23.0, chlorine 2.53, phosphoric acid 5.44, lime 5.7, magnesia 4.0, potassium 8.6, sodium 41.0.

"In forensic medicine meconium has first the significance that the finding it in the intestine of a child indicates that the latter was new-born, because, as a rule, the meconium is discharged immediately, or soon after birth. Some have gone further, wishing to take the presence or absence of meconium in the large intestine as an indication whether the child was born alive or still. This is, however, erroneous on both sides, first, because meconium is by no means always and completely evacuated immediately after birth, and secondly, because it is by no means rare that children are still-born with the rectum emptied, as, for example, occurs nearly always in cases of fœtal suffocation. In such cases the meconium discharged into the amniotic fluid may be swallowed again by the fœtus, and so acquire a new forensic meaning, since its presence in the respiratory passages and stomach of a child, whose lungs at the same time contain no air, indicates fœtal suffocation with great probability, or even certainty. Finally, meconium stains on clothing may have evident value when there is suspicion of a delivery and subsequent doing away with the child. In such cases one must endeavor by microscopical examination to detect the presence of woolly hairs, epidermis cells, cholesterin crystals, and bilirubin crystals. A chemical examination ought also to be made. For this purpose Zweifel recommends moistening the stains with a little water in order to remove them from the cloth, then drying over a water-bath, and making Gmelin's reaction according to the usual rules" (E. Hofmann).

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The most important articles are those of Huber[6] and Zweifel.[11]

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Charles Sedgwick Minot.

MEDIASTINUM, DISEASES OF THE. The mediastinum (from *medius*, middle, and, probably, *stare*, to stand) is that portion of the thoracic cavity which lies between the lungs. It is bounded in front by the sternum, behind by the spinal column, and on either side by the fold of the pleura, apposing that covering the internal surfaces of the lungs. At the upper portion its connective tissue is continuous with that of the neck, and below the space is bounded by the diaphragm. It is divided by different anatomists into an anterior and a posterior, or a superior and an inferior, portion, and for convenience in locating the various organs contained within the cavity, all these four divisions may be retained.

In the anterior portion, extending from the posterior surface of the sternum to the hilus of the lungs, are found the heart and pericardium, the pulmonary artery, the ascending, and part of the transverse, portion of the aorta, the superior vena cava, and the cardiac plexus. In the fœtus there is found also the thymus gland. The posterior division of the mediastinum, bounded by the hilus of the lungs in front and the vertebral column behind, contains the descending aorta, the azygos veins, the thoracic duct, the œsophagus, the pneumogastric nerves, branches of the great sympathetic, lymphatic glands, and connective tissue. The boundary separating these two portions of the mediastinum is made up of the trachea, bronchi, pulmonary arteries and veins, lymphatic glands, nerve filaments, and connective tissue.

In the upper division of the mediastinum are found the upper portion of the pericardium, the left subclavicular vein, the arch of the aorta, and the vessels given off from it, the pulmonary artery, the pneumogastric, recurrent laryngeal and phrenic nerves, the œsophagus, the thoracic duct, the azygos veins, lymphatic glands, and connective tissue. In the lower portion are found the larger part of the pericardium, the heart, and commencement of the great vessels, the pneumogastric and splanchnic nerves, the azygos veins, descending aorta, and thoracic duct.

The lymphatic glands of the mediastinum are divided by Baréty into three sets: 1, the right and left peribronchial; 2, the right and left sub-bronchial; and 3, the inter-bronchial.

The diseases and injuries of the organs lying within the mediastinum will be found treated of in other parts of this HANDBOOK, and we shall consider here only the affections which may be regarded as those of the mediastinum proper. These may be ranged under the four heads of inflammation, abscess, wounds, and tumors.

Inflammation of the cellular tissue may be acute or chronic, primary or secondary. It may be limited to the neighborhood of the mediastinal glands, or may involve, to a greater or less extent, the general connective tissue of the space. Primary, or idiopathic, inflammation is rare, and the possibility of its existence is denied by some writers. In a very large proportion of cases, it is propagated by continuity from some of the neighboring parts.

As the connective tissue of the mediastinum is directly continuous with that of the neck, inflammation of the latter is peculiarly liable to work its way down into the former. Death from suppurative mediastinitis, following tracheotomy or wounds of the neck, is by no means unknown. More frequently, however, the affection follows fracture of the sternum, wounds of the mediastinum, or perforation of the œsophagus. The inflammation may terminate in resolution or, rarely, may go on to suppuration ; it may also become chronic and result in plastic effusion and adhesions between the various organs. The general symptoms of mediastinitis are those of inflammation elsewhere. There is a feeling of weight or of actual pain behind the sternum, extending at times to the neck or shoulders. If suppuration occur, the symptoms of pressure upon the contiguous nerves, vessels, and organs will be superadded.

Abscess of the mediastinum may, as stated above, in rare instances follow an acute inflammation, but more commonly it occurs secondarily to disease of other parts. It may follow mediastinal adenitis, caries of the sternum or of the cervical or dorsal vertebræ, septic wounds of the mediastinum, or perforation of the œsophagus by a foreign body lodged in it. The local symptoms of mediastinal abscess are those of pressure, and vary somewhat according to the size and location of the purulent collection. There is usually present a dull, post-sternal pain or feeling of weight ; the action of the heart is interfered with, either mechanically or in consequence of pressure upon its nervous supply, whence occurs palpitation ; swallowing is difficult, there is apt to be nausea, dyspnœa, and an irritating sensation in the larynx, causing a troublesome, hacking cough ; and often there is congestion of the face arising from compression upon the superior vena cava. There are also fever and the general symptoms of acute suppuration. In cold abscess, when the pus comes from vertebral caries, for example, there may be no constitutional symptoms, or there may be hectic fever, sweating, and other signs of chronic suppuration. When the pus has made its way to the surface, its presence is usually manifested by the appearance of a fluctuating tumor situated to one side or the other of the sternum, more frequently perhaps to the left. In certain rare cases the pus may not point externally, but may pass down into the abdomen, or may break through the pleura or pericardium. The only treatment for acute mediastinal abscess is prompt evacuation of the pus as soon as its presence is detected, for when left to itself there is great danger of perforation of one or other of the adjoining serous sacs. Even after evacuation the prognosis is not favorable as regards a speedy cure, as the inflammation is apt to persist in a subacute or chronic form, the sinus remaining open and discharging for weeks or months. In symptomatic abscess (*Senkungsabscess*) the necessity for immediate evacuation is not so urgent, as perforation of the neighboring serous structures is not likely to occur ; yet it is the better plan to let out the pus at an early moment, and establish free drainage.

Little need be said of wounds of the mediastinum, for the penetrating body seldom spares the vital organs contained within this space, and consequently there is no time for treatment of any sort to be effective. Yet a bullet may enter the mediastinum, carrying with it, perhaps, pieces of the clothing or splinters of bone, and lodge there without having touched any of the important structures therein contained. These foreign bodies may, here as elsewhere in the body, become encysted and remain for years without causing any inconvenience, but most commonly they lead to inflammation and abscess. The indication is, of course, to extract the foreign body and to treat the wound according to the modern rules of antiseptic procedure, in order, if possible, to ward off pyæmia, which is always imminent in acute suppurative inflammation of the mediastinum. The extraction should be attempted through the point of entrance, though great care should be observed in order not to wound the vital organs. But rather than grope around blindly in this dangerous region, it would be safer to enlarge the opening.

We have finally to consider new-growths within the mediastinum. These are formed usually at the expense of the heart, pericardium, aorta, œsophagus, or other organs, or they may arise from the mediastinal glands, or in rare instances, from the connective tissue of the mediastinum. The affections of the different organs, such as hydropericardium, aneurism, carcinoma of the œsophagus, and the like, will be found described under their proper headings in this HANDBOOK, and it remains only to mention the new-growths originating from the lymphatic glands and connective tissue of the mediastinum itself. The glands may be the seat of inflammation, or hypertrophy, or of tubercular infiltration, and occasionally, in pulmonary phthisis, the latter may be present in such a degree as to constitute almost an affection apart, and to add very greatly to the gravity of the original disease (see article Lungs : Diseases of the Bronchial Glands).

The tumors arising from the connective tissue are for the most part cancerous in their nature, the encephaloid variety being found with much greater frequency than the scirrhous. Hydatid cysts have been met with post mortem in the mediastinum, and a case of dermoid cyst of this region has been recorded. There may also be tumors of syphilitic origin in this situation as elsewhere, and in doubtful cases it is always well to try the effects of specific treatment.

The symptoms of mediastinal tumors are chiefly those referable to pressure upon the nerves and blood-vessels of this region, finding expression in pain and in disturbances of the circulation or of respiration. There are pain, sometimes paralysis, dyspnœa, passive congestion, and cough, and these symptoms often vary in degree and intensity according to the position assumed by the patient. Occasionally there is dysphagia from compression of the œsophagus. There are in many cases cyanosis and œdema of the face, neck, and upper extremities. These signs may be present on both sides or only on one, or a single arm may be œdematous and congested, these varying conditions being dependent upon the veins compressed or involved in the growth of the tumor. There may be pronounced cerebral symptoms, vertigo, nausea, tinnitus aurium, etc., occurring usually from circulatory disturbances within the cranium. Sometimes there is asymmetry of the pupils. There is usually, after the tumor has attained a certain growth, flatness on percussion over the sternum, and not infrequently the lung, on one or the other side, is pushed aside and compressed, or, in the case of cancer, may be involved in the new-growth. In such cases the area of dulness or flatness will be greatly increased. Auscultation reveals the presence of pleuritic exudations, bronchitis, localized emphysema or other conditions occurring secondary to the mediastinal growth. The heart-sounds are usually weak, and the presence of a murmur is not infrequently noted. This murmur is caused by pressure of the tumor, and is often irregular in its seat and inconstant, according to the varying conditions of growth and of position of the tumor. The pulse is sometimes remarkably slow, the effect of irritation of the vagus.

The treatment of mediastinal tumors is, as a rule, purely palliative, and the subject is interesting chiefly from a semeiological point of view rather than from a practical one, since operative measures for the removal of the new-growth are clearly unjustifiable. No permanent good could result from the removal of tubercular glands or cancerous tumors, and the immediate danger of the operation would be such as to counterbalance any temporary relief of symptoms which might follow. In the case of cystic tumors, in the somewhat improbable event of a diagnosis being made intra vitam, aspiration ought to be resorted to, and under favorable contingencies, incision into the sac with subsequent drainage might afford permanent relief. In the case of syphilitic tumors, specific treatment is, of course, demanded.

Thomas L. Stedman.

MEDICAL LAKE. *Location and Post-office:* Medical Lake, Spokane County, Washington Territory.

ACCESS.—By Northern Pacific Railroad to Cheney, thence ten miles by stage to the lake.

Analysis (G. A. Mariner).—One pint contains:

	Grains.
Carbonate of soda	7.943
Carbonate of magnesia	0.029
Carbonate of lime	0.023
Carbonate of lithia	trace
Carbonate of iron	0.065
Chloride of potassium	1.155
Chloride of sodium	2.046
Sulphate of potassa	trace
Silicate of soda	1.329
Biborate of soda	trace
Oxide of alumina	0.021
Organic matter	0.069
Total	12.680

Therapeutic Properties.—Medical Lake is a natural curiosity. It is situated in the Big Bend country of Washington Territory, is about a mile and one-fourth long by one-fourth wide, and has neither visible outlet nor inlet. Its depth varies from one hundred to forty feet. The water belongs to the alkaline class, but is peculiar in that it contains a very unusual proportion of silicate of soda. There is a small town on the lake, and primitive arrangements exist for bathing. *G. B. F.*

MEDICATING, MODES OF. Medicines act only by coming into actual contact with the part *primarily* to be impressed, and the various *modes of medicating*, so-called, are simply different methods for securing such contact, varying according to circumstances. Modes of medicating fall naturally into two categories, namely, first, modes of direct medication of surface-parts immediately accessible to local application; and, secondly, modes of medicating internal parts accessible only through the avenue of the blood. Medication by any of the methods of the first category is commonly and conveniently spoken of as *local* medication; and, contrariwise, by any of the modes of the second category, is called *general* medication. But concerning this phrase, "general medication," the obvious point must be noted that, although in one sense medicating by the avenue of the blood is always "general," for the reason that, perforce, under the circumstances, the medicine must be carried wherever the blood circulates, yet in the sense of *therapeutic activity* the medication, as such, is in many instances as purely local as if the drug had been locally applied from without. Thus, for instance, copaiba, swallowed, circulates generally with the blood, in which its virtues become dissolved, but yet the main influence of the drug and the entire therapeutic purpose thereof are commonly upon the surface of the urethral mucous membrane, with which the medicine comes into contact by excretion by the kidneys, in solution in the urine.

I. Modes of Medicating by Direct Application.—Of parts directly accessible, the *skin* is so readily so that but few technical points present themselves in the matter of the application of medicines to this surface. The points, such as they are, are as follows: *First*, the skin being comparatively insensitive on the one hand, and non-absorbent on the other, medicines can, in general, be applied to its surface, *if unbroken*, of higher intrinsic potency, or in stronger concentration, than would be permissible in the case of most mucous membranes. Yet it must not be forgotten that, on the one hand, many even non-corrosive substances may be sharply painful to the more sensitive parts of the skin, as, for instance, chloroform; and, on the other, as regards absorbability, that even the unbroken skin has a certain degree of absorbing faculty; so that substances which are at the same time of high toxic and high diffusive power, such as carbolic acid, may easily produce dangerous and even fatal constitutional derangement by absorption after local application to the skin. The *second* point to note in connection with skin medication is, that different parts of the skin are of very different degrees of general sensitiveness—in general the thinner areas being the more sensitive; also, that the same area may be of different degrees of sensitiveness, as regards results of medicinal applications, in different individuals, and that, obviously, a *clean* skin is medicinally impressed more readily and more thoroughly than a dirty one. The *third* point is, that in the medication of hairy portions of skin, the effect will be far more thorough if the hair be shaved, or at least cut short, before the application is made. *Fourthly*, it is to be remembered that the skin, as a whole, constitutes an organ fulfilling certain physiological functions which it will not do wholly to suppress. The persistent covering of the entire skin with matters impervious to the air is therefore fraught with mischief, and even danger. *Fifthly*, in the choice of materials to serve as a basis for a skin medicament, *oleic acid*, among the substances in common use, seems to show the readiest faculty of penetrating the skin-tissues, the only objection to the substance being its somewhat irritant property.

Besides the skin, the *mucous membranes* present surfaces more or less accessible for direct medication. Concerning these structures, the first point to note is the very great difference of sensitiveness among mucous membranes of different localities—some being hardly more sensitive than the outer skin, while others are most exquisitely tender. According to locality, therefore, applications intended for mucous membranes must vary within wide limits in strength. The *least* sensitive mucous membranes are those of the *alimentary canal*, and of the *female generative organs*; the *middle class* in this regard comprises the mucous membranes, respectively, of the *conjunctiva*, the *air-passages* beyond the larynx, the *middle ear*, the *lower* portion of the *nasal cavity*, and the *urethra*; while as a third class, of *extreme* sensitiveness, stand the mucous surfaces, respectively, of the *cornea*, the *upper* portion of the *nasal cavity*, and the *larynx*. The second point in connection with the medication of mucous surfaces is the fact of the very different degree of *accessibility* of mucous membranes. Some mucous membranes, as for instance that of the mouth, are as easily accessible as the skin itself, while others, such as that of the bladder, can be reached only by special instrumental appliances. It is out of place in this article to describe in detail the various instruments required in the making of medicinal applications, but certain technical points relating to the medication of the mucous membranes, severally, are proper themes for comment.

Medication of the Conjunctiva.—The conjunctiva is directly accessible, and medicaments can be applied in solution, in ointment, in powder, or, as in the case of nitrate of silver, by a touch of the solid substance. The only technical point in medicating the conjunctiva is to thoroughly expose the retro-tarsal fold for the application, when, as happens in the majority of cases in conjunctival affections, the point of greatest intensity of the disease is situated exactly in that locality. To this end the patient should be directed to cast the eyes strongly downward, while the surgeon draws the everted upper lid upward and backward. Another caution well to note in this place is to avoid any application of a salt of *lead*, if there be any loss of the epithelium of the cornea, whether by an ulcer or an abrasion. This, because upon any exposed surface of corneal tissue proper, the application of a lead solution will determine an indelible, white opacity.

Medication of the Nasal Cavity.—The *lower* portion of the nasal cavity may be medicated by the snuffing up of dry powders or of solutions—a very imperfect measure in either case. More thorough is the blowing in of powders by a blast from a rubber bag, or the injection of solutions. But, as regards the latter procedure, the danger must be remembered of the injected fluid passing up the Eustachian tube to the middle ear, with, possibly, disastrous consequences. Direct injection from the anterior nares, and the so-called *nasal douche*, where the injected fluid enters one nostril and, passing around, escapes anteriorly by the other, are measures nowadays very justly condemned by the majority of practitioners. The safest means of flushing the nasal cavity with a solution is by the *posterior nasal syringe*, but even this measure is accused of occasionally producing middle-ear inflammation. *Atomized spray*, driven into the nose from before or behind, is, naturally, far safer than solutions in bulk. To medicate the *upper* portion of the nasal cavity, the same

means are available as just described, with the same inherent dangers; the only point to note being that this same upper portion of the Schneiderian membrane is very much more sensitive on the one hand, and difficult of access on the other, than the lower. It is often doubtful whether insufflations or injections, whether of solutions in bulk or of spray, reach the upper regions of the nasal cavity at all. The mucous cavities, respectively, of the ethmoid and sphenoid bones, the frontal sinuses, and the antrum are practically inaccessible to direct medication.

Medication of the Eustachian Tube and Middle Ear.—In cases of perforation of the ear-drum the middle ear is accessible to injections through the external auditory canal, but otherwise can be reached only by injections or insufflations through the *Eustachian catheter*, a specially shaped catheter introduced through the nostril so as just to engage the opening of the Eustachian tube. Concerning medication through the Eustachian catheter, the only points proper to note in this article are that, in the first place, the manipulation of the catheter itself requires technical knowledge and skill, and in the second, that the mucous surfaces under consideration are very sensitive to irritation, so that mischief instead of benefit may easily result from over-zealous practice of direct medication.

Medication of the Mouth and Pharynx.—The *mouth* may be medicated by mouth-washes, by troches, or by direct localized application at the hands of the surgeon in any of the ordinary ways. The *pharynx* is medicated by applications of spray, by injections by means of the posterior nasal syringe, or by solutions exactly applied by a mop attached to a properly shaped handle introduced through the mouth. Strong applications are best made by the latter method, since sprays and injections may, undesirably, find their way into the larynx or into the posterior nares. *Gargling* is fairly efficacious for medicating parts anterior to the faucial arch, but is of little avail for affecting the pharyngeal region.

Medication of the Larynx.—The larynx is medicated by the inhalation of vapors or of solutions in spray, or, at the hands of the surgeon, by local touch by means of special probangs applied with the help of a view in the laryngoscope. Technical training and a delicate hand are necessary in laryngeal manipulation, and the extreme sensitiveness of the mucous membrane of the larynx to irritant applications must ever be borne in mind.

Medication of the Respiratory Mucous Membrane beyond the Larynx.—The air-passages beyond the larynx can be directly medicated only by *inhalation*. Vapors and solutions in spray can be inhaled with a view to medicinal effect, but the *vapors* must be such as are non-irritant, and as regards *sprays*, the whole drift of exact observation tends to strengthen the belief that fluids inhaled in spray never penetrate beyond the larger bronchial tubes. (See Inhalations.)

Medication of the Bladder and the Urethra.—The *urethra* is accessible by injections, by medicated "bougies" of cacao-butter, and by the sound, smeared with the medicament in ointment or in any pasty condition, The *bladder* is reached only by injection through the catheter. The mucous membranes of these localities belong to the sensitive class, and the introduction of fluids or instruments not *germ-sterilized* into urethra or bladder may determine cystitis. What is practically a local medication of the urinary mucous membrane is afforded by the action of such medicines as buchu, cubeb, and copaiba, when taken by swallowing. The active principle of such drugs is excreted, possibly more or less changed, by the kidney, and so, being dissolved in the urine, makes a local impression upon the mucous membrane of the urinary tract.

Medication of the Female Genital Mucous Membrane.—The *vagina* can be reached by medicated suppositories, by injection, or, its surface being exposed by a speculum, by brush or probang at the hands of the surgeon. As a considerable volume of fluid is required for a thorough vaginal injection, the "fountain"-syringe is here peculiarly convenient. A fountain-syringe is simply a good-sized rubber bag with a long tube leading from its lowest point. The bag is filled with the injection-fluid and hung upon the wall at a height of three feet or more from the level of the part to receive the injection, whereupon gravity determines a steady and strong flow. The force of the stream is regulated by the height at which the bag is hung. The rubber tube is fitted with the necessary nozzle and also with a simple form of clamp to shut off the flow. The *uterus* is accessible to special instrumental appliances, including means for making injections; but, as regards the injecting of this organ, it must never be forgotten that there is an open communication through the Fallopian tubes between the cavity of the uterus and the general peritoneal sac. Peritonitis and death have more than once resulted from a uterine injection.

Medication of the Mucous Membrane of the Alimentary Canal.—The mucous membrane of the *stomach* is, of course, easiest reached by administration of a drug by swallowing; otherwise by use of the stomach-pump. A stomach-pump is a good-sized syringe with a double nozzle-end fitted with a two-way stop-cock appliance. From the nozzle-end two tubes make off at right angles, whereof one goes into the stomach and the other into a basin. By proper manipulation of the two-way cock, fluid may be drawn up from the basin and thereupon discharged into the stomach, or *vice versa*. The mucous surface of the *small intestine* is practically accessible to direct medication only by administration of the drug by swallowing, but that of the *large* intestine, and most especially of the *rectum*, can be reached also by anal injection, or, in the case of the rectum, also by suppository. A rectal injection intended for local medication should be small in bulk—not over two fluidounces; should be blood-warm, and should be *slowly* administered. It will also be more efficacious if the cavity of the rectum have been previously washed out by injections of plain water. In practising a rectal injection, the points should be observed to have the nozzle of the syringe *warm* and *well greased*, and to direct the same, after the sphincter has been passed, *upward* and *backward*, to conform to the lay of the rectum in the concavity of the sacrum. In the case of children crying during the operation, the further point should be observed to force entrance during *inspiration* only, when the abdominal tension is relaxed, merely holding ground, without attempting to advance, during the strained *expiration*. On withdrawing the nozzle after the injection has been finished, a little firm pressure with the fingers or a towel-end should be made upon the anus, until all reflex quivering of the sphincter shall have subsided.

In the medication of mucous membranes the use of solutions in condition of *spray* has several times been mentioned. A fine spray, for medicinal purposes, is gotten by the well-known so-called *atomizers*. An atomizer is, in essence, a very simple contrivance. A tube leading up from a vessel of fluid ends in a capillary orifice. Close to this orifice, and at right angles in direction, is set a similar capillary orifice of a second tube leading from some arrangement for delivering a blast—as of air from a rubber bulb squeezed by hand, or of steam from a small boiler set over an alcohol lamp. Such blast, then, by its close forcible passage immediately across the fine orifice of the first tube, sucks out the air from such tube, and, of course, also the fluid, which at once rises up the tube from the reservoir in which the tube is set, following the exhaustion of the air. But now, no sooner does a drop of fluid present itself at the capillary orifice of the tube through which it is drawn than, by the same blast that has sucked it up, such drop is immediately and literally blown to atoms—dispersed, that is, in exquisitely fine spray. In different atomizers different arrangements of the two related orifices obtain, but the finest spray is always to be found where the device is the original and simple one of having two very fine orifices accurately and closely set at right angles to each other. The *driving blast* is ordinarily obtained by hand-pressure on a rubber air-sphere connected with the atomizer proper by a rubber tube. Such "hand-atomizers" also commonly have a second air-sphere let into the rubber

connecting-tube between the terminal bulb and the atomizing apparatus. This second chamber, by its elastic distention, keeps up an air-pressure during the intermittence of the play of the bulb directly compressed, and so a perfectly steady blast can be indefinitely secured. Should a momentary blast only be wanted, the same can be obtained by direct compression of the middle reservoir-bulb instead of the terminal one. *Steam* atomizers, where the driving blast is steam from a small boiler, are particularly applicable for inhalations of spray, or for the delivery of spray of an "antiseptic" solution during surgical operations—in short, for all such occasions as require a prolonged atomization too tiresome to be maintained by use of the hand-apparatus.

II. Modes of Medicating through the Avenue of the Blood.—As already stated, the only means of access for medicines to parts out of direct reach is through the vascular circulation. The medicine, that is to say, is caused to be dissolved in the blood and so to be conveyed to the part whose medication is desired. Nothing is easier than to attain this end, but yet, it needs to be observed, this same attainment entails what so-called local medication is free from, the medicating of all other vascular parts as well as of the one at which the treatment is aimed. Hence, in "general" medication, it often becomes a practical question whether a given medicine will not produce more obnoxious effect on other parts or functions than can be counterbalanced by the expected beneficial effect on the ailing organ. And also it becomes important, in the selection of a medicine to accomplish, through blood-conveyance, a given therapeutic purpose, to choose that one which will produce a maximum of the effect sought with a minimum of, so to speak, *by-derangement.*

For the introduction of a medicine into the circulation there are several means, as follows: The easiest and altogether most natural one is, of course, to give the medicine *by swallowing*, whereupon absorption of the medicine into the blood occurs by the same avenues as in the case of the products of digestion. And an inherent advantage of this method is that, to a considerable extent, the stomach will assume the functions of a pharmaceutical laboratory, and extract the active ingredients from drugs administered in more or less crude condition. But despite these various advantages, there may arise circumstances making it unadvisable, or dangerous, or futile, to give medicine by the stomach. Thus, *first*, a medicine given by swallowing may greatly derange the function of the stomach itself—destroying appetite, upsetting digestion, or even provoking nausea and vomiting—when the same dose, given by the rectum or injected subcutaneously, might be borne without any substantial derangement; *secondly*, the giving of anything by swallowing may be debarred by the fact of a corrosive poisoning of the stomach, or of a stricture of the œsophagus; and *thirdly*, such administration might be useless, or worse than useless, because of *absorption* being in abeyance through *narcotic* poisoning, or through general collapse from any cause. *Fourthly*, the very chemical activity of the gastric juices, so serviceable to extract certain active principles from crude preparations, may yet injuriously affect certain others. *Fifthly*, the circumstance that the administered dose, after swallowing, unless taken upon a *perfectly* empty stomach, undergoes dilution with a greater or less amount of other stuffs in the stomach before absorption begins, often seriously both delays and impairs full medicinal effect.

Besides the stomach the *rectum* affords, for purposes of medication, a natural avenue of approach to the circulation of no mean degree of availability. Comparing the efficacy of the two organs for the purpose, the most notable point in connection with the use of the rectum is, that there is not in this case the chemical power to extract, in soluble form, active principles from crude drugs. Hence, in aiming to medicate the system by the avenue of the rectum, it is always advisable to use a form of medicine wherein the active principle is either already in aqueous solution, or is at least in such state as to be capable of dissolving directly in the fluids naturally to be found in the rectal cavity. The only other special point is to give by the rectum about twice the dose of any given medicine that would be administered by the mouth.

Still another natural avenue of approach to the circulation is afforded by the *lungs*. Absorption by the lungs is speedy and thorough, but obviously the use of this avenue is limited, since only medicines that are at once *volatile* and *not unduly irritant* can be introduced to the circulation through the lungs. (See Inhalations.)

Next, it is possible to introduce medicines to the blood through the avenue of the *skin*, and that, too, in a variety of ways. Of these ways the simplest is to merely lay upon the skin cloths wetted with a fluid medicine, trusting to direct absorption of the medicated solution through the tissue of the skin. With some medicines, under such circumstances, absorption unquestionably occurs, but at best the method is so crude, and the results so uncertain, that the procedure is not to be commended. The next method of employing the skin for the present purpose is by so-called *inunction*—the rubbing into the skin of the medicine in condition of ointment or oily solution. By this means, with certain drugs, certain, thorough, and rapid absorption is effected, so that inunction is an established and valued method of accomplishing constitutional medication. The only drawbacks to the method are the tediousness of the application, and the occasional soreness of the skin that may result from a repetition of inunction upon an identical skin-area (see Inunction). A third method is *fumigation*, wherein a volatilizable medicine is sublimed in presence of aqueous vapor, and made to condense upon the skin. Under the conditions of such procedure, absorption is as rapid and thorough as in the case of inunction, and fumigation is, indeed, an alternate method to inunction. Obviously, however, but a limited number of drugs are capable of application by fumigation, and, practically, the method is confined to the administration of *mercury*. (For details of the method see *Mercurous Chloride*, under Mercury.) A fourth method of medicating through the skin, is by the procedure of raising a small blister, and then, exposing the raw surface under the bleb, applying to the same the medicine in concentrated condition. This method, called the *endermatic* (see Endermatic Medication), is rapid and certain in its results, but is painful and barbarous, and has been practically wholly supplanted by the fifth and last way of attacking the circulatory system through the skin, that, namely, wherein the medicine in solution is injected underneath the skin, into the subcutaneous connective tissue, by a small syringe—in short, the well-known and popular *hypodermatic* method. By the hypodermatic method absorption is pre-eminently rapid, thorough, and certain—all impediments of varying gastric conditions on the one hand, or of nervous ones on the other, being void—and also, often, the medicinal impression obtained by the use of this method appears to be more radical than when the same drug is given in other ways. There are, however, drawbacks to the method: *first*, that the procedure is not universally applicable, since such medicines only can be hypodermatically administered as combine the several properties of solubility in some bland fluid, smallness of dose, and not *undue* quality of irritating; and *secondly*, that a subcutaneous injection requires the technical skill of the physician himself, or of a trained nurse. (For details of the hypodermatic method, see Hypodermatic Medication.)

Lastly, medicines can be introduced into the circulation by direct *intravenous injection*. In the case of *active* medicines this procedure is so dangerous as to be quite commonly regarded as unjustifiable, but for the *passive* purpose, so to speak, of increasing the volume of the circulating fluid in order to arouse the heart in collapse, the procedure, properly practised, is safe and serviceable. Milk, defibrinated blood, desiccated blood redissolved, and "indifferent" saline solutions, are the substances commonly employed for introduction by intravenous injection. (For details of the method see Transfusion.)

Edward Curtis.

MEDICINAL SPRINGS. The following article will make no attempt to review the entire subject of medicinal springs, but will simply outline the phases most important to the physician, that he may at once estimate the value and importance of any spring by reference to its analysis. The descriptions of the individual springs of Europe and the United States are scattered throughout the volumes, and may be readily referred to under their respective titles; the principal ones occurring in Canada are appended to this article.

Origin of Medicinal Springs.—In seeking for an explanation of the origin and source of what are called mineral or medicinal springs, something more definite is required, than the old and oft-repeated intimation, that the character of the waters is determined by the soil through which they flow. Further facts are required to explain the constancy of the composition of the several groups, the apparently inexhaustible supply of the solid constituents, and the many other features that present themselves to the close observer. To obtain this information it is necessary to leave the region of medical science, and join the geologist and chemist in their researches into the construction of the earth's crust and the influences that are ever modifying its surface. (For an exhaustive treatise on the subject see "Chemical and Geological Essays," by Professor T. Sterry Hunt.)

That the causes may be fully understood, two scientific facts must be borne in mind: First, that the different strata, broken and contorted as they now are, were at one time held in solution by ancient seas, and that, under the influence of chemical action and progressive degrees of concentration, they were deposited in successive layers, according as their constituents were separated. Second, that water is always percolating these rocks, and collecting in their fissures and crevices, and ultimately returns to the surface, bearing with it the products of the reactions and decompositions that occur in its course.

While yet in a state of vapor, and during its descent as rain, water is continually absorbing such gases as may be floating in the atmosphere; and when the surface is reached it conveys with it, in solution, carburetted and sulphuretted hydrogen, carbon dioxide, ammonia, and other similar compounds. Here it meets with decomposing vegetable matter, and the gaseous constituents, combining with the organic and inorganic matter which is being released, form carbonates, sulphates, and nitrates of potassium, magnesium, calcium, and silica. Such waters are found in marshes, bogs, swamps, and streams running through wooded lands. Their characteristics are the comparative absence of soda salts, and the presence of organic matter, potassium, and other bases that help to form vegetable structure. Such portions of water as penetrate below the surface are subject to important changes. The soil by which it is absorbed owes its fertility to the potash, silica, ammonia, phosphoric acid, etc., which it supplies to the growing plant. These very salts are being returned in solution and are greedily retained, while the water carries off soluble soda salts in their stead. The process is one of chemical substitution, the soil abstracting that which is required for plant growth, replacing it with what is of no value for that purpose, and the water reaches the surface as clear flowing springs and streams. This water differs from the surface waters in the small percentage of solid matter and in its great purity. It is free from all organic matter, ammonia, nitrites, and other deleterious ingredients; potash is present in very small quantities, the chief salts being soda, lime, and magnesia. Should iron be contained in the soil, the action of organic matter will form a soluble salt, and the same reducing agent may act on the sulphates, producing sulphuretted hydrogen. When the flow of water continues to a greater depth it may meet with strata rich in soluble saline matter occurring in a crystallized state, or in solution permeating the porous rocks. The deposits consist chiefly of chloride of sodium, magnesium, calcium, and sulphates of the same bases. The dissolved salts are more complex, comprising, besides those above mentioned, bromine and iodine, and other salts of marine origin, the solution representing the dregs of the early seas. Or the penetrating water may be enriched by the action of the elements of which the rock-formations are composed; these reacting on one another produce a slow, but constant, process of decomposition. This becomes more active through contact with a plentiful supply of water, or solution of some other salt, or carbonic acid, and the soluble products are carried off in a dissolved state. The most typical of these reactions is the effect of solutions of carbonate of lime or magnesia, on formations containing soda as a constituent; carbonate of soda is formed, and the lime or magnesia is deposited in an insoluble form. In many of the reactions an equivalent of carbonic acid is set free, and the waters reach the surface rich in carbonic acid and carbonates of the alkalies, alkaline earths, and silica. A portion of the sulphate is also produced in this way, as when sulphate of lime and chloride of magnesium react on one another. In addition to these reactions there is to be considered the influence of subterranean heat in decomposing the more deeply buried strata. It is this force, acting on combinations of carbonic acid, that furnishes the large supplies of that gas. When organic matter is present, whether as coal, shale, fossiliferous strata or in any other form, its deoxidizing power is an important factor. Acting on sulphates it reduces them to sulphides, and these in turn are decomposed by carbonic acid, forming sulphuretted hydrogen and a carbonate of the base. With a variation in the proportion of oxygen, sulphuric acid is produced, and by the same action on chlorides or borates hydrochloric or boric acid results.

The changes in water at the surface, the occurrence of saliferous strata and concentrated brines, and the reactions of mineral compounds, slowly between themselves, or more forcibly when accelerated by external influences, are sufficient to account for the different waters met with, and to explain the sources of the ingredients that form them into groups.

Classification.—The grouping of medicinal springs has been frequently and variously attempted, generally on the basis of their physical qualities, but seldom with any reference to their origin. The prevailing French system classifies them as salt, bicarbonated, sulphated, sulphur, ferruginous, and indifferent. The German is more specific, forming alkaline, earthy, salt, glauber salt, epsom salt, sulphur, iron, and indifferent. The English and American systems follow the caprice of each author, the tendency being to adopt numerous divisions. The objection to these classifications is, that while indicating the predominant constituent, they convey no idea of the other characters of the water. A spring is known as sulphur or chalybeate, but there is nothing to indicate what its other constituents may be, or whether it possesses neutral, alkaline, or acid properties. In the classification here adopted, the object is to overcome this deficiency, and at the same time to arrange them in accordance with their source:

(*A*) *Neutral Springs*, containing chlorides and sulphates as the characteristic salts.

(*B*) *Alkaline Springs*, containing carbonates.

(*C*) *Acid Springs.*

To these may be added:

(*D*) Those in which special constituents, worthy of separate notice, occur, such as arsenic, alum, etc.

This system differs from others in not forming special classes for sulphuretted hydrogen or iron. It is thought preferable to refer to saline, alkaline, or acid waters, as being ferrated or sulphurated, when these ingredients are present. Such a system is justified by the origin of the ingredients, as carbonic acid gas, sulphuretted hydrogen, or iron, may be present independently of the reactions which produce the three groups, and may impregnate any of the waters, or even a water otherwise devoid of mineral matter.

(*A*) *Neutral or Saline Springs.*—These are almost wholly formed by the washing out of soluble salts from saliferous strata, and they form themselves into two classes, according as chlorides or sulphates are in excess. These salts are generally associated with each other, but springs are met with in which one or the other is entirely absent. In the manufacture of commercial salt we have an ex-

ample of these waters, both in the method of production and in the composition. To obtain it, wells are sunk in strata which contain a large percentage of salt, and into these water drains from the surrounding soil, producing nearly saturated solutions of chloride of sodium. There are also present in small quantities chlorides of magnesium and calcium, sulphate of lime, and such other salts as are found in mineral waters. These are separated during the process of evaporation.

The simple saline waters range from those approaching saturation to others so faintly saline that they hardly deserve to be termed mineral. The Erkenbrecker's Salt Well and the St. Catherine's Springs are examples of the first mentioned, and Alburg Springs, and Cooper's Well, of the more dilute forms. Chloride of sodium is the prevailing salt, but in some springs chloride of magnesium or calcium is in excess. It is in this class that bromine and iodine are met with, the concentrated waters containing the largest quantities; but this is never considerable, a small fraction of a grain in a pint being the average. Kreuznach, with 0.34 grain of bromide of magnesium, represents the most strongly bromated waters; but Erkenbrecker's Well is said to possess the remarkable quantity of 3.526 grains of bromide of sodium in a pint, which is far in excess of any other water.

The sulphated springs contain sodium, magnesium, potassium, and calcium, associated together, the first two predominating. The well-known Crab Orchard Springs and Friedrichshall water are examples of this class.

(*B*) *Alkaline Springs.*—The carbonates of sodium, calcium, magnesium, potassium, lithium, etc., which determine these waters, arise from the decompositions which the different geological formations undergo. The amount of solid constituents is not so great as in the saline waters. The carbonates of soda or lime are the characteristic salts of this group, which, however, is rarely free from salts of the first group.

The most common mineral springs met with are those in which alkaline and neutral salts are associated, due to the intermingling of these two groups. The Saratoga waters are the best known of this class. In these the proportion of salines to alkalies is as two to one; other springs will furnish every degree of strength. These waters are not merely a union of the two sources, as certain reactions take place between the solutions. The most important is the reaction between carbonate of sodium and chloride of calcium, chloride of sodium and carbonate of calcium being formed. This process continues until the lime or soda salt is eliminated, and leads to an alteration of the water, in some instances changing members of the second group to the first. The Caledonia Springs have been undergoing this change. When analyzed in 1847 they were classed in the alkaline group, though they contained saline matter, but in 1865 the former quality had almost disappeared, and some springs had become purely saline. A similar change is in operation in some of the Harrogate (England) waters (see "Report of Geological Survey of Canada," 1866).

(*C*) *Acid Springs.*—The only ingredient we have to consider in this group is sulphuric acid. Waters containing it are very rare, but some issue in such volumes as to form streams with a distinctly acid reaction, as in Western New York and Ontario. The acidity of these waters varies greatly, being influenced by the rainfall, particularly the Virginian springs, which are situated in ledges of rocks and at the bases of hills. The strongest are Oak Orchard Springs, New York, containing in one pint 13.37 grains, and the Rockbridge Alum Springs, Virginia, 2.347 grains of free acid. The salts associated are almost entirely sulphates, alumina and iron being the most important.

(*D*) *Special Waters.*—Alum is a not infrequent minor constituent, and in some localities occurs in such large quantities as to determine the properties of the springs. In these it is associated with free sulphuric acid and sulphate of iron. One of the strongest is the Rockbridge Alum Springs, which contains 3.01 grains of alum out of 5.80 grains of solids in a pint. Arsenic is never present in any considerable quantity; the strongest of the arsenical springs, in France, contains one-tenth of a grain of arsenious acid in a pint; all others contain much less. In this country it is not known to occur in any water. Lithia is a very common ingredient in alkaline water, occurring as a carbonate, but it is never present in any large quantity. The Dentonean Well, Ballston, contains nearly one grain (0.950) to a pint. This is probably the strongest water of this kind.

Any of these waters may be charged with carbonic acid gas, and we find it in all springs of any repute; but it is in the second group that it most abounds. It varies from the faintest trace to such an unusual quantity as is present in the Franklin Artesian Well, Ballston, the analysis of which shows 57.51 cubic inches in a pint. The Saratoga waters contain between forty and fifty cubic inches, which is also much more than is generally met with.

Sulphuretted hydrogen may also be a constituent of any of the waters, but it is not so commonly met with, nor does it occur so abundantly, as carbonic acid gas. The Sandwich Spring, Ontario, which is one of the strongest sulphurated waters, contains 4.72 cubic inches in a pint. These springs abound in volcanic districts, and in the neighborhood of deposits of organic matter. The combination of sulphate of lime and this gas points to its superficial origin, and to the presence of organic matter in the form of vegetable growth.

Organic matter exerts a further influence in determining the mineral ingredients by its action on iron as it exists in the soil. This metal is retained there as an insoluble peroxide, a salt which is reduced to a protoxide and rendered soluble in carbonic acid, forming a carbonate. In this condition it is most commonly met with in the alkaline and neutral waters. It is present in very small quantities, from one-tenth to one-half of a grain in a pint producing a strong chalybeate water. In acid waters it is present much more abundantly with sulphuric acid, as a sulphate, the Bedford Alum Springs containing 2.932 grains in a pint. Some analyses represent iron as combined with hydrochloric acid, as in the chloride of iron spring, Harrogate, and Erkenbrecker's Well. This, however, is a very rare combination.

Many of the springs retain the evidence of their deep origin by possessing a temperature above that of the atmosphere at their point of exit. The degrees of heat vary greatly, reaching as high as 171° F., the temperature claimed for one of the Arkansas Hot Sulphur springs. Others, no doubt, reach as high, but this is the hottest spring that has been utilized. Waters of all kinds may be thermal, but an elevated temperature lessens the proportion of constituents, both solid and gaseous. The same subterranean heat that raises the temperature of these springs, also develops large quantities of carbonic acid gas and sulphuretted hydrogen, but the heated water not retaining the gases in solution, they accompany it to the surface and escape with great violence. Thermal waters may be said to be never ferrated.

Therapeutics.—The object of physicians is to adapt these waters to their service as a means to maintain health and combat disease, the former being not the least important of the two, and the more likely to produce satisfactory results. The ancients valued mineral waters highly as natural medicines, and thought them endowed with miraculous powers. The earliest writers on the art of medicine allotted them a prominent place in their list of remedies. Throughout many centuries such springs have continued to be the resort of the diseased and the enfeebled, and at the present day the same courses are followed, and the same illnesses treated, as when patronized by the Romans. Very little progress has been made in their application, and, probably, no better results have been attained from our more perfect knowledge of their constituents.

The waters of Europe are more thoroughly utilized than those of this country. A course of the waters there is more rigorous and more closely adhered to, and more perfect appliances are in use for bathing and inhaling the waters, both in the form of steam and spray. In this country there is not the same faith in their curative

properties, the provisions for their use are more crude, and even the selection of the water is, in a great measure, controlled by the patient's own ideas. This is generally due to the influence of the proprietors of the springs, who act independently of medical men, trusting rather to the atmosphere of quackery with which they surround their possessions. Physicians are not altogether blameless. They seldom acquaint themselves sufficiently with the character of the waters or the suitableness of the resort; directions for the use of the waters are left to some one on the spot; and too frequently does the patient fall into the hands of some self-opinionated empiric, whose judgment is very questionable. What is needed is more carefulness and discretion in recommending a course of medicinal waters; a more thorough system of investigation; and properly recorded observations by those who possess opportunities for studying their effects.

In considering the therapeutic value of medicinal springs the various outside influences must not be lost sight of. Change of air and scene are of undoubted benefit, the one for the body the other for the mind. New and pleasant surroundings, new faces and friends, new thoughts animating the melancholy mind, and bringing out fresh ideas and nobler aspirations, all follow the arrival at the busy, bustling, watering-place, or the quiet, rustic surroundings of the more retired resort. In looking for the good results that are to be expected, everything that can conduce to this end should be taken into account, and these should decide the selection of a spring, rather than the presence of a few grains, more or less, of certain ingredients. The neighborhood and situation should be good; there must be plenty of fresh air, a suitable temperature, a proper degree of humidity; all of which are important matters (see Health Resorts). The exits of these springs are frequently near the margins of bogs and marshy lands, which are alike deleterious to the healthy and the invalid, to say nothing of the effects accompanying the miasm arising from such localities. Then, again, the accommodations must be considered. Many stairs to climb and deficient cubic space in sleeping-rooms are not to be desired. The system of drainage and mode of disposal of refuse are matters to be inquired into, particularly at country hotels. Regard should be paid to the course, if any, that is recommended, and such means as may exist for utilizing the waters.

As for the ingredients themselves, the special effect of each salt is not to be taken into account; the general action of any group being sufficient. It would be superfluous to estimate the value of each chloride associated with chloride of sodium, or the amount of sulphate of sodium with magnesium, unless in decided quantities. It is also obvious that something more than the action of a certain number of grains of ingredients must be considered. This of itself would have no appreciable effect, but in a freely dilute form the salts are enabled to influence the system in a manner not to be expected when otherwise administered. The action of water itself, independent of all ingredients, is essential to a healthy maintenance of the system. By its local action it cleanses the *primæ viæ*, removing secretions and fermenting matter from the stomach and, to a certain extent, from the bowels. It may also be said, after being absorbed, to wash out the system; the fluidity of the blood is maintained, and the products of tissue-change are dissolved and excreted. Water is the great diluent, solvent, and eliminant; it dilutes the contents of the stomach and intestines, producing its laxative effects; it dilutes the blood and circulating fluids, and its cholagogue, diuretic, and diaphoretic actions follow. Unless a supply is constant, excretion almost ceases, and the system becomes loaded with effete material.

In using the simple saline waters there is a choice between the concentrated brines and the more dilute springs. The former are too strong for ordinary use, proving irritating to the walls of the stomach unless freely diluted. At Kreuznach about four ounces is a medium dose, which may be gradually increased. At the St. Catherine Springs it is diluted with four times the quantity of pure water and taken freely. The iodine and bromine present are supposed to add greatly to the therapeutic value, but the amounts are so slight—especially as the waters are taken in small doses—that it is doubtful whether they exercise any specific influence. However, in Europe their efficacy in scrofulous and syphilitic affections is upheld by many. The real value of these waters lies in their application as baths and douches. They are used both warm and cold, and where nature has not lent her aid the waters are heated artificially. The effect is invigorating and tonic, stimulating the skin to renewed action, and promoting circulation in the blood-vessels and lymphatics. Douches are arranged to be applied to any portion of the body, and with them a system of shampooing or massage is carried out by a skilled attendant. Such a course is much valued as a means of effecting the absorption of chronic inflammatory products and deposits of other morbid material. The dilute saline is the mildest of all mineral waters, its action on the system being that of a plentiful supply of water supplemented by a few grains of chloride of sodium. The minor salts are of little value, but when chloride of calcium is present in large quantities it probably adds to the resolvent properties of the water. Chloride of sodium is a normal constituent of the blood and acts with water in removing the products of disintegration; at the same time its presence is necessary in the reconstruction of tissue. Its value in increasing the excretions is evidenced by the greater quantity of urea that accompanies it in the urine. When to ingestion of the waters a course of baths is added, the results are more decided and evident. Its benefits would be looked for in conditions where the tissue-changes are slow and imperfect, and the system overcharged with excrementitious matter, accompanied by a corresponding degree of functional inactivity. The accelerated circulation and more vigorous action of the organs correct the many symptoms caused by this morbid state. It also stimulates the absorbent system and aids the removal of abnormal deposits.

In the class of waters where sulphate of magnesium or sodium is the active ingredient we have efficient purgative waters. Half a glass of Friedrichshall, or a wineglassful of Pullna or Hunyadi Janos, will produce a free evacuation and form an excellent medicine where an immediate action of the bowels is required. They will be found very serviceable in congestion of the portal system, or in conditions generally termed "bilious." When taken for some time, especially in the stronger forms, they are liable to act as irritants and produce a catarrhal diarrhœa. The waters containing sulphate of lime have no purgative properties. They are generally classed with carbonate of lime, as calcic waters, and are said to possess some action on the urinary system; but unless other salts are also present, it is doubtful whether they exert anything beyond a local influence.

In the second group we have the action of carbonate of soda or lime, and other minor alkaline salts. Primarily they are antacid, influencing the secretions of the stomach and intestines. When absorbed, this action is continued, the blood, urine, and fluids of the body becoming alkalinized, and if persevered in, a condition of dyscrasia is liable to ensue. By its local action it proves of service in many forms of irritative disturbances of the gastro-intestinal tract, and may be employed in all conditions where alkalies are indicated. Its secondary action is most evident on the chylopoëtic system. It may be employed in all forms of congestion of the liver and the derangements that follow this condition; and we find it relieving lithæmia, jaundice, and affections of the gall-bladder or duct, and reducing enlargement of the liver. It has a further action on the mucous membranes, and proves of service in catarrhal states of the bronchial tubes, larynx, pharynx, intestines, bladder, etc. The effect on the urinary tract may possibly be aided by carbonate of lithia when present. In Europe this class of waters is particularly renowned as a remedy for gout.

In the springs where saline constituents of the first group are also present, a very desirable combination is obtained; the united action of the two producing more

decided effects in restoring the deranged system than where either one is used simply.

The acid waters of the third group have never acquired much celebrity as therapeutic agents. They are taken for their astringent action, which is due not only to the sulphuric acid, but also to the alum and sulphate of iron which are always present. They are recommended in chronic hæmorrhages and diarrhœas, and locally in chronic ulcers. When used, it is necessary to dilute them with an equal quantity of pure water. A course of these waters lasts for from four to ten weeks. By evaporation an extract is prepared which is said to possess the virtues of the springs.

It is doubtful whether the arsenic contained in any spring is sufficient to impart any medicinal properties; however, in France certain springs have acquired a wide reputation as arsenical waters. The same uncertainty exists regarding the presence of lithia—the quantity being so slight, and the other carbonates so numerous, it is quite impossible to determine any therapeutic action.

The presence of carbonic acid very decidedly increases the value of medicinal waters. What its remedial effects may be is doubtful, but it certainly aids the absorption of mineral constituents, both by increasing their solubility and by its stimulating action on the walls of the stomach. Probably it is most serviceable when present in ferrated waters, holding the iron in solution, and in a condition favorable for assimilation.

When the waters are sulphurated an important addition is made to their therapeutic action, and no water is so popular, and from no other is so much benefit expected. The sulphur contained in the sulphuretted hydrogen generally receives the credit, but what its actual value is, or in what way it produces its effect, has never been fully explained. The sulphurated salines are useful waters, particularly when the purgative salts are the active ingredients; but it is the sulphurated alkaline water that furnishes the most valuable combination. The action of both ingredients is directed to the portal system and to the removal of systemic poisons from the blood, and locally they both have a decided influence on the skin. These springs are sought for their action in hepatic derangements and other conditions in which alkaline waters are serviceable, and prove of particular service in chronic rheumatic and arthritic troubles. In any chronic form of cutaneous diseases they will be of use. The external use of these waters is generally combined with the internal, and this in a very great measure accounts for much of the benefit caused, especially as these springs are so frequently thermal. In recommending sulphurated waters for any length of time, their debilitating influences must not be forgotten, and it is in such circumstances that a combination with iron is to be desired.

In the ferrated waters we possess a most valuable remedial agent, as no drug responds so favorably to dilution. In administering iron the great desideratum is to prepare the system for its absorption, which is most satisfactorily done by preceding it by the use of salines. In the form of springs we have a dilute solution in the most desirable form, and it is but reasonable to expect the beneficial action of iron from this source. The best springs are the ferrated saline, in which all these favorable conditions are combined. When there are indications for alkaline treatment the waters of the second group are to be selected. In Europe it is customary to supplement a course of alkaline or sulphur waters by a sojourn at a pure saline chalybeate spring. The indications for ferrated waters are all derangements arising from a condition of anæmia, whether acute or chronic. The strong waters in which iron is present as a sulphate are serviceable as astringents and styptics, and great virtues are also claimed for them in anæmic and scrofulous affections.

An elevated temperature has a very important influence on the action of medicinal waters. By its sedative properties it increases their local effect on the stomach and intestines, and promotes their absorption. The most famed springs in any class will generally be those possessing a high temperature. The great value of hot water was brought prominently forward by Dr. James Salisbury, in his method of regulating the system and overcoming the tendency to tuberculous disease. By cleansing the stomach after digestion he prevented the absorption of much deleterious matter, and prepared the way for a vigorous digestion and assimilation. To accomplish this he advised the free use of water of a temperature not below 110° F. between meals and before retiring. This course he recommended as "the basis of all treatment of chronic disease. . . . It relieves spasm and irritable conditions generally, it washes down the mucus, bile, waste, etc., it dissolves the abnormal crystalline substances in the blood and urine, it promotes elimination everywhere." All these facts are particularly applicable to waters containing saline matter and gases, which render the fluid more palatable and efficacious. The principal method by which the virtues of thermal waters are sought is their application as baths. By this means both a local and general effect is obtained (see Balneotherapeutics). In the skin a free action is set up, the increased circulation produces a quickening of pulse and respiration, and general stimulation. When to this is added the free use of water internally, a rapid flow is produced through the tissues of the body, which produces the most desirable results. In addition to the water, the deposits of the springs, and the soil surrounding the places of exit, are utilized as mud- and sand-baths. The steam and sulphuretted hydrogen gas that arise from the spring are also carefully secured and made to do service as steam- and vapor-baths.

The use of these waters is not devoid of danger, and certain precautions must be observed in partaking of them freely. By a strong and vigorous constitution they may be taken with impunity, but the ailing and enfeebled require to follow them with the greatest caution. They should always be commenced moderately and increased gradually, and any danger of disturbing digestion must not be incurred by their too free use immediately before or after meals. The lowering influence of protracted courses of sulphurated or alkaline springs is to be borne in mind, and the fact that iron is contra-indicated, when the action of the liver or stomach is impeded, must not be forgotten. When the vital powers are lessened, or when there is any organic disease of the heart, kidneys, or lungs, or any tendency to hæmorrhages, every fact must be carefully weighed and every danger considered, before recommending the employment of medicinal springs.

European Medicinal Springs.—These occur very abundantly in a comparatively small extent of country, and waters of nearly every kind may be found within short distances of each other. Although the springs are so intermingled that limits cannot be given to the different groups, we find them affecting certain districts. Those of France are generally alkaline, and here are found the celebrated Vichy and many other similar springs; in Germany and Austria we find the greatest number of, and the most noted, saline waters. In England waters of every kind occur, but all are more mild in character than on the continent.

Nearly every spring is considered of value, and has acquired a reputation for some special virtue. The most popular are the saline and alkaline, particularly when thermal and ferrated or sulphurated. The carbonated alkaline-saline springs are not so strongly mineralized nor so common as those which abound in America; none equalling the Saratoga or Ballston springs. The most decided in their action are the purgative-saline, which have acquired a universal reputation. Pullna, Friedrichshall, Hunyadi Janos, etc., contain between two and three hundred grains of purgative salts in a pint, and the excellence of these is evident when compared with the Crab Orchard Springs, which contain only thirty-two grains in the same quantity. The concentrated brines, such as Kreuznach, are weaker than the American. No acid or strong alum waters occur.

It is very difficult to state the relative value of European and American springs, owing to the uncertainty caused by the different methods in which chemists combine the elements, and from the fact that the properties of a few grains, more or less, cannot be estimated. But it is

quite evident that in America there are springs of equal value with the most famed spas of Europe, and in every class may be found some that are almost identical in composition. The springs existing in the Rocky Mountain district may be very generally compared with those of Europe. There are the same thermal saline and alkaline waters, with and without sulphuretted hydrogen; the quantity of constituents may not be exactly the same, but the same salts are present, and their relative proportions are very nearly alike. In the East the saline and alkaline springs are superior, in amount of solids and carbonic acid, to members of the same class in Europe, but there is wanting the much-sought-for thermal quality. In Europe there are two circumstances by which may be explained the greater popularity and efficacy of the waters; these are the facility with which any desired water may be obtained, and the more thorough and scientific manner in which it is used. To this is due any superiority that the European waters possess over those of America.

Medicinal Springs of the United States.—In the vast area contained within the limits of the United States, it will be found that every group is represented by a long list of springs, of all degrees of strength and combination. The two main lines of exit of these subterraneous waters follow the contorted and broken ridges of the Rocky Mountains in the West, and the Appalachian chain in the East. They also rise to the surface throughout the intervening basin, wherever the state of the formations allows a passage. In each of these sources certain distinctive features characterize the waters. Those found in the western mountainous district, which extends from the Pacific Coast almost to the Mississippi River, are chiefly alkaline springs containing a few grains of purgative salines, generally of a high temperature and strongly sulphurated. Thermal salines, with and without sulphuretted hydrogen, also occur, such as the Utah and Calistoga Springs. In the East the highly carbonated alkaline-saline springs are the most common, The only thermal springs are in Virginia and the South. These are only slightly sulphurated and almost imperceptibly alkaline. In the great palæozoic basin, which formed the bed of the early sea, we naturally find the waters rich in salines. Those containing chlorides are to be found everywhere, but such as contain the purgative sulphates are chiefly confined to certain districts, as in Kentucky, Michigan, and Western New York. In these the active salt is sulphate of magnesium. In this they differ from the purgative waters of the West, which owe their properties to sulphate of soda. Iron will be found almost a constant ingredient in all springs except those possessing a high temperature.

Canadian Medicinal Springs.—In this country the geological conditions are an extension of those occurring in the United States; the springs are influenced by the same conditions, and their general characters are the same. They abound in greatest numbers in the Province of Quebec, between the Laurentides on the north, and the mountains of New York and Vermont on the south, extending west and south through the Province of Ontario and across the boundary. They are very numerous, and chiefly saline and alkaline-saline; a large proportion are ferrated and sulphurated. Acid waters of the third group are found in the vicinity of Niagara Falls; they are strongly ferrated, similar to those in Virginia. In the west the same thermal sulphurated waters are met with as in the more southern portions of the Rocky Mountains. No hot springs occur in the east, though an occasional spring is found with a slightly elevated temperature, as at Chambly, where one registers 53° F. all the year around.

Nearly every district has its springs, which have acquired an important local reputation, but comparatively few of them have become popular health-resorts. A great number of the waters are sold in bottle and wood, and there is a large demand for them in the cities.

The following are the most noted. There are many others, such as Plantagenet, Varennes, St. Geneviève, etc., which have had a certain reputation, but have now fallen into disuse.

Abenakis Mineral Springs. — *Location,* near St. François du Lac, Que.; *Post-office,* Abenakis Springs, Que.; *Hotel,* The Abenakis House.

Access.—By Richelieu Co. steamer, Three Rivers, plying between Montreal and the Springs, or by Southeastern Railroad to Yamaska station.

Analysis (J. Baker Edwards).—Total saline solids, 110.3 grains to the pint. These are chiefly chlorides of sodium, magnesium, calcium, and potassium, with traces of lithium. It also contains traces of bromides, iodides, and phosphates. This is a very lightly carbonated saline spring. A second spring of the same character is mildly sulphurated.

These springs are pleasantly situated on the west bank of the St. Francis River, near its confluence with the St. Lawrence. The surrounding country is elevated and dry, and well settled. The hotel is new, possesses all modern conveniences, and is well managed. Hot and cold baths are supplied. Recreation is provided at the hotel, which, with the attractions of the river and neighborhood, makes this a very desirable summer resort.

Banff Hot Springs.—*Location,* Rocky Mountains. *Post-office,* Banff, Alberta.

Access.—Via Canadian Pacific Railroad.

Analysis (H. Sugden Evans).—One pint contains:

	Upper Spring. 112° F.	Lower Spring. 89° F.
Sodium bicarbonate	1.62	2.97
Calcium bicarbonate	1.00	1.30
Sodium sulphate	0.84	0.28
Magnesium sulphate	0.73	1.03
Calcium sulphate	4.29	4.70
Silica	traces	traces
Organic matter	"	"
Total grains	8.48	10,28
Carbonic acid	Not determined.	
Sulphuretted hydrogen	"	"

These are strongly sulphurated thermal alkaline springs with a large percentage of purgative salines.

These springs are on the line of the Canadian Pacific Railroad, at a great elevation, in the centre of a most attractive portion of the Rocky Mountains reserved by the Canadian Government as a national park. They are the property of the Government, and the waters are supplied to hotels and bathing-houses in any required quantity. A first-class sanatarium has been erected, and every form of steam and hot-water baths is provided. The proprietor, Dr. Brett, resides on the premises, and directs the use of the waters. The course may be continued throughout the year, the heat of summer and the cold of winter never being excessive. Accommodation may also be secured at several small inns, but it is the intention of the railroad company to erect a large and commodious hotel for the use of invalids, tourists, and sportsmen. The combined action of the Government and the railroad company in preserving the springs and providing for the comfort of visitors, together with the favorable climatic conditions, the properly regulated use of the waters, and the great attractions of the surrounding country, should make this one of the most desirable health-resorts in the country.

Caledonia Springs.—*Post-office,* Caledonia Springs, Ont. *Hotel,* The Grand Hotel.

Access.—From Montreal or Ottawa by steamer, or by Canadian Pacific Railway to Calumet, where means of conveyance is provided.

Analysis.—See Vol. I.

These springs are carbonated saline, with a small amount of alkaline salts. One is mildly sulphurated and more alkaline. They are situated on an elevated plateau, many miles in extent, allowing a continuous cool breeze. The hotel is new and commodious, and under excellent management. All modern conveniences are at hand for furnishing hot and cold baths. A physician resides there during the season, which extends from June to October; during the winter months the hotel is closed. This is probably the most popular resort in Canada, and has acquired an extensive reputation.

Caxton (see Vol. II).—This is an excellent ferrated

saline, with a small percentage of carbonates and a fair amount of bromides.

CHAMBLY.—*Post-office*, Chambly, Que.

Analysis (T. Sterry Hunt).—Temperature, 53° F. One pint contains:

	Grains.
Carbonate of sodium	9.010
Carbonate of calcium	0.304
Carbonate of magnesium	0.650
Carbonate of iron	0.020
Carbonate of strontia	0.034
Chloride of sodium	7.128
Chloride of potassium	0.275
Silica	0.620
Alumina	0.049
Total	18.090

This is an excellent ferrated alkaline-saline spring. The temperature is several degrees above that of the locality, and remains constant. These waters are largely used by those living in the vicinity, but no attempt has been made to utilize the waters in a manner that their properties would warrant.

OTTAWA MINERAL SPRINGS.—*Post-office*, Ottawa, Ont.

Analysis (J. Baker Edwards).—One pint contains:

	Grains.
Chloride of sodium	98.081
Chloride of potassium	1.310
Chloride of calcium	1.832
Chloride of magnesium	2.713
Bromide and iodide of magnesium	0.351
Sulphate of calcium	2.019
Sulphate of magnesium	2.450
Iron, strontium	traces
Total grains	108.756

This is a pure saline, containing a very large percentage of bromides and iodides. A small amount of purgative salts is also present, forming an excellent combination. These springs, formerly known as "Borthwick's," are found near the margin of an extensive marsh, and the surroundings are not likely to attract residents. No hotel has been erected. The waters are very extensively used by the residents of Ottawa and vicinity. Their reputation is steadily increasing, and their sale has assumed enormous proportions.

SANDWICH SPRINGS.—*Post-office*, Sandwich, Ont. *Hotel*, Sandwich Springs Hotel.

Analysis (Professor S. P. Duffield).—One pint contains:

	Grains.
Carbonate of sodium	6.070
Carbonate of magnesium	1.618
Carbonate of calcium	4.813
Chloride of sodium	0.070
Chloride of magnesium	19.220
Chloride of calcium	0.007
Sulphate of calcium	15.479
Silica	0.014
Total grains	47.291
Gases.	Cub. in.
Carbonic acid	1.25
Sulphuretted hydrogen	4.72

Sandwich is situated on the banks of the Detroit River, two miles from Windsor. The spring has acquired a reputation as a most powerful sulphurated water on account of the large quantity of sulphuretted hydrogen it contains. This spring is largely resorted to, and every facility is provided for the use of the water.

ST. CATHARINES WELLS.—*Post-office*, St. Catharines, Ont. *Hotels*, Stephenson House, Welland House, Springbank.

Access.—By Grand Trunk Railroad, or by boat from Toronto, Buffalo, or other lake ports.

St. Catharines is situated in the midst of what is termed "the garden of Canada," near Lake Ontario, and twelve miles from Niagara Falls. These waters are the most famous in Canada, and the hotels are constantly filled with those seeking to be benefited by their use. The hotels are new and fitted in a luxurious manner not surpassed at any health-resort. Springbank is a sanatarium, under the supervision of a physician, rather than an hotel. In it every provision is made to utilize the waters. Baths, hot and cold, vapor and Turkish, sprays and douches—all may be obtained, and with them skilled attendants to carry out a system of massage. A concentrated solution is prepared and used as an embrocation when indicated. The waters are also used internally, but require to be diluted with an equal quantity of pure water. In addition to the most approved systems of hydro-therapeutics, every form of galvanism and electro-magnetism is provided to be used in conjunction with the waters. The hotels are open throughout the year.

Analysis (Professor Croft).—One pint contains:

	Springbank Well.	Stephenson House Well.	Welland House Well.
	Grains.	Grains.	Grains.
Carbonate of iron	0.442	....	0.380
Carbonate of lime	0.080	....	0.060
Chloride of sodium	320.648	217.234	275.868
Chloride of potassium	2.388	2.587	2.060
Chloride of magnesium	36.261	24.760	29.644
Chloride of calcium	148.584	108.271	127.202
Sulphate of lime	16.991	15.981	14.429
Iodide of sodium	0.012	....	0.010
Iodide of magnesium	....	0.030	....
Bromide of sodium	trace	....	trace
Bromide of magnesium	....	0.045	....
Total	525.296	368.964	449.653

ST. LEON SPRINGS.—*Post-office*, St. Leon, Que. *Hotel*, St. Leon Springs Hotel.

Access.—By Canadian Pacific Railway from Montreal or Quebec to Louiseville.

Analysis (T. Sterry Hunt).—One pint contains:

	Grains.
Chloride of sodium	97.716
Chloride of potassium	1.555
Chloride of calcium	0.603
Chloride of magnesium	5.635
Carbonate of lime	2.966
Carbonate of magnesia	7.973
Carbonate of iron	0.123
Bromide of magnesium	0.076
Iodide of magnesium	0.034
Silica	0.731
Alumina	0.114
Total	117.526

This is a very desirable ferrated saline, with a large percentage of bromides and iodides.

These springs are situated on the bank of a small tributary of the St. Lawrence. The hotel is large and contains all modern conveniences. It has always been a favorite water, but until within the last few years the place could only be reached by a long stage ride. It is now being very liberally patronized.

TUSCARORA ACID SPRING.—*Post-office*, Tuscarora, Ont.

Analysis (T. Sterry Hunt).—One pint contains:

	Grains.
Sulphate of potash	0.510
Sulphate of soda	0.421
Sulphate of lime	6.200
Sulphate of magnesia	1.290
Sulphate of iron	3.090
Sulphate of alumina	3.744
Hydrated sulphuric acid (SO_3HO)	34.312

This remarkable spring is situated on the Indian reserve near Brantford, Ont. Its strength varies greatly with the season and rainfall. It is not used as a remedial agent.

Beaumont Small.

MEDICINES, FORMS OF. Under this title will be discussed the class-characteristics of the various kinds of medicinal preparations, so far as they immediately concern the physician. For convenience of reference, the different forms of medicines will be taken up in alphabetical order, and it will be understood that, in matters of pharmacopœial authority, the standard followed is that of the U. S. Pharmacopœia, Sixth Revision (Revision of 1880).

ABSTRACT (Latin, *Abstractum*).—The *abstract* of the U. S. Pharmacopœia is a preparation, in dry powder, of a vegetable drug, of twice the medicinal strength, weight for weight, of the crude drug itself. Abstracts are obtained by first making an extract of the drug by some

appropriate method, and then bringing the same to standard strength by the addition of so much sugar of milk as shall make the product weigh one-half as much as the quantum of crude drug used in the manufacture. By reason of the uniform strength of abstracts, as stated, the dose for a given abstract is always one-half that of the crude drug-substance represented. Abstracts may be administered in powder, pill, or mixture. Eleven abstracts are officinal in the U. S. Pharmacopœia.

BOLUS (Latin, *Bolus;* unofficinal).—By a *bolus* is understood to mean a mass of a medicinal substance larger than a pill, which is yet to be swallowed whole after the manner of pills. Such form of administration of a medicine is so obviously objectionable that, being in the days of modern pharmacy no longer necessary, the "bolus" is rarely resorted to.

BOUGIE (Latin, *Bougia;* unofficinal).—A *bougie,* in medicinal parlance, is an appropriately shaped plug of cacao-butter, which, duly medicated, is intended for insertion for purposes of local medication into the urethra or into the uterus.

CERATE (Latin, *Ceratum*).—A *cerate* is a preparation whose basis is an admixture of a fatty and a waxy body or bodies, so proportioned as that the product shall be of fairly firm consistence, and of a melting-point above that of the temperature of the skin. A cerate thus maintains the consistency of a soft solid when applied to the skin, and is intended to serve as a permanent dressing, being used spread upon a backing of muslin or kid. The preparation of the U. S. Pharmacopœia whose officinal title is the simple word *Ceratum, Cerate,* is a non-medicated simple mixture of white wax and lard, in the proportion of thirty parts of the former to seventy parts of the latter. Including this preparation, eight cerates are officinal in the U. S. Pharmacopœia.

CONFECTION (Latin, *Confectio*).—A confection is a material of the quality and composition of soft confectionery, intended as a pleasant menstruum for the administration of medicines which can appropriately be incorporated in such a substance. Two confections only are officinal in the U. S. Pharmacopœia—one, a *confection of rose,* simply rose-flavored confectionery, suitable for extemporaneous medication, and the other a *confection of senna,* a confection feebly medicated with the drug senna. Confections are, of course, intended to be eaten like ordinary confectionery, and are therefore appropriate for the incorporation of only such medicines as will have their disagreeable taste, if any, fairly well disguised by the sweetness of the confection. Confections are objectionable, generally, because of the amount of saccharine matter which their composition makes necessary to be swallowed with each dose of the contained medicine.

DECOCTION (Latin, *Decoctum*).—When a crude vegetable drug is actually boiled in water for a greater or less time, the resulting aqueous solution of such principles as the boiling water will have extracted is termed a *decoction.* The process of decoction is suitable to such drugs, only, as do not have their active principle or principles either decomposed or dissipated by the heat of boiling; but even in the case of decoctions of appropriate drugs, the preparation will spoil by keeping, unless, indeed, the drug of which a decoction is made contains itself an antiseptic ingredient. Medicinally, decoctions are objectionable because bulky, ill-tasting, and necessarily containing other constituents of the original drug-substance than the active principle. The U. S. Pharmacopœia ordains two specific decoctions, namely, *decoction of ceiraria* and *compound decoction of sarsaparilla,* and also a general formula for the making of decoctions of any drugs extemporaneously prescribed. Such general formula is as follows: "An ordinary decoction, the strength of which is not directed by the physician, nor specified by the Pharmacopœia, shall be prepared by the following formula: take of the substance, coarsely comminuted, ten parts, and of water a sufficient quantity to make one hundred parts. Put the substance into a suitable vessel, provided with a cover; pour upon it one hundred parts of cold water, cover it well, and boil for fifteen minutes; then let it cool to about 45° C. (113° F.), strain the liquid, and pass through the strainer enough cold water to make the product weigh one hundred parts. *Caution.*—The strength of decoctions of energetic or powerful substances should be specially prescribed by the physician" (U. S. Ph.). The average dose of a decoction prepared by the above formula is from one to two fluidounces.

DISK (Latin, *Discus;* unofficinal).—A *disk,* as a form of medicine, means a small gelatin scale of microscopical thickness, impregnated with some medicinal substance, generally a salt of an alkaloid. Such medicated disks are especially devised as a convenient means of applying accurately apportioned, minute quantities of mydriatic or myotic alkaloidal salts to the conjunctiva. When so used the disk is lifted by the touch of a moistened, fine camel's-hair pencil, and gently laid on the inner surface of the lower lid, whereupon the gelatin of the disk is speedily liquefied by the warmth and moisture of the mucous membrane, so setting free the contained charge of medicament.

ELIXIR (Latin, *Elixir*).—The *elixir* of modern pharmacy is a preparation consisting of diluted alcohol, sweetened and aromatized, and containing, in weak charge, in solution, some medicinal substance or substances. The U. S. Pharmacopœia makes officinal only a so-called *elixir of orange,* intended as a simple, pleasantly flavored elixir-basis, to be medicated by the prescriber at pleasure. This officinal elixir, like the majority of proprietary elixirs, is no less than twenty-five per cent. strength of alcohol—a fact to be seriously borne in mind in relation to the table spoonful doses in which elixirs are commonly designed to be prescribed.

EMULSION (Latin, *Emulsio*).—An *emulsion* is a fluid mixture consisting of a fatty body diffused in a state of fine mechanical subdivision through a more or less viscid watery menstruum. Milk is a natural example of an emulsion. Emulsions constitute a serviceable form in which to administer fixed oils whose dose is considerable—such as castor-oil and cod-liver oil—for the double reason that, in such condition, the oil is less apt to nauseate, and also permits of having its taste quite perfectly disguised. The agents most commonly used to emulsify fixed oils are gum arabic and yolk of egg. Of these emulsifiers gum arabic is the more generally serviceable; emulsions made with egg-yolk being not so ready to form, and also, after making, being more prone to spoil. Gum tragacanth may also be used, but gives inferior results; and alkaline solutions, often quoted as emulsifiers, work with oils a chemical change—saponification—instead of the purely mechanical subdivision properly understood as emulsification. To emulsify with gum arabic, a thick mucilage is first made with a quantity of the gum equal to one-half the weight of the quantity of oil to be emulsified, and to this mucilage the oil is gradually added with thorough trituration, one portion of oil not being added until the previous one has been fully emulsified. After emulsification the product may be diluted with an aqueous menstruum, in quantity up to from eight to ten times the volume of oil represented in the emulsion. When yolk of egg is to be used, it should be taken in the proportion of one yolk to each fluid ounce of oil. *Volatile* oils in considerable quantity are best emulsified by first mixing with two or three volumes of a bland fixed oil, and then emulsifying the mixture as in the case of a simple fixed oil. Mixtures of *resins* and of *balsams* in fine mechanical subdivision in viscid menstrua, are also sometimes called emulsions. Such emulsions may be procured by the use of the same emulsifiers and method as above described. *Gum-resins* may be emulsified by trituration with water alone, the gum of the gum-resin serving to make the necessary mucilage for emulsification. No emulsions are officinal in the U. S. Pharmacopœia.

EXTRACT (Latin, *Extractum*).—The word *extract,* unqualified, expresses a preparation of solid or semi-solid consistence, made from a crude vegetable drug by one or other of the following processes In by far the majority of instances—indeed, in the U. S. Pharmacopœia, in all instances but one of officinal extracts—the crude drug is acted upon by a solvent, generally alcohol or alcohol

diluted, and the resulting solution is evaporated down to the proper consistence. In the other case, exemplified in the U. S. Pharmacopœia by the single instance of extract of taraxacum, the drug in the fresh state, bruised in a mortar with the addition of a little water, until reduced to a pulp, is subjected to expression, and the expressed juice, strained, is then evaporated to a pilular consistence. Extracts are of varying consistence, some being sufficiently hard to admit of pulverization, while others—and, indeed, the majority—are semi-solid in consistence, and of just the right degree of stickiness to permit of ready rolling into pills. Extracts are, for this latter reason, very commonly prescribed in pill-form, and extracts of indifferent drugs, such as gentian, are much used as pilular excipients for dry powders. Extracts, especially those—such as extract of taraxacum—which are made by expression of the fresh drug, are apt to be uncertain in strength. In a few instances the U. S. Pharmacopœia designates in the title of the extract the nature of the fluid to be used as the solvent in extracting the drug. Such instances are "aqueous" extract of aloes, and "alcoholic" extract of belladonna, conium, and hyoscyamus, respectively.

FLUID EXTRACT (Latin, *Extractum Fluidum*).—The fluid extracts of the U. S. Pharmacopœia are preparations made by first extracting a vegetable drug with alcohol or diluted alcohol, then concentrating the resulting alcoholic solution by evaporation, and, unless the product be self-preserving, finally fortifying the same against decomposition by the addition of some appropriate preservative, generally glycerin. A further feature of the U. S. fluid extracts is the unique one of a fixed equivalent proportion between volume of product and weight of crude drug taken for the extracting, the equivalence being that between the units of volume and of weight of the metric system—so that, in short, each *cubic centimetre of fluid extract* represents the virtues of *one gramme of crude drug*. Fluid extracts constitute a valuable class of medicinal forms, by reason of their concentration and keeping powers.

GLYCERITE (Latin, *Glyceritum*).—In the U. S. Pharmacopœia the title *glycerite* is given to a fluid preparation of which glycerin is the basis. Such U. S. glycerites are two in number only, viz., a *glycerite of starch* and a *glycerite of yolk of egg*.

HONEY (Latin, *Mel*).—There is but a single medicated "honey" in the U. S. Pharmacopœia, namely, *honey of rose*, a preparation consisting of clarified honey impregnated with red rose.

INFUSION (Latin, *Infusum*).—An *infusion* is a fluid preparation made by steeping a crude vegetable drug in water, cold or hot, and straining the product. Infusions, or "teas," as they are often vernacularly called, are bulky, are generally ill-tasting, and also prone to decomposition. Except in the case of a few special infusions, viz., the infusions, respectively, of *brayera, cinchona, digitalis, wild cherry,* and *compound infusion of senna*, the U. S. Pharmacopœia contents itself with giving a general formula for the making of infusions, leaving the prescriber thus at liberty to order an infusion of any appropriate drug he may please. In such general formula the quantity of ten parts of crude drug, in coarse powder, is directed to be treated with one hundred parts of boiling water, and the mixture to be set aside in a covered vessel for two hours. The infusion is then to be strained, and enough water to be passed through the strainer to make the product finally weigh one hundred parts. The Pharmacopœia enjoins the caution concerning infusions, that "the strength of infusions of energetic or powerful substances should be specially prescribed by the physician." Of infusions generally, the average dose is from one to two fluidounces, but in the case of infusions of powerful drugs, as, for instance, infusion of digitalis, the dose may be very much less.

JUICE (Latin, *Succus;* unofficinal).—In pharmaceutical nomenclature the term *juice* signifies a preparation consisting of the expressed juice of a fresh vegetable drug, to which enough alcohol has been added to preserve from decomposition. Two such "juices" were made officinal in the U. S. Pharmacopœia of 1870, but were dismissed in the revision for 1880. Five "juices" are officinal in the British Pharmacopœia, and in them the proportion of alcohol is one part to three, by measure, of expressed juice. "Juices" are faulty preparations by reason of uncertainty of medicinal strength.

LINIMENT (Latin, *Linimentum*).—A *liniment* is a fluid or semifluid preparation intended for rubbing upon the skin. The liniments of the U. S. Pharmacopœia are so incongruous as to present no class-features for general discussion.

MASS (Latin, *Massa*).—A *mass* in pharmacy signifies a *pill-mass*, and is applied, in the nomenclature of the U. S. Pharmacopœia, to the instances of pill-masses where no subdivision into pills of definite weight is ordained. Such instances are three in number (mass of *copaiba*, mass of *carbonate of iron*, and mass of *mercury*).

MIXTURE (Latin, *Mistura*).—In the U. S. Pharmacopœia the title *mixture* applies to many incongruous mixtures affording *fluid* preparations. Some, such as *mixture of acetate of iron and ammonium*, are clear solutions, while others, such as *mixture of ammonia*, or *mixture of asafœtida*, represent an insoluble substance in powder mechanically suspended in a viscid fluid menstruum. Such condition of suspension is often a convenient one for extemporaneous prescription of powders. In so prescribing, the necessary viscidity is to be obtained by the use of a mucilage, or of syrup, or glycerin, ordered in the proportion of from one part to one, to one part to three, of watery basis. In such viscid menstrua five per cent. of powdered extracts, or twenty per cent. of light vegetable powders, may be ordered to be suspended. Heavy metallic powders should, as a rule, not be prescribed in mechanical suspension.

MUCILAGE (Latin, *Mucilago*).—A *mucilage* is the well-known viscid product that results from treating a gum with water, hot or cold, as the case may be. Some mucilages are perfect, and others but partial, solutions. Five mucilages are officinal in the U. S. Pharmacopœia. The same are all simply bland viscid preparations, devoid of medicinal activity.

OINTMENT (Latin, *Unguentum*).—An *ointment* is a preparation of fatty quality whose melting-point is so low that the substance, partially or wholly, liquefies at the temperature of the body. Ointments are intended for application to the skin, either for purposes of local dressing or to medicate constitutionally by the method of inunction. The common bases for ointments are *lard*, either plain or benzoinated; *lard* with a small admixture of *wax*, or the well-known substance *vaseline* ("petrolatum" of the U. S. Pharmacopœia). Under the simple title *Unguentum*, Ointment, the U. S. Pharmacopœia makes officinal a mixture of lard, four parts, and wax, one part. Such "ointment" is convenient, both as a simple ointment itself, or as a simple basis for extemporaneously medicated ointments. A number of medicated ointments are officinal in the U. S. Pharmacopœia, of which the basis, in the majority of instances, is benzoinated lard. For this, however, the prescriber may, at pleasure, direct vaseline to be substituted.

OLEATE (Latin, *Oleatum*).—In the U. S. Pharmacopœia the title *Oleatum*, "Oleate," is applied to two preparations: one an "oleate" of mercury, and the other an "oleate" of the alkaloid veratrine; such preparations consisting of the oleates of the respective bases, dissolved in an excess of oleic acid. Besides these preparations, however, the oleates of many other bases, metallic and alkaloidal, are offered by pharmaceutical manufacturers, and are considerably used in medicine. Of these unofficinal preparations some, like the officinal so-called "oleates," are solutions of oleates in excess of oleic acid; while others, such as the forms of oleate of zinc and of lead in common use, consist simply of the chemically pure *oleates* themselves. Preparations consisting of oleates in solution in excess of oleic acid, are oily fluids or soft unguents; while some pure metallic oleates, such as those of zinc and of lead, are dry pulverulent bodies of a smooth, soapy feel. Oleates owe their medicinal use to the fact that they permeate animal tissue with unusual facility, after the manner of oleic acid, and so are at once

elegant and efficacious for skin medication. It is also commonly held that, upon inunction, oleates readily pass through the skin, enter the general circulation, and so affect the system at large, both promptly and thoroughly. Some doubt, however, is thrown upon this alleged faculty, by the failure of some clinicians to obtain mercurialization by inunction with oleate of mercury—and that, too, in the case of individuals who, upon trial, were found to be readily affected by ordinary mercurial ointment.[1]

Oleoresin (Latin, *Oleoresina*).—The *oleoresins* of the U. S. Pharmacopœia are preparations made by extracting with ether certain drugs whose medicinal activities reside jointly in oily and resinous constituents. After extraction the ether is evaporated and the oleoresin thereupon obtained in concentrated condition. The pharmacopœial oleoresins are thick fluids of concentrated medicinal strength. They are administered in capsule or emulsion.

Paper (Latin, *Charta*).—Three medicated *papers* are officinal in the U. S. Pharmacopœia. Of these, two, namely the papers of *cantharides* and of *mustard*, respectively, consist of sized paper coated on one side with a preparation of the active medicine. The third—paper of *nitrate of potassium*—consists of unsized paper impregnated with nitre. The cantharidal and mustard papers are intended for local application, but the nitre paper is meant to be burnt, for the sake of the fumes of the deflagrating nitre, desired for inhalation.

Pills (Latin, *Pilulæ*).—The *pill* is a favorite form for the administration of medicines, since in such form are combined the advantages of permanence, portability, exactitude of dosage, convenience of administration, and concealment of bad taste. The only drawbacks of the pill are comparative slowness of action as compared with powders or solutions, and the fact that many persons—all little children, namely, and also some adults—cannot swallow pills. The pill-form is appropriate for any solid medicine which is not corrosive or deliquescent, and whose dose is within the weight of a few grains; and may even also be employed in the case of certain fluids of small dosage, such as croton-oil. In order to be within bounds in the matter of size, pills, if composed of light substances, such as vegetable powders, should never exceed, individually, the weight of thirty centigrammes (five grains), nor, if made up of heavy matters, such as metallic powders, the individual weight of from forty to forty-five centigrammes (from six to seven grains). And pills are of most convenient size which do not weigh, indeed, more than half such stated quantities. The proper *excipients* for pills will vary according to the nature of the basis-ingredient of the pill. *Sticky vegetable extracts* need no excipient; such substances, indeed, constitute themselves excellent excipients for heavy powders. *Soft gum-resins* also require no excipient, although in making such material into pills the addition of a few drops of alcohol may be necessary to reduce hardness. *Substances, fluid or semifluid*, acquire the proper consistency for the pill-condition by admixture with some indifferent dry power, such as pulverized starch or gum arabic. *Powders*, if heavy, are best treated, for making into pills, by incorporation in some indifferent sticky vegetable extract, or in confection of rose; or, if light, by admixture of some viscid fluid, such as glycerin, syrup, or honey. Mucilage is unsuitable for such purpose, because of its tendency to make the pill-mass unduly hard when dry. For *resinous and fatty* bodies, *soap* makes a convenient excipient. In the prescription of extemporaneous pills it is not commonly necessary for the physician to specify the excipient—the selection of the appropriate substance being regarded as the function of the pharmacist. After being made, pills are variously *coated*. Shaking with an indifferent dry powder, such as lycopodium or liquorice powder, is the simplest procedure in such line, and suffices to prevent the pills from cohering, but does not effect concealment of taste. For the latter purpose, if the pills have been freshly made, a convenient operation is the shaking of the pills in a box with silver or gold foil. By this manipulation the pills become covered with bits of foil which adhere fast enough to conceal taste during the act of swallowing, but which break away readily enough thereafter to interpose no obstacle to the prompt dissolution of the pill-substance in the stomach. By special processes, also, pills made by the wholesale are given coatings of gelatin, sugar, or other analogous material. Such coatings, by the measure of the time required for the solution or disintegration of their substance in the stomach, entail delay in the development of the medicinal action of the pill. A special make of pill is what is called the *compressed* pill, wherein, it is stated, that a light vegetable powder is, without the use of any excipient, made to take and maintain pilular condition by simple subjection to powerful mechanical pressure. Such pills may be so hard as to be soluble with difficulty. The writer has known quinine pills of this make to be vomited, almost intact, several hours after swallowing. For the *administration* of pills, it suffices, with the majority of persons old enough to take pills at all, to put the pill, naked, upon the back of the tongue, and thereupon take a gulp of water. If, however, there be difficulty in swallowing under such conditions, the pill may be put in the middle of a pulpy mass, such as preserve or apple scrapings, and so offered for deglutition. Or, a method which the writer has found to succeed when all others fail, is to take a grape whose pulp will slip readily out of the skin, dig out the seeds, put the pill in their place, and then give the grape to be swallowed in the manner common to most persons—namely, to be taken by popping the pulp from the skin into the mouth and bolting without chewing.

Quite a number of pills of special composition are officinal in the U. S. Pharmacopœia. In the majority of instances of these preparations, the Pharmacopœia establishes the weight for the individual pills as well as the constitution of the mass. Such officinal pills are then entitled *Pilulæ*, Pills. In three instances, however, the composition of the pill-mass is alone directed, in which case the preparation is entitled *Massa*, Mass (see *Mass*, above).

Plaster (Latin, *Emplastrum*). — In pharmacopœial parlance the word *plaster* signifies a kind of stuff, intended for spreading upon a backing for the making of *a plaster*, in the ordinary sense of the phrase. Materials fit for service as plasters are such as are hard at ordinary temperatures, but soften readily and become sticky upon gentle warming. *Lead plaster*, so-called, which, while possessing these qualifications, is also devoid of any specific effects of its own, is the most common excipient for plasters. By their very nature, plasters can exert only the feeblest possible medicinal influence proper, the clinical results that follow their application being commonly either the usual reflex influences of persistent counter-irritation, or the natural consequences of the exclusion of air, and of mechanical support. For service, plasters are spread upon a backing of sheep-skin or of cloth, and, according to quality, may or may not require artificial softening by a gentle heat before application. The majority of plasters are not affected by water, and hence, for removal, require stripping off by force. A corner should first be loosened, by action of a few drops of oil of turpentine, if hard to start, and then the plaster quickly stripped by a backward pull parallel to the trend of the part. Hairy areas of skin should be shaved before a plaster is applied, by which procedure the pain of stripping is greatly lessened. Plasters are prescribed by dimension in inches, not by weight, and are dispensed, ready spread, for use. Seventeen plasters are officinal in the U. S. Pharmacopœia.

Poultice (Latin, *Cataplasma*; unofficinal).—A *poultice* is a mass of soft, water-moist material intended for local application. In the great majority of instances such material is designed to be, not only devoid of special medicinal activity, but even locally as unirritating as may be, the whole purpose of the application being for the sake of reflex results following from combined *warmth* and *moisture* continuously acting. The notable exception to such kind of poultice is the *mustard* poultice. For materials for poultices of the ordinary category the desired qualities are *convenience, cleanliness,*

lightness, smoothness, and *capacity to retain heat.* The commonest used poultices are as follows: 1. Flannels, or picked lint, wrung out in very hot water, and applied under some water-proof covering. Such material is cleanly, convenient, and light, but not over-smooth, and of little power to retain heat. 2. *Flax-seed meal* and hot water. This poultice keeps its heat well, but is heavy and irritating. 3. *Stale bread mixed to a pulp with hot water or milk.* The bread poultice is light and soft, but rapidly loses heat and easily turns sour. 4. *Yeast, flour, and water, set to "rise" and applied during fermentation,* a convenient and smooth material. 5. *Powdered slippery elm and hot water.* This material makes a particularly light, smooth, and unctuous poultice, well adapted for application to very tender parts. Poultices of flax-seed or slippery elm should be mixed by stirring the dry material, in powder, into a bowl of *boiling-hot* water, until a mass of proper consistence is obtained, instead of, as is sometimes improperly done, pouring the *water* upon a bowlful of the powder. Poultices should be always abundantly *thick* and *big;* should be *hot,* and should be renewed often enough to maintain a continuous hot impression. If the necessary thickness make the mass too heavy, the poultice proper may be made comparatively thin, and then be covered with a thick layer of cotton-batting. To maintain a prolonged heat-effect, the poultice-mass should be made with water actually boiling when poured from the kettle; should then be rapidly sewed up in a flannel-bag previously warmed, and then such bag should be wrapped around, several-fold, with a long flannel strip also previously warmed. A poultice so made will make and maintain for a long time a strongly hot impression (Brunton). No poultices are officinal in the U. S. Pharmacopœia.

Powder (Latin, *Pulvis*).—Medicines are often prescribed to be dispensed, and also to be administered, in the condition of powder. Furthermore, the U. S. Pharmacopœia establishes certain powders of special composition as officinal preparations. Medicines fit for administration in the condition of powder are ordinarily such as are neither oily on the one hand, nor deliquescent on the other, and are neither corrosive, bad-tasting, nor bulky in dose. So far as bad taste is concerned, however, this objectionable feature can be neutralized with more or less completeness by mixing the dose with molasses, honey, or syrup, or by enclosing it in a pulp of apple-scraping, or better yet, for such patients as are old enough to swallow whole a bolus, by encasing the powder in a so-called *capsule* or *wafer.* The *capsules* designed for such purpose are commonly made of jujube paste or some similar material, and consist of a cylindrical chamber, made in two pieces, each open at one end, of which pieces one closely fits into the other, telescope-fashion. These capsules are made of several sizes, of capacities to hold from two to four or five grains of a light vegetable powder, dry, or—if moistened so as to pack closer—ten grains. *Wafers* are of two forms. One style consists of two watch-glass shaped bodies, whose edges, upon moistening, will cohere, leaving a central space for enclosure of the powder. The charged wafer is dipped for an instant into water, whereby its surface becomes soft and slippery, when it is to be immediately swallowed whole with a sip of water. The other style consists of a single large, thin, circular sheet of wafer-material. Such sheet, dipped into water, becomes flexible, and in such condition is used as a literal *wrap* for the dose of powder.

Resin (Latin, *Resina*).—In the U. S. Pharmacopœia there are a few preparations bearing the title of *resin* of the respective drug from which they are made. These preparations are obtained by exhausting the crude drug with alcohol, and then precipitating the resulting tincture by the addition of water. The precipitated matter, in these cases, is an impure mixture of resinous principles. Such special "resins" are the "resins," respectively, of *copaiba, jalap, podophyllum,* and *scammony.*

Solution (Latin, *Liquor*).—As a title for preparations officinal in the U. S. Pharmacopœia, the word *solution* is applied to such solutions of medicinal principles as do not belong to some technically named class. With two exceptions—*solution of pepsin,* consisting of saccharated pepsin in solution in acidulated glycerin and water, and *solution of gutta-percha,* consisting of gutta-percha dissolved in chloroform—the officinal "solutions" of the Pharmacopœia are solutions of chemicals in a watery basis. Concerning aqueous solutions in general, two points present themselves for regard: first, the fact that many substances—even salts, and notably salts of the so-called "organic" acids, citric, tartaric, acetic, and lactic—which may keep indefinitely in the dry condition, will yet spoil quite readily in simple aqueous solution; and *secondly,* the fact that substances soluble in water are so soluble in very different degrees. In the revision of the U. S. Pharmacopœia for 1880 the solubilities of the several officinal chemicals were very carefully redetermined.

Spirit (Latin, *Spiritus*).—In the case of drugs containing active principles at once *volatile* and *soluble in alcohol,* the pharmacy of former days obtained alcoholic solutions of such principles by distilling the crude drug with alcohol. Such distillates were called *spirits* of the respective drugs from which they were obtained, and the principal drugs so treated for the obtaining of "spirits" were those whose activities resided in a *volatile* or so-called *essential oil.* Alcoholic solutions of volatile oils are still officinal under the title of *spirits*—constituting, indeed, the great majority of officinal so-called "spirits;" but such spirits are now obtained by direct solution of the previously extracted volatile oil in alcohol instead of by distillation of the crude drug. Such "spirits" of the present U. S. Pharmacopœia are solutions of the volatile oils of the more fragrant so-called "aromatics," and constitute a fairly distinct class of medicinal preparations. The same are often called *essences,* as, for instance, so-called *essence of peppermint,* and are, as a class, strong preparations of their kind, whose dose ranges from a few drops only to not more than a teaspoonful. Besides such spirits of the aromatic herbs, the U. S. Pharmacopœia entitles as "spirits" the alcoholic solutions, respectively, of *camphor,* of certain volatile *ethereal* bodies, such as ether, chloroform, nitrous ether, etc.; of *ammonia,* and also the two distilled liquors, *brandy* and *whiskey.* All so-called "spirits," being solutions in alcohol of sufficient concentration, are self-preservative against decomposition.

Suppository (Latin, *Suppositorium*).—In common parlance the word *suppository* means a properly shaped plug of medicated material, intended for insertion into either the *rectum, urethra,* or *vagina,* with the design of having this plug, after insertion, liquefy by the warmth of the part, and so set free a contained medicament. By custom, however, a *urethral* or a *vaginal* suppository is, respectively, so designated specifically, and the word "suppository," unqualified, is held to refer to a *rectal* suppository only. The U. S. Pharmacopœia, under the title *Suppositorium,* Suppository, gives a general direction only for the making of a plug intended for use as a *rectal* suppository, leaving it to the prescriber to order the active ingredient to be incorporated with the same. By such pharmacopœial direction, the suppository is made up, in substance, of *oil of theobroma* ("cacao-butter"), and weighs "about fifteen grains or one gramme." The special medicament is to be mixed with the oil of theobroma, melted by heat, and the mixture then run into elongated cylindrical or conical moulds. Oil of theobroma is specially adapted for a suppository-basis, because it combines the qualities of medicinal inertness and hardness at ordinary temperatures, with ready capability of liquefaction at the temperature of the rectal cavity. In the administration of a suppository the points should be observed to clean out the rectum before insertion, and, in the inserting, to push the suppository well past the sphincter.

Syrup (Latin, *Syrupus*).—The title *syrup* is given to such fluid preparations of aqueous basis as contain in solution notable amounts of sugar. Such saccharine impregnation may be for two entirely distinct purposes, viz., on the one hand the gaining of a pleasant *flavor,* or, on the other, the securing of *preservative* properties. The officinal "syrups" of the U. S. Pharmacopœia are

quite incongruous, and are variously made by the addition of sugar or of syrup to, severally, expressed juices, solutions, "waters," infusions, decoctions, "vinegars," tinctures, and fluid extracts. Syrups prepared from *vegetable* drugs are, as a class, of comparatively feeble medicinal power, and are prone to decomposition by fermentation, but, as an offset, are comparatively pleasant of taste. Quite a number of vegetable "syrups," indeed, have no other medicinal purpose than to serve the prescriber for flavoring ingredients. As such may be enumerated the pharmacopœial "syrup," simply so called—an aqueous solution of cane-sugar of specific gravity 1.310, and the "syrups," respectively, of *citric acid, almond, orange, orange-flowers, lemon, wild cherry, rose, raspberry, tolu,* and *ginger*. In prescription a flavoring syrup should, as a rule, not exceed one-half the volume of the prescribed mixture.

TABLET (unofficinal). — Recent pharmacy supplies, under the name of *tablet,* a solid disk of small, convenient size, made of some material at once soluble in water and medicinally indifferent; which disk is, in the making, duly charged with a specified dose-quantity of some active medicinal substance. These so-called *tablets* are specially convenient for use in hypodermatic medication, a single tablet containing an exact dose of the medicine to be used. For administration, by such method, a tablet is taken and dissolved in a few minims of water in a spoon, and then the whole of the extemporaneous solution so made is to be drawn up into the syringe and injected.

TINCTURE (Latin, *Tinctura*).—The word *tincture* applies pre-eminently to the fluid preparations that result from treating vegetable drugs with *alcohol,* strong or diluted. From the circumstance that alcohol is a potent solvent of organic coloring substances, such tinctures are, in the majority of instances, darkly *colored,* whence the name. Tinctures of vegetable and animal drugs form a well-defined class, presenting the following characteristics: 1. They are medicinally comparatively *strong,* from the fact that alcohol is, generally, a powerful solvent of medicinal principles. Hence the dose of an organic tincture rarely exceeds a teaspoonful, and may be but a very few drops only. 2. They *keep well,* because of the preservative effect of the alcohol which is their basis. 3. Compared with fluid preparations of the same respective drugs of an aqueous basis, tinctures commonly *taste* less disagreeably. 4. Because of their alcohol basis, tinctures deliver in much *smaller drops* than aqueous preparations—a point to be remembered in prescribing the dose of a tincture to be measured in drops. 5. Such tinctures as contain resinous bodies, as, for instance, *tincture of myrrh,* will precipitate on admixture with water. Besides the more common tinctures of vegetable drugs, the U. S. Pharmacopœia establishes, under the title of *tincture,* alcoholic solutions, respectively, of *acetate of iron, chloride of iron, iodine,* and *green soap.* The same authority, in its revision for 1880, establishes a general formula for the making of preparations entitled *Tinctures of Fresh Herbs, Tincturæ Herbarum Recentium.* The formula provides for the steeping of one part of a fresh herb in two of alcohol. This pharmacopœial provision is to meet those cases where a tincture is desired of a vegetable drug whose active principle may volatilize or undergo chemical change through the drying of the drug-substance. A disadvantage of these tinctures of fresh herbs is that the strength of any given sample is indeterminate, because of the variable amount of water which different samples of the same herb, when in the fresh condition, may hold in their respective juices.

TRITURATION (Latin, *Trituratio*).—The U. S. Pharmacopœia of 1880 establishes under the title *trituration,* any mixture of one part of a powdered drug with nine parts of sugar of milk. No special "triturations" are ordained. Triturations are convenient to meet the case of powerful drugs of small dose, when administration in condition of powder is desired. The dose of a trituration of a given drug is, self-evidently, ten times the quantity of the undiluted powdered drug itself. Of drugs likely to be prescribed in trituration, the dose of trituration can commonly be taken dry upon the tongue and swallowed with the help of a gulp of water, all without undue disagreeable taste. From the hardness of the particles of sugar of milk, the drug-substance, in a well-made trituration, comes to be very finely subdivided during the process of making, and so is in a condition fit for speedy solution, and hence absorption, when swallowed. Triturations are, therefore, apt to be quicker of medicinal action than other *solid* forms of medicine.

TROCHE (Latin, *Trochiscus*).—The *troche* or *lozenge* is a well-known disk-shaped preparation, consisting of an inert basis impregnated with a proper charge of some medicinal substance, and intended for slow solution in the mouth, commonly for the purpose of medicating directly the mucous surface of the mouth or pharynx. Since slowness of solution is here an obvious desideratum, *tragacanth* is the material commonly taken for the basis of troches. Troches are, generally, weakly medicated and pleasantly flavored. A number of troches are officinal in the U. S. Pharmacopœia.

VINEGAR (Latin, *Acetum*).—*Vinegars* were formerly preparations made by extracting the virtues of a vegetable drug with *vinegar,* but now, though the old title of the preparation is retained, *diluted acetic acid* is used instead of vinegar for the making. Four so-called vinegars are officinal in the U. S. Pharmacopœia, of which the strength is uniform—virtues of ten per cent. of crude drug in a given weight of preparation. Vinegars do not keep so well as tinctures, and are rather superfluous preparations.

WATER (Latin, *Aqua*).—Medicated "waters" were originally the preparations resulting from distilling water from an herb containing an aromatic volatile oil, whence the common name *distilled waters* applied to such preparations. Aqueous solutions of volatile oils still constitute the majority of medicated waters so-called, but nowadays, most commonly, the oil previously extracted is dissolved directly in the water, in place of the cruder process of distillation. The aromatic waters form a well-defined class of drugs, characterized especially by the feebleness of their medicinal activity, due to the very slight solubility of volatile oils in water. Hence the dose of an aromatic water is commonly safely at least a tablespoonful, and many of such waters are only of service as pleasantly flavored aqueous bases for extemporaneously prescribed fluid mixtures. The aromatic waters of the U. S. Pharmacopœia are those, severally, of *bitter almond, anise, orange-flowers, cinnamon, fennel, peppermint, spearmint,* and *rose.* Besides these aromatic waters, the U. S. Pharmacopœia establishes under the title *waters,* aqueous solutions, respectively, of *camphor, creasote, ammonia,* and *chlorine*—substances, it may be noted, all *volatile,* like the aromatic oils.

WINE (Latin, *Vinum*).—Medicated wines are now ordered by the U. S. Pharmacopœia to be made of an officinal *stronger white wine,* compounded of seven parts of a natural white wine and one part of alcohol. Medicated wines are substantially feeble tinctures, of comparatively poor keeping qualities, and, generally speaking, are not very eligible preparations. Eleven "wines" are officinal in the U. S. Pharmacopœia. *Edward Curtis.*

[1] Stelwagon: American Journal of the Medical Sciences, October, 1885.

MEHADIA, called also Herculesbad, is a spa in Hungary, about fifteen miles from Orsova, lying in a valley in the foot-hills of the Carpathian range, at an elevation of between 500 and 600 feet above the sea. There are twenty-two thermal springs here, ranging in temperature from 29° to 62.5° C. (84.2° to 144.5° F.), only nine of which, however, are employed to any extent therapeutically. The following table shows the composition of the most important spring, the Herculesbrunnen. In one litre are found of:

	Grammes.
Sodium chloride	1.0779
Calcium chloride	0.7800
Calcium sulphate	0.0645
Calcium carbonate	0.0364
Silicic acid	0.0142
Iodides and bromides	traces
Total solid constituents	1.9730

The gases are carbonic acid and nitrogen. Some of the springs contain a much larger proportion of chlorides, and others are charged with sulphuretted hydrogen.

The Mehadia waters are used internally and externally in the treatment of rheumatic and gouty enlargements of the joints, various scrofulous affections, exudations remaining after traumatisms, and in syphilitic troubles, particularly the joint affections. These waters are very similar in their action to those of Aix-la-Chapelle, and by some balneotherapists Mehadia is called the Hungarian Aachen. The climate is very mild, and sometimes in summer a little too warm for comfort. The season extends from the middle of May to the middle of September. The accommodations for guests are said to be very superior. The number of visitors averages about five thousand during the season. *T. L. S.*

MEINBERG is a spa in the principality of Lippe-Detmold, Germany, about five miles from the city of Detmold, and ten miles from Pyrmont. It lies at an altitude of about 650 feet above the sea-level. The climate is mild and agreeable. The following is the composition of the three most important springs, according to an analysis made many years ago by Brandes. The proportion of solid constituents is computed in grammes per litre of water.

	Schwefelquelle.	Kochsalzquelle.	Altbrunnen.
Sodium sulphate. ...	0.724	1.365	0.143
Potassium sulphate ..	0.001	0.005	0.002
Magnesium sulphate.	0.214	....	0.142
Calcium sulphate....	1.033	1.669	0.034
Strontium sulphate..	0.002	....	0.001
Sodium chloride	....	5.078	....
Magnesium chloride..	0.128	0.782	....
Magnesium iodide....	....	0.001	....
Sodium sulphide.. ..	0.008	...	0.003
Aluminium	0.001	0.001	0.001
Calcium carbonate...	0.266	0.748	0.055
Magnesium carbonate.	0.021	0.064	0.019
Ferrous carbonate....	0.001	0.001	0.009
Manganous carbonate.	...	....	0.001
Silicic acid...........	0.014	0.001	0.007
Organic matters......	....	....	0.008
Total solids....	2.413	9.715	0.425

All these waters are heavily charged with carbonic acid gas, the Altbrunnen in particular. The Schwefelquelle contains also a considerable amount of sulphuretted hydrogen. The springs are athermal.

The season at Meinberg runs from the middle of May to the middle of September. The waters are taken internally as well as in the form of baths of various kinds; gas-baths of "live" carbonic acid, just as it bubbles from the spring, are also much used.

The spa is frequented by sufferers from gout, rheumatism, neuralgia, locomotor ataxia, and other nervous affections; from catarrhal troubles of the respiratory and digestive organs; from scrofula in its various manifestations, and from menstrual disorders and other diseases of the female organs of reproduction. *T. L. S.*

MELANOSIS (μελάνωσις, from μέλας, black, and νόσος, disease). Synonyms. — Melanoma, melanotic tumors; Ger., *Melanose, Melanoma;* Fr., *Melanose, tumeurs melaniques.*

Definition.—The term melanosis is properly applied to the morbid state of the system which is associated with the development of multiple pigmented tumors, marked chiefly by the presence of abnormal pigment in the blood, urine, and other fluids of the body; and sometimes resulting in more or less general and uniform pigmentation of the various organs and tissues, notably of the integument and mucous membranes.

The term is applied also to all pathological productions having a brown or black color, due to the presence of granular pigment analogous to that which is found in normally pigmented parts of the body.

History.—Melanosis was first accurately described by Laënnec in 1806. To him the melanotic masses were adventitious in character, without analogy in the body, and probably closely related to the carcinomata. He further divided the disease into four varieties, based on the ocular appearances of the melanotic masses. These were: 1, The encysted; 2, the non-encysted; 3, the infiltrating or impregnating varieties, and 4, masses deposited on the surface of an organ. Laënnec's classification, entire or with slight modifications, was generally adopted by his immediate successors, and the varieties of appearance represented in it have been recognized by most subsequent observers. It was not long, however, until the melanotic masses began to be confounded with the discolorations of the tissues by extraneous matters, as by the deposit of various carbons in finely powdered form. This led Carswell to make a distinction between true and false melanosis, and subsequent authors have introduced various subdivisions of the latter class. Robin, for example, classified the disease into four varieties, based on the origin of the melanotic deposit. These have been very properly embraced in three divisions by Heurtaux, as follows: 1. Deposits in which the color is due principally to the entrance of minerals, as soot, carbons, etc. 2. Alterations in the composition of exuded or infiltrated blood. 3. The result of an abnormal production or distribution of pigment or melanin. Of these only the last division belongs to true melanosis, with which we are chiefly interested. Laënnec recognized the fact that the melanotic deposit sometimes occurred in cancerous growths as well as in the unaltered tissues of the body, and by many of his followers the carcinoma, especially the medullary variety, was considered the only form of neoplasm in which the melanotic deposit was likely to occur. Later, however, the more general use of the microscope demonstrated the fact that other tumors sometimes become melanotic, notably the sarcomata and the fibromata. Stromeyer was the first to recognize the condition in the sarcoma. His discovery was soon confirmed by Virchow, Förster, and many others, and the sarcoma is now recognized as the most frequent bearer of melanotic matter. Cornil and Trasbott go so far as to assert that they have never encountered melanotic carcinoma, but the reality of such a combination is fairly established by the statements of Rokitansky, Förster, Rindfleisch, and others. The occasional occurrence of melanosis in non-malignant growths, especially in the fibroma, has been noted by most writers; and a tendency to the production of secondary deposits, more or less generally, throughout the organs and tissues of the body, was early recognized as characteristic of all melanotic tumors.

Pathology.—Various opinions have been entertained by the more recent authors with regard to the morbid anatomy of melanosis. Rokitansky affirmed that cancer melanodes, the so-called malignant melanosis, is but a medullary carcinoma modified by pigment; but he includes under this title also the black coloring which is observed, in some few cases, spread over the whole body, but more frequently limited to certain parts, especially the lower extremities; and also, more particularly, the accumulation of black pigment, in small raised points and berry-like tumors, on the trunk and face. Paget adheres to the view that melanotic tumors are, with few exceptions, medullary cancers modified by the formation of black pigment in their elementary structures. Billroth ascribes it to either sarcoma or carcinoma, admitting, however, the occurrence of melanotic fibromata and cancroids. Cornil and Ranvier consider the tumors simple melanotic masses, entirely distinct from sarcoma and carcinoma; although recognizing also a melanotic form of the latter growths. Heurtaux, to whose excellent article the writer of this is much indebted, divides the disease into two classes, namely, benign melanosis and melanotic tumors. The latter of these he further subdivides into three principal varieties: (1) the simple infectious melanosis; (2) the melanotic sarcoma; (3) the melanotic carcinoma, and two exceptional varieties: (1) the melanotic cancroid, and (2) the melanotic fibroid.

In the *benign melanosis*, according to this author, there is simply a hyperplasia of pigmentary matter in the regions where it normally exists, without any marked tendency to extension or generalization. It is marked by the presence of small spots or tumors occupying the position of the normal pigment of the tissues, as in the skin,

the iris, the connective tissue of the pia mater, etc.; and it may frequently remain for a long time in the body of the individual without causing apparent injury. This class is usually made to include all those small congenital pigmentary spots or tumors sometimes observed in the iris, or at the sclero-corneal junction, and the pigmented nævi, moles, or "beauty-spots" of the skin.

The simple infectious variety of melanosis consists, like the preceding form, of a deposit of granular pigment in the histological elements of the tissues involved; but differs from that class in the fact that it exhibits a decided tendency to become generalized—extending as a rule, first to the tissues in the vicinity, but finally invading the most remote parts of the body. The chief mark of distinction between these growths and melanotic sarcoma and carcinoma, therefore, is the fact that the pigmentary particles do not lie in the cells of a new-formation, but that they simply infiltrate the normal tissues. The size of the melanotic masses varies between microscopic dimensions and those of a hen's egg, or larger. Tissues infiltrated by these masses frequently undergo destruction, in which case the masses become softened, even fluidified, at their centres. This tendency toward the destruction of infiltrated tissues is a further distinguishing feature between the benign and the malignant forms of melanosis. The periphery of a simple melanotic mass is usually sharply defined, and there is apparently little or no tendency to the formation of a capsule or a proliferation of the interstitial tissue of the organ in which it is located, as is generally observed about other infiltrations.

All organs and tissues are liable to invasion by the simple melanoma; its invasion is, as a rule, rapid, its result ultimately fatal. The disease frequently appears to develop simultaneously in many parts, so that it is not possible in some cases to determine whether the growths in a particular region are primary, or are secondary to some unrecognized focus. The simplicity of structure which characterizes this form of melanosis has, until within recent years, prevented its receiving the attention which its malignancy justifies.

Melanotic Sarcoma.—In this form of neoplasm there is simply the addition of a melanotic deposit to the elements

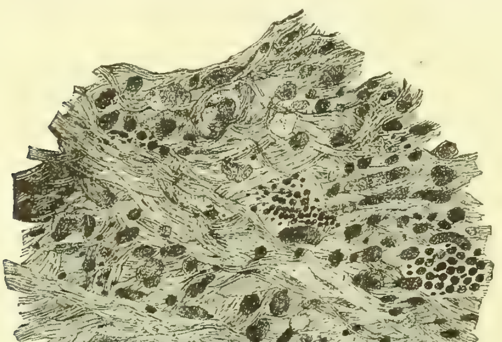

FIG. 2203.—A Section of a Small Secondary Melanotic Tumor in the Substance of the Heart. × 300. The specimen was obtained from the subject presented in Fig. 2204.

of a sarcoma either of the round- or the spindle-celled variety. The pigment is deposited first within the cells, and later in the basement substance of the tumor. The particles appear first in the protoplasm of the cells, but later they may invade the nucleus, or they become so numerous as to conceal all histological structures. The tumors vary in size between that of an accumulation composed of comparatively few cells, and visible only with the aid of the microscope, to that of the fist. Like the simple infectious melanomata, they have a decided tendency to degenerate and fluidify at their centres. The primary growth, with few exceptions, springs from the Malpighian layer of the skin, or from the choroid coat of the eye. It arises with special frequency from moles or pigmented nævi, or from their vicinity. Metastasis occurs in the same manner as in the simple sarcoma, through the medium of the circulation, and the secondary growths are found in every region of the body, notably in the skin, serous and mucous membranes, in the liver, lungs, kidneys, spleen, and heart. (See Fig. 2203).

The term melanotic sarcoma does not include those tumors in which the discoloration is due to the presence of blood that has been deposited within them by extravasation or hæmorrhage.

Melanotic Carcinoma is much less common than the preceding form of growth. Its minute structure is that of the carcinoma, usually of the soft or medullary variety, in whose elements the melanotic granules have been deposited. The pigment frequently infiltrates not only the cells within the alveoli, but even also the trabeculæ. The secondary deposits are disseminated like those of the melanotic sarcoma, throughout all parts of the body.

Exceptional Varieties.—Melanotic deposits occur only in the soft variety of fibromata. These are rarely encountered in man, but are not infrequent in the inferior animals, especially in the horse. Still more rare is the pigmented epithelioma or cancroid. Paget records but one case, and Heurtaux refers to two cases, in one of which, at least, the diagnosis is doubtful. In these growths the infiltration of the neoplasm occurs in the same order as in the melanotic forms of sarcoma or carcinoma, the pigment appearing first within the cells, later between them.

Secondary Tumors.—The tendency to the production of secondary deposits in the same or other organs and tissues, has long been recognized as stronger in melanotic tumors than in any other form of neoplastic growth. The fact that this peculiarity pertains as well to the simple infectious melanoma as to the growths in which the melanotic process is engrafted upon a commonly malignant one, renders it the more difficult of explanation. The distribution of secondary deposits is usually not limited to any particular region.

Eiselt, as a result of fifty post-mortem examinations, found secondary deposits in the various organs as follows:

Organ.	Times.
Liver	28
Spleen	13
Bones	27
Lungs	24
Pleura	29
Pancreas	20
Kidneys	16
Heart	17
Thyroid gland	6
Supra-renal capsules	3
Vertebral muscles	2
Lymphatic glands	22
Brain	8
Stomach	7
Uterus	6
Ovaries	8
Testicles	5
Penis	2
Costal cartilages	1
Diaphragm	2

The location of the primary tumor unquestionably exerts an influence upon the character and extent of the secondary invasion. The secondary tumors, as a rule, exhibit the same degree of pigmentation as presented by the primary growth. In a certain proportion of cases, however, little or even no pigment is found in them; on the other hand, cases are not infrequent in which the secondary growths are much darker in color than the primary. The structure of the original growth is usually preserved in the secondary, but instances have been recorded in which a primary malignant tumor of melanotic character has given rise to secondary growths which presented rather the character of simple infiltrations of the histological elements of the tissues in which they were located.

With regard to the origin of the pigment, or melanin, to which these melanomata owe their peculiar color, there is a considerable difference of opinion. Of whatever variety the growth, and wherever located, the pigment is first observed within its cellular elements. This fact has led some authors, among them Cornil and Ranvier, to infer that the pigment is produced by an action of the cell in which it is observed; that it may be formed at the same time in the cells of the connective tissue, in the cells of the epithelium, and even in the muscular fasciculi; and that the pigment is not derived immediately from the blood. Rindfleisch, on the other hand, believes that the pigment is taken up from the blood, first by the epithelium of the walls of the blood-vessels in the tumor, and that it is afterward absorbed by the cellular elements of the new-growth. Langhans maintains that the pigment is derived from the red blood-corpuscles through a process of transformation which occurs only within the cells of the new-growth. Gussenbauer attributes it to a modification of the coloring matter of the blood, but explains it by the supposition that the blood-vessels of the tumor become here and there thrombosed; that the coloring matter of the blood escapes from them by diffusion, saturates the tissues, and is ultimately precipitated in granular form. Kunkel's assertion, that it is possible to isolate from melanotic tumors a pigment containing iron, points also to its origin from the blood; yet the spectroscope fails to establish its identity with hæmatin, or with bilirubin or hydrobilirubin. Although Gussenbauer's theory does not seem sufficient for the explanation of the origin of the melanin of all pigmented tumors, the frequency with which we encounter individual cells or groups of cells having a diffused yellow or brownish-yellow color, without granules, especially in the peripheral zones of such growths, supports the proposition that the pigmentary deposit may become granular after it has reached the cells, probably by a process of oxidation.

ETIOLOGY.—Our knowledge of the influences which lead to the development of melanotic tumors is exceedingly limited. The great frequency of melanotic growths in the white horse led Andral to infer that the phenomenon was due to a local deposition of pigment which should normally be distributed in the pigmentation of the general integument. But melanosis is no more frequent, if indeed it is as frequent, in those of light complexion than in individuals of dark skin. Montgomery observed the disease in a negro.

The disease is most frequent in middle life. Most of the cases collected by Cornil and Trasbott occurred between the ages of forty and sixty, with five per cent. under twenty, and ten per cent. over forty. Sex has probably no influence in predisposing to it. Hereditary tendency has not been established in man, but is generally recognized in the lower animals.

Goujon inoculated four animals with the juice of a melanotic tumor, producing melanotic tumors in two instances. The frequent occurrence of melanæmia in the course of the disease suggests the importance of more accurate inquiry with regard to coincident or previous malarial infection, which was a prominent feature of Fall's case, to which reference is to be made.

In the melanotic sarcoma and carcinoma, the character of the malignant growth forming the basis of the tumor is not materially altered by the infiltration of pigment granules. That the pigment is not essential is indicated by the fact that the deposit is not always equally distributed throughout all parts of the growth, whether primary or secondary in character. As has been stated, melanotic malignant tumors are most likely to occur in tissues which normally contain pigment, and therefore frequently arise from the choroid, or from moles or the skin in their vicinity. Further than this the origin of these growths is clouded in the same obscurity as surrounds the origin of the more simple malignant tumors.

SYMPTOMS.—The primary lesion of melanosis very often appears as a pigmented sarcoma within the orbit, involving the adipose tissue of the orbit, the cornea, the conjunctiva, or the tissues of the globe in immediate relation with the choroid. In the cornea and conjunctiva the melanotic masses usually appear as small spots, at first solitary, later multiple. The development of tumors in or beneath the choroid is sometimes first announced by an impairment of vision. Ophthalmoscopic examination will now reveal the presence of a tumor causing a protrusion inward of the retina. Later the vitreous body may be absorbed, the lens displaced anteriorly, and, finally, the entire globe of the eye may be converted into a melanotic mass. In some cases the growth passes beyond the limits of the eye and appears externally as a fungous mass or excrescence; or, following the course of the optic nerve, attacks the tissues of the orbit or enters the cranium.

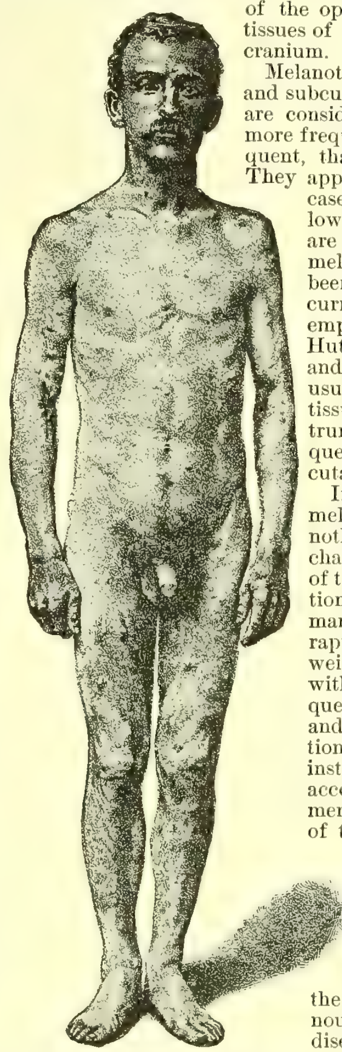

FIG. 2204.—Dr. Falls' Case of Melanosis, about three months after the commencement of the discoloration of the skin, and about six months after the first appearance of the disease. The larger subcutaneous nodules are also represented.

Melanotic tumors of the skin and subcutaneous cellular tissues are considered by some authors more frequent, by others less frequent, than those of the eye. They appear in the majority of cases in the face or in the lower extremities. They are rare on the hands; but melanotic whitlow has been observed, and its occurrence has recently been emphasized by Jonathan Hutchinson. On the face and the feet the masses usually develop within the tissues of the skin; on the trunk they are more frequently located in the subcutaneous tissues.

In the early history of melanosis there is often nothing to indicate the real character or malignancy of the disorder. Constitutional disturbances may manifest themselves, with rapid emaciation, loss of weight, failure of strength, with anorexia, and frequently also constipation, and various other indications of ill-health. In some instances these symptoms accompany the development of the primary lesion of the disease; as a rule, however, their occurrence is delayed until a more general invasion of the system has occurred. In some cases, on the other hand, they are the first symptoms to announce the outset of the disease, developing even before the existence of a tumor has been discovered.

At a variable time, generally two or three months after the first appearance of the disease, small pigmented spots or nodules begin to appear in the skin over various regions of the body. The appearance of the disease at this stage has been well described by Dr. W. H. Falls, of Cincinnati, in his report of the case which he has kindly granted me permission to illustrate in Fig. 2204. He says: "The integument of the ears, face, and neck, and the mucous membrane of the eyelids, nares, mouth, and fauces are of a dark ashy color. The lips also present the same appearance. The integument of the trunk and upper and lower extremities, with the exceptions named, is normal in color. Scattered over the various parts of the body are numerous nodules varying in size from that

of a pinhead to that of a large pea. These nodules are thickest on the anterior portion of the trunk, and on the anterior portions of the upper and lower extremities. On the extremities they are prominent in the course of the veins. A few are scattered over the scalp, face, and neck, one being quite prominent on the upper eyelid of the right eye; a small number on the scrotum and penis, one being very conspicuous on the glans penis. To the touch they are hard, and seem to be situated in the subcutaneous tissue, the integument being freely movable over them, except those on the anterior part of the trunk. Several of them are flattened, and the integument is not as freely movable over them. I should judge, with a rough estimation, that there are at least two hundred of these nodules on the body.

"Physical examination: Heart and lungs normal. Abdomen prominent. Liver enlarged, the hepatic dulness extending three inches below the margin of the ribs. Splenic dulness increased about two inches in each measurement. Some tenderness over the spleen, but over no other portion of the abdomen."

The appearance of the body at the time of death, about two months later, was described as follows: "The entire cutaneous surface, from the scalp to the lower third of the legs, was irregularly studded with numerous projections, due to subcutaneous nodules, varying from the size of a pea to that of a filbert; the smaller ones being chiefly situated on the extremities, scalp, and eyelids. These nodules were most thickly distributed over the flexor surfaces of the extremities, and on the anterior surface of the trunk; they were probably about one hundred in number on the arms alone. On the lower extremities the nodules gradually increased in size from below upward; on the upper extremities they were more uniform in size than elsewhere, averaging about the size of a large pea. The right upper eyelid presented two nodules, one the size of a pea, the other about one-fifth as large; the left upper eyelid contained two very small prominences, each about the size of a pin-head; another, nearly as large as a pea, was situated at the inner and upper angle of the left orbit. The anterior abdominal wall was the seat of eight or ten nodules, which differed considerably in shape from those found elsewhere, being decidedly flattened or nummular in form, and varying from a half-inch to an inch in diameter."

Four linear cicatrices, three in the region of the sterno-clavicular articulation, and one at the inner border of the left scapula, denoted the sites of congenital nævi which had been removed shortly before the disease first appeared, on account of the irritation produced in them by the clothing. Upon section, every organ and tissue was found studded with melanotic masses identical with those described, or diffusedly pigmented. Such universal discoloration of the body is not present in a majority of cases. It has, however, been encountered by Ernst Wagner, and more recently by J. Wickham Legg, in a case reported to the Pathological Society of London in 1884. In the case reported by the latter observer, the discoloration of the skin was one of the earliest manifestations of the disease.

In some cases the neoplasms have not appeared on the surface of the body, but have been discovered upon autopsy. In these cases the symptoms were simply those of melanæmia.

Sooner or later in the history of the disease, melanæmia becomes a prominent symptom, the fluids of the body becoming more or less extensively pigmented. The alterations of the blood were first studied by Nepven, in 1872. They consist in an increase of the number of white corpuscles and the presence of granular pigment, in the form of round or angular particles, both within the white corpuscles and floating freely in the plasma. The urine when voided sometimes has a dark-brown or a black color, owing to the presence of pigment which, later, subsides in the form of a dense, dark sediment. This sediment is resolved by the microscope into numerous pigmented casts and free granular pigment. Albumen is usually present in small amount. Eiselt has observed a peculiar condition of the urine. When voided it presented no abnormal appearance, but after exposure to the air, or upon the addition of such oxidizing agents as sulphuric or hydrochloric acid, or potassium bichromate, assumed a dark color. This reaction was demonstrated also in Legg's case.

Ascitic fluid and vomited matters have been found stained with pigment in melanosis. The sputum also sometimes contains melanin from the secondary growths in the lungs.

The abdomen generally becomes prominent, owing to distention by enlargement of the liver and spleen, and ascites is not infrequently developed.

The duration of a case of melanosis is from a few months to five or six years. The limit is usually less than one year after the generalization of the disease. Its course is usually afebrile throughout. As it advances, the strength of the individual progressively declines. Hæmorrhages sometimes occur from various mucous surfaces or from the kidneys, and sometimes an exhausting diarrhœa develops. Hemiplegia, partial or complete, and other paralyses, not uncommonly occur near the termination of the disease. Death may be sudden, as from hæmorrhage, but is more often the result of gradual exhaustion, terminating in coma.

Diagnosis.—The diagnosis of this disease generally presents no difficulty, if once a suspicion of its existence has been aroused. Whether the tumors involve the skin or only the subcutaneous tissue, their character is generally soon announced by a bluish or livid discoloration of the surface. When the melanotic spots are yet few in number, it is sometimes not easy to distinguish them from pigmented nævi. The same difficulty is experienced in determining the character of tumors about the eye, and in either case the diagnosis must often be deferred until the progress of the disease has been studied. Apparent error of diagnosis may arise from the fact that the simple benign melanotic masses, moles, and nævi may, after the lapse of a year or more, assume malignant properties. To establish the character of the tumors, one of the smaller growths may be excised and its structure examined microscopically.

When the neoplasms are confined to the interior of the body, and the only symptoms presenting themselves are those of simple melanæmia, the diagnosis is exceedingly difficult. In these cases the chief difficulty arises in the exclusion of Addison's disease, abdominal tuberculosis, discolorations from the prolonged use of silver or arsenic, the melasma of pregnancy or of chronic uterine disease; or the pigmentations which sometimes follow psoriasis, scabies, pruritus, or pediculosis. The disease is not, as a rule, accompanied by so great prostration or by such marked gastric disturbance as belongs to Addison's disease; the symptoms on the part of the abdominal organs are not so prominent as they sooner or later become in tubercular disease; it can generally be distinguished from argyria or chronic arsenical poisoning, by the slower development of the latter, and by the absence of a history of the prolonged ingestion of these agents. Pregnancy and chronic uterine disease are usually easily eliminated, and the location and form of the pigmented spots of itching diseases, as well as their permanent character, are generally characteristic. When a decision cannot be arrived at from inspection, however, the diagnosis can usually be established by an examination of the fluids of the body, the microscope revealing in them, as a rule, the presence of pigment granules. Further, it is an important fact that diffused pigmentation of the skin from a melanosis of internal organs, rarely exists for a long time without the development of melanotic masses in the skin or in the mucous membranes, where their presence can be detected.

Prognosis.—As has been stated, one of the most constant features of melanotic tumors is their tendency to become generalized, and to recur after removal. The presence of pigment in a tumor, whatever its structure, is therefore sufficient to justify a guarded, and in many instances an unfavorable, prognosis. In a few instances the disease has remained latent, the primary tumor presenting no malignancy for several years; or its removal has been followed by a considerable period of quiescence,

as in cases reported by Lawrence, Simon, and others. But more commonly the disease advances rapidly, and the removal of the primary growth, or of any number of the first recognized masses, is followed sooner or later by a redevelopment of the disease in the cicatrix, or in more remote parts. The removal of pigmented nævi has in some instances appeared to hasten the generalization of the disease. Nepven entertains hope for the success of operative measures previous to the appearance of melanotic granules in the blood ; but this is not always a safe criterion, for in Legg's case the blood showed no pigment until late in the course of the disease.

After generalization of the disease has occurred, its course is invariably fatal.

Treatment.—The propriety of operative measures in the treatment of melanosis is questionable. Early removal of the primary tumor or masses may, however, prevent, or at least delay, the advance of the disease. Where it is possible, therefore, moles and pigmented nævi should be excised upon the first indication of an active hyperplasia within them. After the disease has become generalized and the strength of the patient has begun to decline, nothing can be hoped for from operation. The treatment then becomes wholly symptomatic, its aim being to secure the comfort of the individual, to support his strength, and to control as far as possible the occurrence of accidents which tend to hasten the fatal termination.

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James M. French.

MELBOURNE. The city of Melbourne, capital of the colony of Victoria, and the most populous town in Australia, lies at the head of Port Philip Bay, in latitude 37° 49′ 53″ south, longitude 144° 58′ 42″ east. The city proper stands back from the shore of the bay, at a distance of about three miles, and is built along the north bank of the Yarra Yarra River. Its population in 1881 was 65,800. No less than twenty-three suburban towns, lying within a radius of about five miles, are specified in the article on Melbourne in vol. xv. of the "Encyclopædia Britannica ;" the largest of them, Emerald Hill, having a population of 25,300 ; the smallest a population of 4,200 ; and many smaller suburbs filling up the intervening spaces are alluded to. Fifteen of the suburbs "rank as independent municipalities, and many of them have streets which for importance rival the main streets of the city." The suburbs, taken collectively, far outrank the city proper in population, the census of 1881 allotting them no less than 217,048 souls. Fine parks exist both in the central city and in the suburbs.

"Melbourne is by no means a crowded city ; the streets are all ninety-nine feet wide, and the parks, squares, and gardens are so numerous, that with only one-thirteenth of the population of London, it occupies very nearly half as great an area. . . . It is one of the peculiar features of Melbourne that about three out of every four mechanics who have reached middle life, own the neat cottages they occupy. . . . The cost of living is about the same as in London" (*loc. cit.*). Of the drainage and water-supply at Melbourne, I find no specific mention ; probably, however, it is safe to assume that due attention has been bestowed upon these important matters in a city having its population so scattered, and the most densely populated portion of which is built upon two hills by the bank of a navigable river, and where, too, so much labor and expense has been applied to public works (*vide* "Encyclop. Britannica").

The chief purpose of this article is to present data showing the climate of Melbourne ; a climate which may be considered as fairly typical of that of the colony of Victoria, despite the decided local modifications of the type (dependent upon relative distance from the coast, shelter against hot winds by proximity to the mountains, greater or less elevation above sea-level, etc.) which are to be found in different parts of the colony. Some information not given in this place will be found in the article on Victoria, and also, so far as Australia as a whole is concerned, in the Appendix, under the title Australia.

The figures of the accompanying chart were very kindly sent me by Mr. Robert L. J. Ellery, the Government Astronomer of Victoria. A careful study of the chart by any reader who is at all familiar with the subject of climatology, or by one who has read the brief article on Climate in vol. ii. of this Handbook, will serve to demonstrate fairly well the leading features characteristic of the Melbourne climate. In the main, the data of this chart will be found to correspond in kind to those presented in the large United States Signal Service charts published in the Handbook. The period of observations from which the figures of columns AA, B, E, F, J, K, X, and O are derived, is decidedly longer than that of any of these United States charts ; that of columns R and S is somewhat longer ; that of columns T and V is of about the same length ; while that of columns C and D is decidedly shorter. The data of column X and of columns T and V do not occur in any of the United States Signal Service charts ; on the other hand, columns A, G, H, L, M, and N of those charts are missing in this chart for Melbourne. The reader will, of course, bear in mind that Australia lies south of the equator, and that the terms "spring," "summer," "autumn," and "winter," are to be interpreted in accordance with this fact.

To supplement the chart I introduce figures and statements from Mr. Ellery's "Notes on the Climate of Victoria," and from Dr. Julius Hann's "Handbuch der Klimatologie." The mean daily range of temperature at Melbourne in winter is 13° F. ; in summer it is 22° F. (Hann., *op. cit.*). The summer is the season of greatest variability—partly, no doubt, by reason of the greater dryness of the atmosphere at that season ; chiefly on account of the sudden extreme elevations of temperature brought about by winds blowing from the desert of Central Australia. The maxima of temperature at Melbourne exceed those at Cairo, while the mean summer temperature is the same as that of Middle Europe ; and the summer minima correspond to those of Middle Germany (Hann). "It is during the hot winds to which this climate is subject in summer that our highest temperatures occur, but they seldom last many hours, and are usually rapidly followed by a change in direction of the wind and by a comparatively low thermometer—when a fall of twenty to twenty-five degrees often occurs in as many minutes" (Ellery, *op. cit.*). Variations, and great variations, in atmospheric humidity occur at Melbourne. "The humidity of the air," says Mr. Ellery, "is subject to very great and rapid variations, especially during the summer months, when it is not at all unusual that it is reduced from sixty to twenty-four per cent. in a few hours ; and frequently, during the occurrence of hot winds, with a daily mean of thirty or forty per cent., it has been reduced as low as thirteen or fifteen per cent. In such cases of minimum humidity, however, the daily mean or even an excessive humidity immediately follows the change of wind." Dr. Hann tells us that, according to a careful reckoning by Neumayer, about nineteen of

Climate of Melbourne, Victoria.—Latitude 37° 49′ 53″ *South, Longitude* 9 *h.* 39 *m.* 54 *s. East.—Period of Observations,* 1858 *to* 1884.—*Government Observatory.—Elevation of Place above the Sea-level,* 91 *feet.*

	AA	B		C	D	E		F		T	V	J
	Average mean temperature.*	Mean temperature for period of observation.		Average maximum temperature for period. 1880–1884.	Average minimum temperature for period. 1880–1884.	Absolute maximum temperature for period.		Absolute minimum temperature for period.		Greatest monthly range. 1858–1871.*	Mean monthly range. 1858–1871.*	Range of temperature for period.
	Degrees.	Highest. Degrees.	Lowest. Degrees.	Degrees.	Degrees.	Highest. Degrees.	Lowest. Degrees.	Highest. Degrees.	Lowest. Degrees.			Degrees.
January	66.6	68.7	62.8	79.94	55.28	111.2	94.7	51.6	42.3	67.2	55.4	68.9
February	65.6	70.3	63.2	78.06	57.26	109.0	89.6	53.3	40.3	68.7	53.3	68.7
March	63.8	65.7	60.2	75.54	55.36	104.6	86.7	51.4	37.1	62.8	48.9	67.5
April	59.0	60.9	55.9	69.00	50.74	94.0	75.9	45.2	35.1	58.9	45.0	58.9
May	53.3	56.4	51.3	61.94	47.24	82.1	66.5	41.7	31.8	50.3	35.2	50.3
June	49.5	53.4	46.5	57.18	43.84	68.1	57.5	37.3	28.0	40.1	30.9	40.1
July	47.8	50.5	46.1	55.42	41.02	66.1	58.1	39.0	27.0	38.7	31.1	39.1
August	50.2	52.6	47.1	59.90	44.58	74.7	65.2	39.6	28.3	45.7	34.9	46.4
September	53.2	54.9	50.5	65.10	45.58	80.1	69.4	38.2	33.0	46.0	40.3	47.1
October	57.0	59.3	54.3	66.16	46.98	95.8	73.8	42.8	32.1	63.7	46.9	63.7
November	60.9	64.1	56.8	70.76	51.12	103.2	83.5	45.0	38.1	64.4	52.0	65.1
December	63.7	67.9	61.0	73.78	53.26	110.7	86.9	50.0	40.0	70.0	54.9	70.7
Spring	57.0**	59.43	53.87	......	......	......	......	......	......	......	......	71.1
Summer	65.3**	68.97	62.33	......	......	......	......	......	......	......	......	71.2
Autumn	58.7**	61.00	55.80	......	......	......	......	......	......	......	......	72.8
Winter	49.2**	52.17	46.57	......	......	......	......	......	......	......	......	47.7
Year	57.5	60.39	54.64	......	......	......	......	......	......	......	......	84.2

	K	X	O	R	S
	Mean relative humidity.	Average number of days of rain.	Average rainfall.	Prevailing direction of wind. 1867–1883.	Average velocity of wind in miles, per hour. 1867–1883.
	Per cent.		Inches.		
January	64	7	1.60	S. & S.W.	11.0
February	66	8	1.95	S.E. & S.	10.8
March	68	8	2.13	S. & S.E.	9.6
April	72	11	2.27	S. & S.E.	8.9
May	78	13	2.16	N. & N.E.	9.5
June	80	13	1.97	N. & N.E.	10.5
July	80	13	1.78	N. & N.E.	10.1
August	75	14	1.89	N. & N.E.	10.7
September	71	14	2.33	N. & N.E.	11.2
October	70	13	2.88	S. & S.W.	11.3
November	67	11	2.44	S. & S.W.	11.1
December	64	9	2.36	S. & S.W.	11.3
Spring	69	38	7.65	N. & S.W.	11.20
Summer	65	24	5.91	S. & S.W.	11.03
Autumn	73	32	6.56	S. & S.E.	9.33
Winter	78	40	5.64	N. & N.E.	10.43
Year	71	131	25.76	N., S.W. & S	10.50

* From Notes on the Climate of Victoria, by Robert L. J. Ellery, Government Astronomer of Victoria.
** Seasonal averages deduced from Mr. Ellery's monthly averages.

these hot winds (north winds) occur at Melbourne between the second month of spring (October) and the first month of autumn (March); and that they effect, on the average, a temporary elevation of temperature of 26.5° F. above the normal of the season; at the same time reducing the relative humidity to 24.6 per cent. Frequently the relative humidity falls to twelve or to ten per cent. Thus, on December 23, 1857, the mercury, at 9.30 A.M., stood at 94.46° F., while the relative humidity was twenty-three per cent.; at 3.30 P.M. of the same day the temperature had risen to 107.24° F., the relative humidity had fallen to twelve per cent. The temperature, after having reached 40° C. to 44° C. (104° F. to 111.2° F.) during the prevalence of the north wind, may fall 10° C. to 17° C. (18° F. to 30.5° F.) as soon as the direction of the wind has changed ("plötzlich nach Umspringen des Windes"). "The hot north winds at Melbourne are always accompanied by dust, and by a condition of negative electricity. The frequently sudden change of the wind to southwest brings rapid cooling of the atmosphere, a high degree of humidity, heavy thunder-storms, and increased atmospheric pressure." As illustrating the damaging effect upon vegetation produced by a summer north wind, and the extreme heat of such a wind, we may cite a remarkable instance, mentioned by Dr. Hann (and by him quoted from Neumayer), when, during the hot wind of January 21st and 22d, 1860, "apples were literally roasted on the trees where they were exposed to the wind" (Hann, *loc. cit.*). Respecting the relative force and frequency of the different winds at Melbourne, we are told by Mr. Ellery (*op. cit.*) that "it seems evident the northerly winds have the ascendancy both in frequency and force, more especially during the summer months. South and southwest winds come next in force, and, generally speaking, in frequency also." As to cloudiness of sky, the same writer tells us that the night is less cloudy than the day, and that a minimum of cloudiness seems to occur at 9 P.M., and a maximum at 7 A.M. The table of percentage of cloudiness at different Victoria stations, given in his pamphlet, shows that at Melbourne this percentage is as follows: January, 53; February, 50; March, 52; April, 58; May, 64; June, 65; July, 64; August, 61; September, 61; October, 60; November, 59; December, 55; Year, 58.

An interesting article by Dr. C. Faber, treating of the Australian climates, may be found in the London *Practitioner* for the year 1878 (vol. i., p. 17, and vol. ii., p. 351). From this article I quote the following passage descriptive of the climate of Melbourne, which climate Dr. Faber regards as fairly representative of that of the whole colony of Victoria. "During seventeen years (1858–1874) the thermometer in the shade has risen at Melbourne sixty-one times to or above 100°, and only in two years has it failed to rise so high. During the same period it has fallen fifty-two times to or below the freezing point. In three years only it did not fall so low. The greatest yearly range of temperature was 82.6° in 1868; *i.e.*, still ten degrees less than the extreme range observed at Greenwich within a thirty-five years period. Yet Melbourne has, as we have seen, the least equable climate of all the Victorian coast stations. This is shown by a comparison between the maximum temperatures ever observed; that of Melbourne being 111.2°, while that of the other stations, where I find the maximum and minimum temperatures to be recorded, viz., Cape Otway and Portland, was 105° and 108°, respectively. The absolute minimum was the same—27° at Melbourne and Portland; at Cape Otway it was 30°. The average yearly range at the two first named places is 76° and 69.5°, respectively." The mean daily range of

temperature at Melbourne and at Greenwich, for each of the four seasons, is given by Dr. Faber as follows: *

	Melbourne.	Greenwich.
Spring	20	18
Summer	22	21
Autumn	18.5	15
Winter	15	10

The same writer states that the greatest mean daily range at Melbourne occurred in November, 1862, and that it was no less than 27° F., while the lowest mean daily range, not exceeding 7.7°, occurred in the winter month of June, 1860.

The statements already quoted, taken in connection with a careful study of the meteorological chart, will doubtless suffice to give the reader a fairly accurate idea of the Melbourne climate; but to make the picture more graphic I subjoin Mr. Ellery's brief "description of a cycle of the seasons" in Victoria:

"The spring season, which may be said to include September, October, and November, generally sets in about the beginning of September; during which month, although slight frosts sometimes occur, the weather is usually mild and often quite warm. Rather above the monthly average of rain also frequently falls. Strong northerly and westerly winds are prevalent in September and October, but the currents of air, both as regards frequency and velocity, seem to be more equally distributed during these months than at other parts of the year. The northerly winds begin to assume the dry and warm condition which characterises them throughout the summer months, and it is not at all unfrequent that quite a hot wind may prevail for a short period even in October; the weather generally, however, in September and October, is genial and pleasant. November also, representing the height of spring, is usually characterized by fine, warm, and sometimes even hot weather. It is not at all unusual to get a large rainfall in October or November, sometimes giving rise to extensive floods; in some seasons, however, the rainfall after the commencement of October diminishes considerably, and frequent dry, and even hot, northerly winds in November parch the grass and other herbage, giving to the plains and hills a sand-like appearance; but in others the pastures remain green till January, and in many parts of the colony throughout the year."

"The summer season includes the months of December, January, and February. December is often marked by very changeable weather, and although generally hot and dry, it is not unfrequently broken up by cold and stormy intervals, with heavy rains, and gales of wind. The northerly winds become more or less hot according to the amount and distribution of the rainfall throughout the interior during spring. Very great changes of temperature often take place in a few hours; for instance, a warm north wind prevails in the morning, with a temperature reaching as high as 90° to 100°; a lull in the afternoon is quickly followed by a strong breeze from the S. W., and the temperature becomes reduced to 65° or 60° in fifteen or twenty minutes."

"The highest mean temperature occurs in January; February, also, is often characterised by great heat and dryness. It is during these months that the northerly winds become perfect siroccos for short periods, and if the spring has been dry, extensive bush-fires occur on the plains and in the forests, giving rise to a considerable increase of temperature, and superadding to the already unpleasant state of things a smoky and lurid atmosphere over considerable areas in the vicinity. Although unpleasantly hot weather very frequently intervenes throughout the summer months, yet a large and often the largest portion of the weather is fine and pleasant, with cool southerly or southwesterly winds."

"The autumn season, including the months of March, April, and May, although subject to stormy weather, gales of wind, and large rainfall—especially in its earlier part, and following the equinoxes—may nevertheless be called the most genial and beautiful portion of the year. It constitutes a second spring, for so soon as vegetation receives the moisture it has thirsted for through the summer, the indigenous plants and trees put forth a growth that often exceeds that of spring. The temperature on the whole maintains a moderate mean; the northerly winds now become cooler, and solar radiation is considerably reduced; heavy dews fall at night, and sometimes towards the end of this season fog occurs during the night and early morning in very calm weather. In April the mean temperature becomes 59°, and in May 53°."

"Winter includes June, July, and August. This season, though usually marked by frequent rain and strong winds, especially from the north, is in some years remarkably dry, with a small rainfall; the temperature does not reach its minimum till the middle of July and the beginning of August, and seldom in Melbourne falls much below freezing point. Ice and hoar-frost occur generally only on a very few occasions during the winter in the neighbourhood of Melbourne, the former sometimes attaining a quarter of an inch in thickness. At higher levels, however, frost and ice have been observed as early as May, and form much more frequently during the winter months than at the lower levels; the highest mountain summits too are in most seasons seen to be clothed in snow by June, and sometimes even as early as the beginning of May. The strongest winds in winter are usually from the north, from which quarter it often blows with great violence; wind from this direction is dry, and usually very cold at this season."

"The worst vicissitude to which the climate of Victoria is subject, in common with Australia generally, is the occasional droughts; these as already stated appear to follow those years characterised by unusual rainfall; a fact that has given rise to a conjecture that both the excessively wet and the excessively dry seasons are periodical. The last drought to which the colony was subject extended from the summer of 1865 till almost the winter of 1866, and was doubtless due to the small rainfall in the autumn and spring months."

CLIMATOTHERAPY.—A discussion of this subdivision of our subject would fall more naturally under the titles Victoria, New South Wales, and Australia, inasmuch as the city of Melbourne and its immediate vicinity present no special and peculiar attractions, as a residence for invalids, which are not equally shared by other places in southern or southeastern Australia. Nay, more than this, we find Dr. Faber (*loc. cit.*) warning invalids resorting to Australia for the relief or cure of pulmonary phthisis, that to "linger about the place of arrival, that is, one of the large cities, Melbourne or Sidney," is "the worst thing they can do." Mr. Isaac B. Brown, late Surgeon Superintendent of H. M. Emigration Service, who is an advocate of New South Wales as the part of Australia best suited for the residence of invalids, speaks in the same way against the city of Sidney as a resort for such persons. ("Australia for the Consumptive Invalid: the Voyage, Climates, and Prospects"). Nevertheless, it is proper to say something under the heading of climatotherapy in this place, even if in so doing it becomes necessary slightly to transcend the strict limits of our subject.

Except for persons living in India, China, Japan, or in some of the islands of the Malaysian Archipelago, Australia may be considered entirely useless as a health-resort, unless, indeed, it be regarded as a temporary landing- and resting-place for such as have undertaken a long sea-voyage for the benefit of their health, or for such invalids as may have been recommended to try a double method of cure, viz., sea-voyage and complete change of land climate for prolonged or permanent residence after the voyage.

Among permanent residents of Victoria and of Melbourne pulmonary phthisis is found, to be sure, but it appears to be of comparatively rare occurrence. Thus, according to Dr. H. Lombard, who makes the statement apparently on the authority of Dr. S. Dougan Bird, of Melbourne, the percentage of the city's total mortality, in

* See page 238 in vol. ii. of this REFERENCE HANDBOOK, for like data from sixteen stations in the United States.

1861, which could be assigned to consumption, was only 7.4. "In the colony at large, the deaths from pulmonary consumption are probably not more than 4.5 or 5 per cent. of the total mortality" (Dr. S. D. Bird "On Australasian Climates and their Influence in the Prevention and Arrest of Pulmonary Consumption."). Dr. Bird's testimony as to the freedom of native-born children from inherited tubercular diseases is interesting. He says: "In the Immigrants' Aid Society Home at Melbourne, with which the writer is officially connected as physician, there are maintained an annual average of four hundred children from birth to thirteen years of age. The greater part of these are the offspring of the very dregs of the colonial population. Five-sixths of them are Australian born. During the last twelve months there has been no case of infantile phthisis, only one of tabes mesenterica, and one of disease of the brain of tubercular origin. No case of scrofulous disease of bones or joints has occurred, and hardly any of enlargement or suppuration of the lymphatic glands." Dr. George Fullerton, in a paper entitled "Observations on the Climate and Diseases of Australia" (*N. Y. Med. Times*, February, 1855), states that pulmonary phthisis occurring in natives of Australia "runs its stages more quickly than in Europe; while emigrants who started with sufficient stamina to bear the voyage, are invariably improved by the mildness of the climate, and, if careful in their habits, never fail to obtain a respite from the ravages of this destroyer." Concerning the results of treatment in cases of pulmonary consumption, Dr. Bird ("On Australian Climates in Consumption," *Lancet*, January 5, 1867) reports as follows: The observations covered 46 cases; of which 15 were in the first, 9 in the second, and 22 in the third, stage. Of the latter but 1 had died, 7 had derived little or no benefit, 5 were improved, and 8 were more or less completely restored to health. Out of the 24 cases in the first and second stages of the disease, some 20 were restored to more or less perfect health. Certainly such results as these speak well for the treatment and the climate, but it is to be observed that the particular climate of Melbourne does not deserve all the praise for such results. Thus Dr. Bird says in conclusion: "Some of my patients spend the spring and autumn in Melbourne, summer in the highlands of Tasmania, and winter, which is barely ten weeks in duration, on the plains of the Murray or Darling. By this means they enjoy a bright, cloudless, invigorating climate of a mild temperature all the year." *

Dr. Hermann Weber's experience in fourteen cases of phthisis, six of whom were in the first, and eight of whom were in the second stage, and where the same method of changing the local climate according to the season was followed, appears to have been very similar to that just quoted from Dr. Bird.

The summer season at Melbourne is evidently too hot for invalids. Intermittent fever does not prevail in Australia. Rheumatism and cardiac affections appear to be very common in the coast region. However beneficial the climate of Melbourne, during the autumn and spring months, may be in the case of phthisical patients who pass the remainder of the year in Tasmania and in Central Australia, in the case of such as *combine temporary sojourn there with a long sea-voyage*, or for those resorting thither from India, or from China and Japan; it can seldom be thought necessary or advisable that a consumptive patient from any part of Europe, or of the United States, or of Canada, should resort to residence in so remote a country, when he has the choice of such excellent anti-phthisical climates as those of Southern California, Egypt, Colorado, Davos and the Upper Engadine, Florida, Madeira, or the famous Italian Riviera, etc., all of which lie so much nearer to his home.

Huntington Richards.

* The plains of the Murray and Darling Rivers lie far back from the coast, in the central portion of Australia, beyond the Australian Alps, the Blue Mountains, and the Liverpool and New England Ranges; their elevation above sea-level is, in some places, very considerable. Rainlessness, cloudlessness, and powerful insolation are especially characteristic of their climate. See New South Wales.

MELILOT (*Herba Meliloti*, Ph. G.; *Melilot officinal*, Codex Med.; Sweet Clover). The dried herb of two species of *Melilotus*, *M. officinalis* Desr. and *M. altissimus* Thuill.; Order, *Leguminosæ*. These are tall, upright, or straggling biennial herbs, with small trifoliate leaves and axillary spikes of minute clover-like flowers. Both plants are fragrant, having the pleasant odor of Tonka beans, which is also increased by drying. They contain also the same odorous substance found in Tonka beans, *cumarin* (cumaric anhydride), as well as the related substances, *melilotus oil*, *melilotic acid*, and *cumaric acid*.

Melilot is a mild and pleasant aromatic of no special value in medicine, and is fairly obsolete. The infusion was formerly employed to a considerable extent as an eye-wash. Dose indefinite.

Allied Plants.—The genus contains six or eight other species of about the same qualities; for the order see Senna.

Allied Drugs.—See Tonka bean. *W. P. Bolles.*

MEMBRANA TYMPANI, ARTIFICIAL. The artificial membrana tympani, according to Roosa ("Treatise on Diseases of the Ear"), was first proposed by Marcus Banze in 1640, but it is not stated whether he carried out his proposition of placing in the auditory canal a tube of ivory having its end covered with a bit of pig's-bladder. In 1841 a gentleman from New York consulted Dr. James Yearsley, of London, in regard to his deafness, and informed Dr. Yearsley that he was enabled to improve his hearing-power so that he could produce in his left ear a degree of hearing quite sufficient for all ordinary purposes. This was done by the introduction "of a spill of paper, previously moistened with saliva, to the bottom of the passage" (see Yearsley, "Deafness").

"In 1853 Toynbee suggested another artificial membrana tympani, without knowing of the previous invention. Toynbee's appliance consists of a thin disk of vulcanized rubber, in the centre of which is attached a fine wire about an inch long, which terminates in a little ring to enable the fingers more readily to grasp it for the purpose of removal."

Fig. 2205.—Toynbee's Artificial Membrana Tympani.

The cases in which benefit may be expected from its use of course depend on the actual functions of the normal membrane. Probably the most important uses of the membrana tympani are: 1. Protection of the mucous membrane of the tympanic cavity; and, 2, preservation of the vibratility of the ossicles. These functions may be performed by the cotton-plug of Yearsley, by Toynbee's artificial drum-membrane, or temporarily by a drop of water, etc.

Dalby (*American Journal of the Medical Sciences*, July, 1886) says: "Structural changes in the tympanic membrane of a very extensive nature may exist without impaired hearing;" and, "Loss of continuity in the tympanic membrane does not necessarily interfere with its functions, provided that the ligamentous support which it affords to the chain of ossicles is not impaired." Sometimes an artificial perforation of the membrana tympani improves the hearing.

Of this, as of so many remedies, it is impossible to say beforehand in just what cases it will prove useful; but it should be tried in all cases of perforation of the membrana tympani with impaired hearing.

As the instrument has to be inserted and removed daily, however, and is never used for its cosmetic effect, few patients who hear well with one ear will take the trouble to wear an artificial drum-membrane in the other.

In the personal experience of the writer the instrument is of use only in certain cases. For example, when the Eustachian tube is closed, or the mucous membrane lining the tympanum is swollen so as to block up the cavity and impede movements of the ossicula or press on the fenestræ, the artificial drum is useless, and will do no good until these impediments have been overcome by appropriate treatment.

Toynbee's artificial membrana tympani is the one in

ordinary use, and which is found at the surgical instrument-makers', and when used in suitable cases there are few things that give greater relief or more pleasure. As above stated, they are only useful where the drum membrane has a perforation, and they may be tried in all such cases when the hearing is much impaired, which is not always the case. If the hearing-distance be not increased by their use we should test the permeability of the Eustachian tube ; and if this be patent, examine carefully for polypi and granulations of the middle ear. Frequently cases which at first receive no benefit will have good hearing-power after appropriate treatment.

The ear having been properly cleansed, if necessary, the artificial drum is taken between the thumb and finger by the ring on the handle, and passed into the meatus till it reaches the plane of the membrana tympani. Its position is now determined by inspection through the speculum, and if it prove to be too large to lie smoothly it should be removed and properly trimmed. It is then reinserted, and if the hearing-distance be not increased it may be moved slightly and the hearing again tested. If the hearing is improved the patient can readily be taught to introduce and remove the instrument as he would an artificial eye ; and as in the latter case, he will soon become so dexterous as to do it with more facility than the surgeon would.

At first an artificial drum-membrane should be worn only a few hours daily, even though it should cause no pain, for its presence may induce irritation and necessitate its abandonment ; later, it may be worn from the time of rising to that of going to bed. With proper care one will last weeks or months. On being removed from the ear the instrument should at once be carefully cleansed and placed where no weight comes on the rubber to distort its shape. *Charles E. Hackley.*

MEMORY, DISORDERS OF (Asynesia or Amnesia, Pseudamnesia, Hypermnesia). In examining troubles of the memory, many preliminary considerations of a pedagogical and philosophical character must here give place to the mention of more important symptoms that constitute the habitual accompaniment of sundry morbid states when this faculty is affected.

Mental flights, aimed at the conception of memory with a view to tell just what it is in its essence, soon come to an end ; scholastic discussions as to its modes of existence are equally fruitless ; and, in fact, the majority of inquiries, whether critical or ontological, as to the nature of the most brilliant mental attribute that we possess, lead but little beyond the girlish definition of "something that we forget with."

Doubtless with the advance of science we shall some day have clearer notions regarding the wreckage of the memory-train, how it is arrested and thrown from the rails, how shunted off on the side track of forgetfulness, and how it pursues the down grade to oblivescence. As a matter of fact the phenomena of memory are equalled, if not surpassed, by many of an analogous character in the physical world, notably in the pent-up energy of seeds and eggs, the revivescence of dried rotifers when sprinkled with water, the phonographic retention and preservation of sound, and in the potential energy of an electric cell. The genesis of memory is no less strange than the elasticity of a watch-spring or the sprouting of an acorn ; its shortcomings and deflections are no less wonderful than the modification of the heart-sounds or the troubles of stomachic digestion ; and the transmission and velocity of mental associations or the revival of long-distant impressions are no less remarkable than the warning of a seismometer or that slight disturbance in the perpendicularity of the Washington Monument from the swaying of the wind, which may cause a burglar alarm to ring in San Francisco.

The study of the recall of ideas and the notion of objects produced by sensations has heretofore been pursued in a manner prejudicial to science, for the reason that memory was considered as a faculty one and indivisible rather than as an attribute of the mind resulting from the reunion of its elementary functions. Happily the speculations of pure reason do not in these days prevail against facts in the scientific world, and this error no longer exists ; memory being now regarded as not only a fundamental power of the nervous system, but a general property common to all the anatomical elements. Doubtless the cells of gray matter throughout the body being endowed with their memory like those of the perceptive centre, may account for the existence of a sense memory as well as a memory in the motor and intellectual centres. Some writers even speak of memory as a general function of organized matter, and attempt to show the reality of the memory doctrine in disease—a neurosis itself, according to late authority, being merely the "self-existent memory of a disordered reflex" (see Dr. Charles Creighton, "Illustrations of Unconscious Memory in Disease," London, 1886). The present tentative having to do with cerebral memory only, its scope will be purely clinical and pathological, and it presupposes on the part of the reader a knowledge of the different species of normal memories.

In studying the lines of descent of organic beings philosophical biology recognizes the influence of atavism not only in the anatomical, but in the pathological and even intellectual order. Philogenic heritage manifests itself in connection with memory. Certain ancestral substrata, having been realized in time and space, may crop out in the form either of a new evolution or of a pathological reversion. This morbid atavism may be studied in the pleasures and pains of memory that are transmitted as antecedent syneses from remote ancestors ; in the abnormal reminiscences and reproductions of sleep and dreams; in the special conditions of somnambulism and insanity ; in the reversions of speech common to some savage races and to aphasics ; and in the reversions arising from defective evolution and nutrition.

A common example of the last is found in theroid idiots in whom the dominant aberrations of a brute-like character are unaccompanied by signs of morphological reversion. Defective development of the brain of idiots, backward children, and certain imbeciles or cretins, known as *agenesic amnesia*, is, next to dementia and general paresis, the most common cause of deficient memory. Most individuals of this class are incapable of acquiring or keeping the least notion, yet exceptions occur to the rule, since some idiots have been known to possess remarkable memory for adjectives, and others have shown exceptional ability to preserve and reproduce the impressions of certain objects, as localities, figures, dates, and the like ; while others still have phenomenal memory of auditive impressions, as in the case of the negro musician "Blind Tom."

A peculiar psychic state in which the mind seems to work retrogressively is witnessed in the condition known as *pseudamnesia*. It consists in a belief in the remembrance of facts that have never existed. This state of consciousness on the part of the subject in reality is new, but the illusion consists in believing the state of consciousness to be a repetition of a former experience. Medical authors record but few cases of this trouble of the memory, which they appear to have confounded with illusive transformations and double consciousness, and have been somewhat unfortunate in naming. Eyselin, for instance, in *Archiv für Psychiatrie und Nervenkrankheiten*, v. Band, 2 Heft, p. 575, with a view to throwing additional light on the illusions of memory, reports, under the title of "Erinnerungstäuschungen," the case of a woman in the fourth month of her first pregnancy, who was "continually troubled to recollect something, but is unable to recognize what this something is." The foregoing condition, though suggestive, can hardly be said to be parallel to the state of mind mentioned in the "Confessions" of St. Augustin, who says: "The mind, when it tries to remember something it knows it has forgotten, has, as it were, hold of part and thence makes quest after the other part."

This trouble of the mind, which, in plain English, is false memory, may be either spontaneous or provoked, and is usually associated with an anomalous working of the mind that eludes the subtlety of our apprehension.

False memory may be compared to the seeing of ghosts or spirits, in which the subject of the delusion actually sees them, as far as his own consciousness tells him, but is wrong in supposing that others see them as he does; so a pseudamnesic, judging according to his own consciousness, really receives as a subsequent experience the impressions that saner minds, looking from a different point of view, regard as an erroneous localization in the past. Whether the appearance of repetition in cases of false memory is or is not the cerebral repetition of a former sensorial image, we know that false memory is mostly observed in vivid hallucinatory states, which seem to favor the production of false representations of the mind. One of these states is persecutional insanity. The condition is also sometimes associated with paralysis and fevers.

A more instructive object of study than pseudamnesia is the rather curious condition known as *hypermnesia*, in which the revivescence of ideas, of objects, or of facts, relates to anterior impressions long past that seem to have been forgotten. The reversion in this condition is brought about by abnormal functioning of the brain; but just where the deflection begins in excitation of the memory it is difficult, if not impossible, to say, since this attribute differs widely in each of us and is subject to psychic changes. We may remark, however, that when these psychic changes are of such a nature as to destroy the current presumptions founded on the healthy relations of the memory to the elementary functions of the mind, a pathological condition of the memory is present.

Over-activity of memory may occur in numerous physiological circumstances. Many of us have witnessed it in youthful prodigies at school, whose brain and memory become subsequently weakened. It has often been noticed by persons while saying their prayers at night before going to bed that the memory becomes unusually vivacious, calling up long-forgotten episodes of childhood in the most surprising manner. This may be accounted for by the effort of the mind to bring itself in relation with the infinite and by the change in the cerebral circulation brought about by the kneeling posture. Often in writing I have found memory recalcitrant as to certain facts, which have come to me instantly on changing my bodily posture in such a manner as to bring about a sudden change in the cerebral circulation. Many persons in whom strong tea or coffee produces insomnia know how the mind teems with old recollections during this state of wakefulness; it has also been remarked that certain women during the menstrual period give birth to memories that come and go with the suggestiveness of paroxysms; and everybody has observed that remembrances are depicted with more vividness during dreams.

As a rule, the exaltation of dream memory is of a transitory character; but it goes to illustrate that the mind is often recipiently active, though not percipiently so, and that the fund of our memory is richer than it seems to us. A case in point, remarked by myself, is that of an intelligent and versatile Washington correspondent of a New York journal, who, some years ago, at a time when the discovery of a private cipher turned the destiny of a presidential candidate, dreamt one night of a novel and improved system for sending cipher dispatches. The matter was presented with such vividness to the mind that he happily remembered the system on waking, and has preserved a copy of it to be used when occasion shall require. The most curious and unaccountable part of this affair to the dreamer is that he had never given the matter of cipher dispatches the least attention, but, on the contrary, had rather avoided it.

These anomalous conditions of the memory, besides their occurrence in normal sleep, may be provoked by the ingestion of hasheesh and certain other cerebro-spinal stimulants, as opium, oxide of carbon, cocaine, and also by anæsthetic agents. There may occur to many the old anecdote of the man who, having lost a package when drunk, had to get drunk a second time to remember where he had left it. Most medical men have noticed that during the stages of anæsthesia, when the blood is poisoned, that the "idle comments of the brain" usually turn to the events of childhood, and many are familiar with instances of old foreign-born persons who, during anæsthetic sleep, speak only in their native language, which they have not used for years. According to the narratives of many drowning persons who have escaped the last consequences of asphyxia, this condition was attended by general exaltation of the memory of such a nature that their whole previous conscious existence seemed to pass before them in panoramic review. Hypermnesia exists to a marked degree in the somnambulic state, and is almost always present in the provoked sleep of hypnotism and in the ecstatic and hysteric states. I have also observed it in persons whose minds have become disordered by spiritualism, and I recollect the instance of a so-called medium, a hysterical woman in bad health, who on occasions would recite and compose without relevancy or logical sequence poems and verses by the hour, and this, too, with a volubility and facility of execution of which she had never been capable when in a state of good health.

Besides the existence of hypermnesia in these borderland conditions, it may appear in divers other situations of a strictly pathological character, such as fevers, maniacal excitement, the prodromic period of certain brain affections, and in particular during the period of exaltation in circular insanity. I have observed this exceptional but transitory superactivity of memory in a case of acute mania in the Danvers Asylum. The patient, an illiterate man of low tastes, recited with the greatest volubility the reclaims of showmen and patent-medicine men, parts of political stump speeches, and portions of salvation-army sermons, interspersed with obscene remarks. The whole jumble of stored-up impressions was disengaged without regard to filiation or relativity, and they were of such a character that they could not by any possible effort be recalled when the mind was acting in a regular way.

The observance of cases of hypermnesia appears to have been comparatively rare in asylum practice. Dr. Godding, in charge of the Government Hospital for the Insane, informs me that he has seen but two instances, one in a woman, the other in a man, who suffered from dementia of alcoholic origin. In the earlier stage of his trouble this man showed a surprising memory for the smallest details of his profession—that of chemist—and for the minor events and scenes of his previous life; but the augmentation of memory was only transitory, having been replaced by progressive amnesia. Dr. Forbes Winslow, in a popular article on "Mad Actors" in the *Pall Mall Budget* of October 14, 1886, mentions the apparently wonderful memory of insane actors whom he has known to repeat lines with perfect accuracy.

The transitory character of hypermnesia has led many to regard as apocryphal the stories of old authors regarding the permanent exaltation of memory resulting from traumatic and other causes that profoundly affect the circulation and nutrition of the intra-cranial contents. Yet there is reason to believe that hypermnesia may assume a permanent form. It is reported to have been observed after various morbid excitations, as small-pox and brain concussion, and as one of the results of senile decline.

Morbid excitation of memory is less common than forgetfulness or the want of memory, arising from weakness or from trouble in the laws that register it. Some writers doubt whether perversions of memory can be separated from those of enfeeblement. In fact, an analogy not very remote is the vaso-motor enfeeblement and hyperæsthesia of an inflamed finger.

Notable diminution or total loss of the memory is old in science, and authors of the past generation have added to the confusion of the subject by making as many as ten species, which are of no practical value to the physician, since they are in reality only different degrees of the same psychic state. The old term amnesia, according to Laycock, is objectionable on the ground of being too general, and signifying loss of both retention and reminiscence, or else loss of reminiscence alone. He uses the preferable term *asynesia* to express the perturbation or

the absence of the synetic principle, which is defined as the process resulting from the combined mental, vital, and physical energies and subserving to the retention, conservation, and accumulation of knowledge and experience.

The facts of asynesia, owing to their semeiological and diagnostic value, are of great interest from a clinical point of view. They should, however, be studied not as something belonging to an imaginative morbid entity, but rather as a symptom that may occur in various cerebral troubles of a neurotic, organic, or traumatic nature, since asynesia is almost always symptomatic of other diseases of the organism, and rarely exists without concomitant sensory, motor, or intellectual trouble.

Since it has been shown that memory is a complex mental operation, in which all the intellectual faculties concur, and consisting of not one but several memories, its asynesic condition must be studied according as the memory is affected in its entirety, or as certain groups of recollections are affected. In other words, asynesia may be general or partial. It may also be congenital or acquired, transitory or durable. In the congenital form general debility of memory is the rule, but exceptions sometimes occur, partial memory being found to exist in many idiots. This fact has been turned to account in their education, and Ribot thinks that the methodical study of the limited partial memories as occurring in idiots would enable us to determine the anatomical and physiological conditions of memory.

Asynesia of a temporary character, being a morbid curiosity, is interesting from a psychological rather than from a clinical point of view. Its occurrence being a matter of current observation would seem, however, to merit more than passing remark. In this form one or several blanks may occur in the patient's memory from pathological circumstances. He forgets all that relates to a period of his existence more or less long; but the memory is intact regarding the recollections that belong to previous states, or to those following the period of the attack. The suspension may be but momentary, or the memory may be eclipsed for years and then suddenly return. The facts of temporary asynesia are well known, and illustrative examples are to be found in medical and other works. Those occurring in sleep and dreams are such that anyone may note and inspect in himself—a subjective observation that may be turned to account in the investigation of other temporary amnesias of a pathological order, as the amnesia of vertigo and of epilepsy. It is well known that epileptics, on regaining consciousness, have not the least remembrance of the automatic movements, impulsive acts, and even delirious phenomena that often accompany the fit. During the epileptic dream consciousness falls to a minimum, and the patient acquires a sort of mental automatism, of which he has no recollection whatever on coming to his senses. A great number of examples of this kind have been observed.

Transitory asynesia is of common occurrence in hysteria and in what are known as the syggignostic conditions, as ecstasy, catalepsy, and somnambulism, in which the patient has acquired a sort of double personality. A brief gap in the memory may follow various nervous commotions, as cerebral shock or traumatism, syncope, strong impressions of fright, anger, chagrin, and the like. Momentary disturbances of the memory have been known to occur on exposure to intense cold (see Cold, Effects of). Firemen exposed to the opposite condition have also been noticed to be similarly affected as regards the memory. After shipwrecks and disastrous retreats of armies the same phenomenon has been observed. The subject has been so often mentioned in connection with the famous retreat from Moscow as to render a detailed reference unnecessary. Soldiers after battle often have temporary amnesia, being unable to recall their experiences until several hours have elapsed, and the same thing has occurred to persons that have made balloon ascensions. Others have been known to leave home for a period of several days and commit delinquent acts without recollection of the same, and it has often happened to sailors, whose memory has been temporarily impaired, whether from alcohol or other cause, to come suddenly to their senses a long way at sea on board a whaleman or a merchantman, only to find that they have been "shanghaied."

Temporary asynesia has been noticed to follow other circumstances of a somewhat different nature, as the introduction of poisonous substances into the economy, which, interfering with the chemical constitution of the blood, bring about profound disturbance of the cell-elements. That of nicotinic origin is common in great smokers, among whom exists a weakness of memory especially for proper names. The ingestion of various drugs may cause the same effect. The temporary effacement of memory from anæsthesia is well known, and that of alcohol is a matter of current observation. Persons under the influence of alcohol often commit misdemeanors, and even crimes, such as attempts at murder and other impulsive acts, which they afterward totally forget—the period of mental activity in this condition is as though it had never been. Its study is of interest as regards forensic medicine.

Besides the occurrence of transitory asynesia from alteration of the blood by infection or toxæmia, it may follow various troubles of the cerebral circulation, as that of hyperæmia, or of anæmia. Congestion following the suppression of old suppurations, hæmorrhoids, or of the menses, and sunstroke, may provoke this trouble. It may also occur after excessive hæmorrhage and venery, after privation and fatigue, and after various physical or moral causes. One of these, which is rather physiological than pathological, is the influence of the progress of age. All of us know of old people that hunt for their supposed missing spectacles while wearing them on the top of their head. I recall an instance of an old clergyman, who seldom recognized his wife when away from home; another, of a pseudo-scientific man whose head, like an intellectual garret, will not retain the simple fact that he has ordered champagne for dinner; and still another, of an old gentleman who often forgets whether or not he has lunched, and in order to ascertain that fact is obliged to ask his secretary.

Past events, which are the property of the memory up to the time of some accident causing a cerebral commotion, may be temporarily effaced. The profound impressions of falls, or of puerperal and other troubles that affect the nerve-cells, are sufficiently illustrative. Whymper, in his "Scrambles in the Alps," gives an interesting account of the temporary asynesia of a retroactive character that followed his fall of two hundred feet. Sometimes there will be an apparent loss of several years of life. Cases are known in which women have forgotten the fact of marriage, and even of pregnancy.

Temporary suspension of the memory is often of a grave character, and may not return except by re-education. All previous syneses are wanting, and there is left but a few latent aptitudes, by means of which we are enabled gradually to form a provisional memory. With improvement of the nutrition of the nerve-elements this condition may suddenly disappear, and the hitherto sluggish brain be lighted up by the spark of the original memory.

Certain states of the vascular system, suspension of inhibitory action, and the like, may give rise to an intermittent confusion of personality known as *periodic asynesia*. This is simply a disturbance in the general sense of unity in our body, which, in passing through alternate phases, forms two association centres and a consequent double personality, each of which is endowed with separate memories. It is a singular nervous trouble, found principally in neuropathic or hysterical individuals, and though instructive rather from a psychological point of view, its facts may be turned to clinical advantage.

The elements of periodic asynesia are to be found in certain cases of drunkenness, as in the instance already cited, of a person who could not remember where he had left a package until he got drunk again. The general characters of periodic asynesia are also exhibited in the phenomena of the somnambulic state, where the patients, on regaining consciousness, have no recollection of the

crisis just passed, but can recall the circumstances of the penultimate one.

More complete examples of periodic asynesia occur in those singular cases in which the patient, usually after a fit of somnolency, passes alternately from one state to another, and apparently leads a two-fold life.

The alternation of the two personalities is very distinct in some cases. Such often comes under the observation of neurologists, and typical cases of asynesia and amnesia are matters of medical record easily accessible. It may be remarked that, for the purpose of study, the examination of these morbid facts is better than the perusal of dry definitions and of cold abstract descriptions.

Putting aside the old tendency, so prejudicial to science, of personifying an abstraction, and acknowledging the existence of several unequal and independent forms of memory in one and the same individual, we are led to recognize the fact that asynesia may affect certain categories of recollection and leave the rest intact. The recognition of this independence between different forms of memories has led to the creation of a type known as *partial asynesia* or amnesia. It concerns a restricted group of recollections only, but the facts of the order are of common observation in clinical medicine, and might be cited by thousands. Why there should be partial loss of memory relatively to certain categories of recollections and to certain epochs of existence, or why any one of the memories of the sensation of touch, of auditive, visual, or olfactory sensations and the like, should be forgotten and the memories of other things retained, is seemingly strange and unexplainable.

Owing to the delicate psychological analysis that the study of these troubles requires, the history of partial amnesia is still incomplete. If, however, we resolve memory into a variety of memories, the consideration of the subject is much simplified; the seemingly non-existent becomes manifest, and the limited faculties of mind are enabled to take cognizance of the unknowable.

The best-known facts of partial asynesia are those that relate to the memory of auditive or of visual impressions, and the recollections derived from these impressions. A change in the circulation and nutrition of the brain brought about by fatigue and inanition, may cause the loss of an acquired language, which returns with convalescence. This is often noticed among sick Germans in our large hospitals. When much exhausted during a descent in a deep mine in the Harz Mountains, Sir Henry Holland relates that he utterly forgot every word and phrase of German, and did not regain them until after refreshment and rest. Persons have been known to lose all knowledge of Greek after a blow on the head; others have entirely forgotten music after an injury; and in others the psychic blindness has extended to the loss of memory of substantives, the loss of the remembrance of forms of objects, their relief and coloration, and of the recollection of personal individualities. Thus temporary acritochromacy may occur after coming from a photographer's "dark-room." An instance has lately come under my observation. A knowledge of drawing or writing, or of some other handiwork, may be lost; the ability to read, or the faculty to interpret written words, which also depends on visual memory, may disappear; and the loss of visual memory of one's most intimate acquaintance may happen. An elderly man at a public gallery has been known to see the passage barred by a person to whom he apologized, and which was only his own image reflected by a mirror. When the change in the intellectual state is more profound, as in cerebral softening and a certain degree of dementia, the patient's recollection of faces is not revived even by that association known as "contiguity in place," and the loss of memory is of such a nature that he recognizes no one (see C. Cronigneau, "Étude clinique et expérimentale sur la vision mentale," Th. de Paris, 1884).

The species of partial asynesia that has been most studied is that of signs. The destructive process in sign amnesia follows a progressive decadence from proper to common nouns, thence to verbs or pronouns and adjectives, and finally to emotional language and gesture. It may be remarked that the observance of this process in an inverse order may afford valuable guidance in the practical acquirement of languages. Further reference to the subject would involve repetition, since aphasia, agraphia, and amimia have already been treated in a previous volume.

The gravest form of diseased memory, and the one most commonly met in practice, is the *progressive amnesia* of dementia and general paresis. It differs in all points of view from temporary asynesia; its consideration being no longer a question of one or several gaps that pathological circumstances create in the field of recollection, but of a slow and continuous forfeiture of the memory, which may lead to complete abolition.

The study of the retrogression of the memory in this form throws a new light upon successive organization; for in the break-up of the mind, the failing memory following a fixed law of dissolution, which proceeds in an order inversely to that of evolution, exhibits memory as a biological fact, and thereby simplifies its discussion.

This reverse course in the process of restoration seems to have been observed by former writers, although but few cases are cited, since it is such a rare occurrence to note recovery from amnesia when progressive. Louyer-Villermay remarks that "memory, when in process of re-establishment, follows an order inverse to that followed when in decay: events, adjectives, substantives, proper names." Taine, in his work on "Intelligence," speaking of the revival and obliteration of images, narrates the case of a celebrated Russian astronomer, which illustrates this law of regression. The events of the previous days, says he, were forgotten, then those of the years last past, and so on, the chasm gradually increasing, till at last he could recollect only the events of his childhood. His case was considered hopeless; but by a sudden stop and unforeseen return, the blank was filled up in an inverted manner, the events of his youth first reappearing, then those of his manhood, and finally the more recent, those of the previous day. His memory was wholly restored at the time of his death.

But the most confirmatory example is that reported by Koempfen ("Mém. de l'Académie de Médecine," 1835, vol. iv., p. 489), of a man who was pitched from a horse, lost his memory, and subsequently regained it. The facts in this case are well noted, and being detailed at some length, prevent the citation here of more than the following summary: "The loss of memory was in the inverse ratio of the time that had elapsed between the several occurrences and his fall, and the return of memory was distinctly in the order from the more remote to the more recent."

This retrogression of psychical life to earlier stages of development is often seen in old people, who are prone to retain a memory for old things, but not of recent events, nor of dates and proper names. It is, however, as before remarked, more noticeable after a lesion of the brain-substance, whether traumatic or organic. Progressive loss of memory may result from diffuse interstitial encephalitis, or from brain tumors, and it usually follows cerebral hæmorrhage accompanied by hemiplegia. The latter accident is often found along with a particular trouble of the memory of words, which causes the disturbance of language known as aphasia. The more serious disturbances of the memory may be sometimes confused with aphasia; in fact, it is difficult to draw the line between them and the aphasia of recollection.

Progressive decadence of memory of words advances with the structural changes of the brain. All the organic affections of the brain are in fact accompanied by notable diminution, or total loss, of memory; and this mental degradation, when observed in the different forms of partial alienation, is a general sign of the passage of the disease to chronicity, or to dementia. In general paresis memory becomes more and more weakened as the disease progresses towards dementia. No other form of lunacy affords such striking illustrations of the progressive decadence of memory. Whether relatively to recollections taken in certain groups or taken collectively, the march of the amnesia is on the down grade; old facts as well as

recent ones gradually disappear ; registration and recall of impressions of the senses, or even those of the organic side, are reduced almost to a standstill, and, later on, the failing memory, like a dying spark, gradually fades away.

In considering the foregoing types many of the pathogenetic and etiological conditions have already been touched upon ; but in order to be more explicit, these conditions may be further and more systematically enumerated.

First among the long series of causes that may produce asynesia is old age, a factor rather physiological than pathological, but one that should not be overlooked. In the matter of age the number of years is of less importance than the physical condition, since it is quite possible to be chronologically of one age and physiologically of another.

Change in the elements of the blood brought about by infection or toxæmia has long been recognized as a cause. Lucretius and Thucydides mention the loss of memory that occurred among the survivors of the plague or typhus. Permanent and durable troubles of memory often follow cholera, typhoid and rheumatic fevers, and excessive hæmorrhages ; and the same results may accompany certain dyscrasic maladies, as diabetes and uræmia. Inveterate syphilis, chronic purpura hæmorrhagica, alcoholic poisoning, and nicotinism, are also common causes. It has also been observed after chronic pyæmia contracted in a dissecting-room. Slower, but none the less remarkable, are the toxic effects of lead, mercury, arsenic, and carbon dioxide. Narcotic medication is a source of disturbance of the memory, fantastic visions and illusive transformations often following the ingestion of opium, hasheesh, stramonium, belladonna, cannabis indica, gelsemium, and the like.

Another pathogenetic factor is the trouble of the cerebral circulation. There may be pigmentary degeneration of the cerebral cells from senility, or the sanguineous irrigation of the brain-substance may be too much or too little, or defective in quality.

Functional trouble of the nerve-cells occupies an important place in the etiology of disorders of the memory. Many of these are the so-called moral causes, as anger, fright, joy, depression, and other emotional states. Dr. Winslow, in an article previously cited, mentions temporary loss of memory as a characteristic feature in the madness of actors, whose condition is supposed to have been caused by the long continuance of impersonating the same characters night after night. Cerebral commotion, pain, nervous exhaustion from excess of work or from venery ; any acute mental illness, either with or without bodily disorder ; vertigo, epilepsy, chorea, mania, and melancholia with stupor, each come under this category.

The last and most apparent causes of asynesia are those arising from vices of structure or from anatomical lesions of the brain-substance. One does not look for the existence of memory in idiots, in microcephalic and hydrocephalic children, or in cases of infantile cerebral atrophy ; nor is it expected to find this faculty intact when local basilar and other cerebral symptoms are present ; or when the brain, especially the anterior portion, has been seriously disturbed by traumatism. Loss of consciousness from wounds and injuries, and its effects upon the memory of preceding events, is well known in surgery. An instructive paper on this subject, by the late Dr. Frank H. Hamilton, is to be found in *The Sanitarian*, New York, February, 1876.

Disorders of the memory holding such a great place in mental pathology, their diagnosis merits serious study—not that there is any difficulty in recognizing ordinary degrees of impairment, such as may excite the alarm of the patient himself, or even in recognizing the graver form in general paresis, of which the patient is unconscious. It is in slight changes of the memory which may pass unnoticed, or in those that may be mistaken for aphasia, or in cases of feigning and dissimulation, that the diagnosis is really difficult. Some confusion may also arise in appreciating the difference between disordered memory, melancholia, mania, and idiocy. The feigning of disordered memory may become the object of a sham with an interested party. For instance, a man having served in the military or naval service may claim a disability from loss of memory, with a view to being placed on the Invalid Pension List ; the friends or lawyers of an accused person, or the criminal himself, in order to escape disgrace or punishment, may pretend to have lost more or less completely the recollection of the act for which he is indicted, and of the attending circumstances.

To ascertain in a given case how far the memory is disordered, one must compare the existing with the previous state of this faculty, and take into consideration the varying psychic state of the individual. The study of the latter being complicated, requires close analysis of all the faculties. Except in case of complete dementia, the patient is irritable, impatient, and despondent. To discriminate between amnesia and aphasia is almost impossible in case the patient is illiterate, but the difficulty is not so great when the faculty of writing has been preserved. Adroit questioning, taken in connection with the previous history of the case and the clinical facts observed in disordered memory, may lead to the detection of feigning. It would seem, however, that an incriminated person who pretends to have no recollection of the act is entitled to the benefit of a doubt, although he may recall other facts, as proper names and dates, with great precision. There has been a disposition, both from a medical and juridical point of view, to deny the reality of loss of memory in such cases ; but the study of facts leaves a doubt as to the exactness of the postulate, since it has been shown that loss of memory attends many forms of lunacy, and may exist at the time of an attack, and stop during the intervals.

Loss of memory following organic lesion, dynamic trouble, or any sudden metabolic disturbance of the brain, may recover rapidly. It is the same with many other cases in which the trouble disappears with the removal of the cause. But the prognosis is of a serious nature in the progressive amnesia of organic brain affections, and the congenital defects of memory in idiots and cretins are incurable.

We should not, however, on this account, neglect to develop any germs of memory that may be left in these unfortunates ; for memory, in addition to being the most unstable of the faculties and the one most easily impressed and modified by the multitudinous activity of the nervous system, is more than any other susceptible to the influence of education and good cerebral hygiene, and for that reason warrants persistent efforts to secure its development as long as any glimmer of the faculty is left.

Most persons know that a weak memory may be materially strengthened, and that a good one may be further developed by a good method of mnemonics. Mnemonical aids promote facility, retention, and readiness, as many students can testify, besides leading the mind into the natural channels of memory. Who, for instance, has the least difficulty in retaining the order of the cranial nerves after committing to memory the following :

> "*O*n *o*ld *M*onadnock's *p*eaked *t*ops
> *A* *f*ine *a*uld *G*erman *p*icked *s*ome *h*ops."

All the modern mnemonical systems are founded on some such arbitrary associations, and teachers of this art rely principally on a nomenclature table with a topical system, and homophonic analogies. The student will find "All about Mnemonics" in Middleton's excellent little work (London, 1885). The subject is explained chronologically, extending down to the system approved by Professor Proctor and Dr. Wilson.

Since so much may be accomplished by well-directed education to develop memory, it seems reasonable to infer that the continued and intelligent efforts of physicians may, in many cases, lead to its complete redintegration. This inference is borne out by facts ; for we may do much towards rehabilitating the memory by re-education when the general and special sensibility remain intact. Cases of progressive asynesia accompanying old age or dementia from any cause are, however, not amenable to treatment. Whatever plan is adopted should have

chiefly in view the removal of the cause and the restoration of the general health. Further discussion of these curative means would lead only to tedious repetition of many therapeutical adages and of the laws of personal hygiene. *Irving C. Rosse.*

MÉNIÈRE'S DISEASE.—The term Ménière's disease has been used so indiscriminately that it is safe to assume that few general readers have any clear ideas what it is meant to express.

P. Ménière, who was in charge of a deaf and dumb institution in Paris, claimed, in a paper presented to the Academy of Medicine of Paris, in 1861, that during a practice of many years he had met with a large number of patients who always presented the same symptoms, which symptoms often repeated themselves at intervals during weeks, months, and even years; and, as a rule, ended with the destruction of the hearing.

In his memoir (*Gazette Médicale de Paris*, 1861) on affections of the internal ear giving rise to symptoms of apoplectiform cerebral congestion, he gave publicity to a series of observations on a disease hitherto undescribed, presenting the following clinical picture: There is an apoplectiform attack accompanied by tinnitus aurium, dizziness, and vomiting, leading to loss of consciousness of longer or shorter duration. These alarming symptoms soon pass off, leaving only a staggering gait, which also, as a rule, disappears, and complete recovery takes place, except that there remains, almost always, marked deafness, accompanied by continuous subjective noises in the ear. In these cases an examination of the ear reveals no visible changes, and the aural trouble, as a rule, remains, in spite of treatment, incurable.

A narrative of one of his cases, in practically his own words, may be of value: "A young, robust man suddenly experienced, without any appreciable cause, vertigo, nausea, and vomiting, the pale face, bathed in sweat, announcing impending syncope. The patient, after staggering, became deaf, and fell to the ground, unable to get up. Lying thus on his back he could not open his eyes without seeing the objects around him apparently whirling about in space; the slightest movement of the head increased the vertigo and nausea; and vomiting recurred whenever the patient attempted a change of position. These conditions were in no way dependent upon an empty or full stomach, and occurred during perfectly good health. Though of short duration, their character was such as to lead the physicians, who were called, to think of cerebral congestion, and to prescribe treatment in conformity with this view." The author states that these attacks were always regarded as cerebral congestion; that while the general health remained unimpaired, a certain tendency to dizziness and deafness followed.

As all the functional disturbances, except the deafness, sooner or later disappeared, Ménière was led to suspect that the entire chain of symptoms was due to disturbances in a single organ; and, inasmuch as tinnitus and deafness remained even after years, although the patients were in the best of health, he fixed upon the ear as the seat of the trouble. Since his examination showed the external and middle ear to be normal, he regarded the labyrinth as the part affected. He was confirmed in this view by the following case: A young woman, travelling on a winter's night by post-wagon, while having her menses, caught cold, became suddenly deaf, and was admitted to one of the Paris hospitals. There was found complete deafness, attended with symptoms of constant dizziness, and vomiting on the slightest movement. Death occurred on the fifth day. The post-mortem examination showed the brain and cord to be intact. The semicircular canals contained a red plastic mass, a sort of bloody exudation, with scarcely a trace in the vestibule, and the cochlea was entirely free. The cause of death remained unexplained.

Having met with conditions, similar to those described, in cases of external and middle-ear affections, and supported by the experiments of Flourens, he was led to seek for the cause of the symptoms in variations of pressure in the labyrinth, with conduction through the chain of little bones, or by means of pathological products, and he summarized his views as follows:

1. An auditory apparatus, hitherto perfectly normal, can suddenly become the seat of functional disturbance, consisting of noises of a variable character, continuous or intermittent, and accompanied soon by a greater or less diminution of the hearing.
2. These functional disturbances located in the internal auditory apparatus can give rise to phenomena that are regarded as cerebral, such as vertigo, deafness, uncertain gait, turning about, and falling; and, furthermore, they are accompanied by nausea, vomiting, and syncope.
3. These accidents of an intermittent type are at last followed by deafness, becoming more and more profound, though the hearing is often abolished suddenly and completely.
4. All this leads to the belief that the lesion causing these functional troubles is located in the semicircular canals.

Exceptions have been taken to these propositions, and we will consider them first from a physiological standpoint. Although phenomena certainly analogous to those pictured by Ménière had been described before his time, he was the first to regard them as indicative of a special form of disease.

It is a well-known fact that Flourens claimed from his experiments that loss of co-ordination, among other phenomena, resulted from destruction of the semicircular canals; and Czermak found in his experiments that vomiting also resulted. Goltz also, by his experiments, confirmed Flourens' views, and claimed, still further, that the semicircular canals are the peripheric organs of the so-called static sense. Boettcher, who is supported by von Bergmann, claims that the phenomena observed from destruction of the semicircular canals are to be referred to injuries of the cerebellum, especially of the *corpus restiforme*, lesions which of themselves are competent to explain all the vertiginous symptoms. Högyes asserts that the cause of the vertigo is an injury to the labyrinth alone, especially the vestibular nerves.

Quite recently Baginsky (*Berlin. klin. Woch.*, February, 1885), by an exhaustive repetition of the experiments upon the semicircular canals of pigeons, has endeavored to show that the vertiginous phenomena are observed only in connection with lesions of the brain (cerebellum, medulla oblongata, corpora quadrigemina), which of themselves serve to explain them. Baginsky in his experiments found that increased pressure in the middle ear produces dizziness, along with nystagmus, in guinea-pigs; as does also perforating the membrana tympani and injecting fluids, or blowing in air, or filling the middle ear with a column of fluid. In all these cases, where the phenomena in question appeared, autopsy showed rupture of the membrane of the round window, hyperæmia and œdema of the brain, and inflammation or hæmorrhages into the parts of the brain adjacent to the ear. He showed, further, that the fluids or the air injected reached the brain through the aquæductus cochleæ and produced direct irritation, especially of those parts of the brain (corpus restiforme) whose irritation, according to the older observations (Magendie, Brown-Séquard, and others), excite the symptoms in question. (For an analysis of Baginsky's work, see Eulenburg's "Real-Encyclopädie," vol. viii.)

Lucae says that without rupture of the membrane of the round window, pressure in the middle ear, in man, excites (in a transitory manner) phenomena closely allied to the complex of symptoms of Ménière. This he has shown on a series of ear-patients with perforated drum membranes and patulous Eustachian tubes, whose middle ears were exposed to a suddenly increased pressure of air. The most important appearance noted by Lucae were disturbances on the part of the eyes (double vision, apparent movements of objects, abduction), which were the chief producers of the dizziness; and everything, he says, showed that the pressure suddenly communicated through the labyrinth window, probably through the aquæductus cochleæ, produced a corresponding increase of pressure of the cerebro-spinal fluid, and irritation at the base of the brain.

Clinically considered there can be no question as to the truth of the phenomena as pictured by Ménière, although so far neither physiology nor pathology has been able to determine their absolute, or even their chief, cause. Still, there seems to be a pretty general agreement that, as there are both physiological, pathological, and clinical facts that militate, in whole or in part, against Ménière's conclusions, we should refuse to recognize the term "Ménière's Disease," as the expression of a special affection whose seat is in the semicircular canals, and whose sole cause is that claimed by him, and simply describe such cases under the heading of "Ménière's Complex of Symptoms."

To conclude this part of the subject, we will say that when an individual, especially an adult in good health, who has previously enjoyed perfect hearing, becomes suddenly affected with symptoms of apoplexy (unattended by fever), followed by marked or total deafness, accompanied with great noises in one or both ears, inclination to vomit on attempts to move, dizziness, and a staggering gait; or when one is attacked pretty suddenly with dizziness, noises in the ears, nausea, perhaps vomiting, unsteady gait, and marked deafness—we are in the presence of "Ménière's Complex of Symptoms."

Course of the Disease.—Usually the more alarming symptoms pass away in a few days, leaving only the vertigo, staggering gait, and deafness; and if no relapses occur, the first two symptoms usually disappear in from a few weeks to a few months, though the staggering unsteady gait has been known to last for years. The tinnitus and disturbing noises in the head may grow less annoying; but no assurance can be given that they will ever cease. The deafness, as a rule, remains, with some few exceptions, unchanged; now a little for the better, but usually, however, going from bad to worse until it becomes total.

Treatment.—From local treatment little or nothing is to be expected. After the severe symptoms have subsided, hypodermatic injections of pilocarpine (four to ten drops of a two per cent. solution) may be tried; or a few drops of a one or two per cent. solution of the iodide of potassium may be injected into the middle ear by means of the Eustachian catheter; or an ointment of the iodide may be rubbed in over the mastoid process, and this procedure be continued for many weeks. Of the constitutional remedies those that have proven of most value are the iodide of potassium (in five to fifteen grain doses thrice daily), the salicylate of sodium, the bromide of sodium or ammonium, and quinine. It is well to mention that in the administration of the last-named remedy the symptoms in the beginning are aggravated, or are liable to be, then finally disappear. This remedy must be persisted in for even two or three months, with short periods of interruption.

Electricity, which is not available in the earlier stages, may be tried later; but in this, as in other forms of aural disease, little must be expected from its use.

W. W. Seely.

MENINGES, CEREBRAL, TUBERCULAR INFLAMMATION OF. Synonyms.—Acute Hydrocephalus, Granular Meningitis, Basilar Meningitis, Dropsy of the Brain.

Definition.—Tubercular meningitis is an acute inflammation of the pia mater of the brain, caused by a deposit of miliary granules, and characterized by an effusion of pus and lymph.

General Observations.—In 1768 the attention of the profession was first particularly called to this disease by Dr Robert Whytt, of Edinburgh. His remarkable monograph, entitled "Observations on the Dropsy of the Brain," ranks to-day as one among the few medical classics, and is highly commended by all recent writers for its accuracy of description and fulness of detail.

Dr. Whytt, and the observers immediately succeeding him, framing their opinion as to the nature of the affection from the very prominent anatomical lesion—the ventricular effusion—unavoidably included, under the term *dropsy of the brain*, several other diseases besides tubercular inflammation of the meninges. No correct idea of its pathology could be attained until Göelis, in 1815, pointed out that acute ventricular dropsy was not a primary condition, but was always dependent upon some antecedent affection of the cerebral vessels or nerves.

Although the granular condition of the meninges had been previously noted by Guersant, it was reserved for Papavoine, in 1830, to establish the tubercular nature of these granules, and to point out their pathological relation to the meningeal inflammation.

The name of tubercular meningitis, which has won its way to universal acceptance, was suggested by Bricheteau. Dr. Gerhard, of Philadelphia, was the first to call attention to the disease in this country. His most valuable paper, published in the *American Journal of the Medical Sciences* (1833–34), was based upon the reports of thirty-two cases, with autopsies (Minot).

Tubercular meningitis is not an independent affection, but is one of the most important phases of that protean malady, acute miliary tuberculosis.

Two forms of the disease are recognized, a primary and a secondary form. In the former, although other organs besides the pia may be the seat of tubercle, the symptoms first noticed are those arising from the cerebral lesion, and these retain their prominence throughout the attack. In the secondary form, on the other hand, the brain symptoms are preceded by those arising from inflammatory affections of other viscera, also dependent upon the diathetic influence, and are only manifested toward the close of the illness.

Tubercular meningitis is one of the most important and most fatal organic diseases of the cerebro-spinal system. The primary form is essentially a disease of early life, and occurs with special frequency between the ages of two and ten years. Infancy and adolescence do not confer entire immunity, but at these periods of life the disease is almost always secondary to advanced pulmonary tuberculosis. Statistics indicate that males are more susceptible to the disease than females; according to Huguenin, this preponderance is much oftener observed in children under fifteen years of age than in adults.

Etiology.—The causes of tubercular meningitis are those common to all scrofulous affections. Foremost among the predisposing causes must be placed the hereditary diathesis. The badly nourished and physically ill-developed children of consumptive or scrofulous parents are the most susceptible, but the apparently rugged and robust are not exempt; in the latter, however, a careful search will almost certainly disclose a taint in some collateral branch of the family, if not in the direct line of descent.

That the disease is occasionally dependent upon foci of caseous degeneration in some remote gland or viscus, a suppurating joint or scrofulous inflammation of bone, is now generally recognized by modern pathologists. Seitz found such lesions in more than ninety-three per cent. of the cases tabulated by him.

The exciting causes are obscure. Unpropitious external conditions of all kinds, such as impure air, unwholesome food, exposure, bad drainage, may kindle into activity a slumbering predisposition.

Blows upon the head, emotional excitement, exposure to the direct rays of the sun, and like causes exert a doubtful influence. Climate and seasons have no place among the etiological factors, although the disease is more prevalent in the changeable weather of winter and spring.

It is not improbable that, in older children, excessive study and worry, or the high-pressure system of modern schools, may promote the disease; and, in this connection, it may be stated that children predisposed by inheritance to tubercular affections are, as a rule, precocious and ambitious to excel in their studies.

Morbid Anatomy.—The distinctive anatomical feature of tubercular meningitis is a deposit of miliary tubercles in the pia mater of the brain. These granules are always found on the inner surface of the membrane, are grayish-white, semi-transparent, and vary in size from an object just visible to the naked eye to that of a millet or hemp seed. The coalescence of several nodules may form tubercular masses as large as, or larger than, a pea. They are usually more numerous at the base, especially

about the fissure of Sylvius and the optic chiasm, but in rare instances are formed in greater numbers on the convexity. The distribution is generally symmetrical in the two hemispheres, but may be limited to any particular portion, even to the narrow area fed by the branches of a single artery. They are always developed within the perivascular canals, and adhere to the coats of the arteries, giving somewhat the appearance of a string of beads. They may be few in number or so abundant as to impair the integrity of the coats of the vessels and completely obstruct the circulation. The number of the nodules does not determine the intensity of the inflammation, which may be slight in the presence of a large deposit, or severe with a few widely scattered granules.

After suitable preparation the bacillus tuberculosis in considerable numbers may be found in the pia, in places adjacent to the arterioles (Minot). The pia mater is thickened, opaque in appearance, and more or less adherent to the surface of the brain.

Other changes may be noted which are, to a certain extent, common to all forms of meningeal inflammation. A sero-purulent exudation covers the pia, especially at the base, and extends along the course of the arteries. It may be so copious as to fairly imbed the cranial nerves and fill up the natural depressions at the base of the brain.

The ventricles are almost invariably distended with fluid. The effusion into the ventricles, which was considered by the early authors to be the essential anatomical lesion, furnishes the most common name for the disease. It varies largely in quantity, but is generally sufficient to distend the ventricles, flatten the convolutions, and render them dry and anæmic. The fluid has a specific gravity of about 1,010, is usually turbid from the admixture of epithelium and leucocytes, and is sometimes, though rarely, tinged with blood. The portions of the brain adjacent to the ventricles are softened. The fornix and septum lucidum may be almost diffluent, and the basal ganglia so altered in consistence as to fall into a shapeless pulp on being removed from the skull (Fagge).

The choroid plexuses are hyperæmic, and sometimes covered with purulent exudation. The convolutions are œdematous and injected when the ventricular effusion is small or wanting, but are dry, bloodless, and flattened when the effusion is large. Occasionally patches of red softening, punctiform hæmorrhages, and, very rarely, large extravasations of blood are met with in the substance of the brain.

Changes similar in kind to those above described, but less in degree, are sometimes found in the spinal cord and its membranes.

In tubercular meningitis the lesions are very rarely limited to the intracranial viscera. Tubercular deposits almost invariably occur in other organs of the body, most frequently in the lungs; or there are remote depots of caseating material or other evidences of the cachexia. Tubercles can often be demonstrated by means of the ophthalmoscope in the choroid coat of the eye. Dr. Money found the choroid affected in fourteen out of forty-two cases of tubercular meningitis. In one instance tubercles were observed in the eye, but not in the brain or its membranes; in another, the meninges were free, but there was a mass of crude tubercle in the cerebellum (London *Lancet*, 1883).

SYMPTOMS.—Tubercular meningitis is nearly always preceded by premonitory symptoms which, if rightly interpreted, are of the highest value. In twenty-six cases collected by Dr. Gee there were only two in which prodromi were absent. These symptoms are usually so indefinite in character as to excite little attention at the time, and are rarely thoroughly appreciated until the developed disease leads the parents to carefully review the past weeks of the child's life.

This period probably corresponds with the deposit of miliary tubercles in the pia mater before serious structural changes have taken place.

The symptoms met with during the prodromal stage relate chiefly to the nutritive and digestive processes. The appetite is capricious, the breath offensive, and the tongue furred. Vomiting is not common. The bowels are slightly constipated, or diarrhœa and constipation alternate. The child tires easily and will often be found asleep on the floor surrounded by his playmates and toys. At night, sleep is restless and disturbed by dreams. Headache is not a prominent symptom, but is rarely wholly absent. Frequent complaints of dizziness are made. Very rarely double vision is observed. Along with these symptoms will be noted an alteration in the child's character. This is one of the most important of the prodromata and should never be overlooked in endeavoring to make a diagnosis in a doubtful case. The patient, before precocious and vivacious, becomes dull and listless, indifferent to his books or plays, moody, and petulant. Many grow very emotional, bursting into tears on the slightest provocation, or dispensing their caresses with annoying lavishness. Before the close of the prodromal period the effect of imperfect nutrition is apparent. The patient grows thinner and paler. The muscles become soft and flabby, and he is, day by day, less inclined to exertion of any kind. The prodromal stage may last from one week to three months.

It is customary, for convenience of description, to divide the disease into distinct stages, based upon the predominance of certain symptoms at different periods in its course, viz., a stage of *invasion*, of *pressure*, and of *paralysis*. This arrangement is purely arbitrary, and is rarely justified by clinical observation.

There are few diseases more irregular in the development or sequence of symptoms than tubercular meningitis, and he who seeks at the bedside only the typical case of the books may long search in vain.

Since the age of the patient impresses some minor differences upon its course, we will first describe the disease as seen in children.

Stage of Invasion.—The onset is rarely announced by any sudden perturbation, like a chill or convulsion, but usually the symptoms of the prodromal stage are increased in severity and gradually reinforced by others characteristic of cerebral lesions.

Headache, vomiting, and fever are the common initial symptoms. Of these, vomiting is perhaps the most constant. It varies greatly in frequency, is not usually troublesome after the first few days, though it may continue during the entire illness, and seldom returns, after it has once ceased for twenty-four hours. It is especially provoked by the ingestion of food or drink, and by rising in bed. As a rule, it is not preceded by nausea or accompanied with severe retching.

The headache is intense, and constitutes one of the most distressing features of the disease. It is usually referred to the frontal region. The pain is aggravated by sudden movement, bright light, or loud noises, and is subject to exacerbations without apparent cause. It, at times, compels the child to make outcries, hold his head with his hands, or bury his face in the pillow. Fortunately, remissions of variable duration are not infrequent. Vertigo is occasionally present, manifested by unsteadiness of gait, or a sensation of falling, even when lying in bed. The complaint of headache in a child, especially when associated with vomiting, should always awaken the gravest apprehensions.

There is no distinctive temperature curve. The fever is moderate in intensity, irregularly remittent in type, and rarely measures more than 103° F. in the evening, and 100° F. or 99° F. in the morning. Constipation is very constant. It is usually marked from the beginning of the illness, and is rebellious to the action of laxatives; yet cases are recorded in which persistent diarrhœa has occurred without tubercular or other disease of the gastro-intestinal mucous membrane (Huguenin). Anorexia and moderate thirst are present. The tongue may be clean, but is generally heavily coated.

The pulse for the first few days is rapid and regular, but soon becomes slow, irregular, and variable. The variability is marked; the slightest exertion or excitement will cause an increase of twenty or more beats per minute, and a like effect may be often produced without known cause.

The respiration is changed in like manner, and after

three or four days becomes irregular and sighing. These alterations in the pulse and breathing are by no means constant in the early stages. They may be marked at one, and absent at several subsequent visits; in fact, fluctuations may be noted in the course of the same observation. Repeated and lengthy examinations must therefore be made before they are declared absent. It is important to make the examination of the pulse when the child is at rest, since a pulse which is slow and irregular during repose may be rapid and regular under excitement or after movement.

Sleep is fitful and disturbed. Mild delirium is observed at some period of the day or night. The pupils are contracted, and light is painful to the eyes.

During the early part of this stage, both special and general sensibility are increased, so that the child often receives with dread even the gentle ministrations of its mother. Later on he becomes more passive, and will without a murmur submit to the protracted examination of the physician.

If the cranial bones are unossified, the anterior fontanelle is distended.

Strabismus, double vision, and ptosis, sometimes appear toward the end of the stage of invason. Convulsions are not common, but muscular twitchings and rigidity of the muscles of the spine are occasionally noted.

The child is dull, apathetic, and drowsy from the beginning. At first he can be easily aroused, and although his mental operations are sluggish, he notices his surroundings and may amuse himself with his playthings. The somnolence gradually increases until, toward the close of this period, he will, if undisturbed, lie for hours in a deep sleep, with eyelids half-open, grinding his teeth, and at times uttering a sharp, piercing shriek—*the hydrencephalic cry* of Coindet. Some authors place great stress upon this cry, but Rilliet, Gee, and others, hold that it is not special to nor frequent in tubercular meningitis.

The duration of this stage is from seven to fourteen days.

Stage of Pressure.—The signs of irritation now give place to those of pressure or exudation upon the surface of the pia and into the ventricles of the brain. The transition takes place gradually; in fact, there is usually a period of uncertain duration, which has been not inaptly named the *mixed stage*, in which the "symptoms of irritation still linger and the symptoms of depression are just manifesting themselves" (Bartholow).

Paroxysms of pain, great restlessness, irritability, and delirium, are succeeded by periods of extreme drowsiness or even of profound stupor, out of which the child is aroused with difficulty, perhaps replies in monosyllables, or stares vacantly at the questioner through half-open lids, and again lapses into his former condition.

The most characteristic feature of this stage when fully developed is loss of consciousness. The patient remains in a state of complete insensibility, and at times moans or shrieks out wildly. He commonly lies on one side, with the knees drawn close to the abdomen, one hand pressing his head and the other grasping the genitals.

The head is often retracted, and the muscles of the nape of the neck are rigid. The pulse becomes very slow—from forty to eighty beats in the minute. The irregularity of the pulse and respiration are more pronounced and more constant than before. Typical Cheyne-Stokes respiration is often observed. The temperature falls a degree or more, and often becomes subnormal. Vomiting ceases, if it has not already done so, but constipation persists. The abdomen is deeply hollowed. The common term, boat-shaped, very accurately describes the sunken belly bounded by the unduly prominent symphysis, iliac crests, and ensiform cartilage.

The pupils are dilated, often unequally, and sometimes waver under light. The globe rolls from side to side, the sclerotic is suffused, a puriform secretion collects in the angles of the eyes, or glues together the edges of the lids. The ophthalmoscope shows ischæmia of the optic disks or beginning neuro-retinitis. In rare instances, miliary tubercles are seen in the choroid. Dr. Albutt found retinal lesions in twenty-nine out of thirty-eight cases of tubercular meningitis.

The skin presents peculiar vaso-motor disturbances. Small patches or spots of congestion appear on the cheeks, forehead, or ears, and quickly fade away, their bright color making a vivid contrast with the general pallor. If the finger-nail be lightly drawn across the abdomen or inner surface of the thigh, a bright-red line comes out slowly, persists a few moments, and then gradually fades —the *tache cérébrale* of Trousseau.

Paralyses, both local and general, are commonly met with at this period; as are also rigidity or pendulum-like movements of one or more of the extremities.

The contents of the bladder and rectum are usually discharged involuntarily.

Stage of Paralysis.—From twenty-four to forty-eight hours before death, some of the characteristic symptoms undergo a remarkable alteration. The period covered by these changes is known as the stage of paralysis. The child now lies completely comatose and irresponsive to external irritations. Only reflex movements can be excited, and these imperfectly.

The constipation which has marked the whole progress of the illness is now replaced by copious, involuntary, liquid stools; the sunken abdomen becomes distended with gas; the slow pulse becomes rapid and feeble, numbering one hundred and sixty to one hundred and eighty beats per minute, and the mercury registers a temperature of 104° to 107° F. This second rise in pulse and temperature is a certain forerunner of speedy dissolution.

The capillary circulation is more and more interfered with, the respirations become less distinct, and death may occur quietly in deep coma or be ushered in by a convulsion.

Sometimes the death-agony is prolonged for several days, to the great grief of the parents. Death occurs in from sixteen to twenty-one days from the appearance of the initial symptoms.

TUBERCULAR MENINGITIS IN THE ADULT.—The course of tubercular meningitis varies sufficiently from that observed in children, to deserve brief mention.

The disease is more common in men than in women, and occurs at all ages, but especially between the years of seventeen and thirty. It is almost invariably secondary to advanced tubercular disease in some remote part, the symptoms of which to a certain extent mask those of the meningeal affection. The primary form of the disease is rarely met with in adult life.

Premonitory symptoms are usually absent, and when present never obtain the same prominence as in early life. Persistent vomiting and convulsions rarely usher in the attack, but local paralyses, hemiplegia, and aphasia—very seldom seen in childhood—are not infrequently the first symptoms to direct attention to the cerebral complication.

The disease ordinarily runs a much shorter course than in children. Death may occur within forty-eight hours after the appearance of brain symptoms, and is seldom delayed longer than fourteen days.

DIAGNOSIS.—The diagnosis of typical, fully developed tubercular meningitis can scarcely give serious trouble, but in the prodromal period, or in those cases which pursue an irregular course or in which some of the prominent symptoms are absent altogether, it is proverbially difficult.

Since the disease is almost invariably engrafted upon a scrofulous or tuberculous diathesis, a careful investigation of the family record and personal history should be at once instituted. It is, however, only by the exercise of the most painstaking care, by closely observing the physiognomy and actions of the child, and by noting the hourly variations in the symptoms, that an early diagnosis can be reached in doubtful cases. Ill-defined ailing in a scrofulous child which resists ordinary treatment, especially if accompanied with headache, should always awaken suspicion.

The diseases for which tubercular meningitis is most liable to be mistaken are acute simple meningitis, hy-

drencephaloid disease, gastro-intestinal disturbances, and typhoid fever.

Simple meningitis is ordinarily recognized by the sharper onset (without prodromes), more severe headache, more furious delirium, higher temperature—in short, the greater intensity of all the symptoms and its rapid course. The comparative rarity of the simple over the tubercular form of the disease should be remembered. In exceptional cases the differentiation cannot be made.

False hydrocephalus is usually readily known by the history of antecedent diarrhœa or other exhausting malady, the prostration when the cerebral symptoms began, the rapid and feeble pulse, the depressed fontanelle, the pallor, and the normal or even subnormal temperature. All authors speak of the resemblance which certain cases of typhoid fever bear to the disease under discussion. The infrequency of typhoid fever in patients of the age most prone to tubercular meningitis, the regular temperature curve, the diarrhœa, the iliac gurgling, the rose-colored spots, and the splenic tumor will generally easily establish the nature of the disease.

The subacute gastro-intestinal disturbances to which children, especially scrofulous children, are so liable, will lead to frequent errors. Feverishness, anorexia, vomiting, irritability, and headache may be common to each. In many cases the development of the symptoms must be patiently awaited to clear up the diagnosis.

The more intense headache, the irregular pulse, sighing respiration, the alterations in the pupils, and the graver aspect of the illness will generally speedily indicate its cerebral nature.

The changes which take place in the fundus of the eye are often among the early signs of meningeal inflammation, and hence valuable in diagnosis. However, too much reliance must not be put upon the ophthalmoscopic examination. Dr. Fagge remarks: "The clinical value of ophthalmoscopic changes in the optic disks is still somewhat doubtful. It is certain that a normal state of the retinæ is no proof of the absence of tubercular meningitis, but I believe the time has not yet arrived for a dogmatic expression of opinion as to the positive significance of ischæmia (or even of retinitis) as between that disease and some less severe affection of the brain, such as might be attended with great vascular congestion of its tissue. One appearance, indeed, is conclusive, namely, the presence of tubercles in the choroid. It is true that they belong not to the meningeal affection itself, but rather to a general acute tuberculosis, but this fact in no degree diminishes their diagnostic importance" ("Practice of Medicine"). Dr. Minot says on this point that "choroidal tubercles are so rarely seen as to be of little avail in diagnosis. In fact, they are less frequent in this disease than in general tuberculosis without meningitis. In twenty-six cases of tubercular meningitis examined by Garlick at the London Hospital for Sick Children they were found only once" ("System of Medicine," Pepper).

Dr. Bastian ("Dictionary of Medicine," Quain) places great reliance upon the microscopic examination of the blood in the diagnosis of tubercular meningitis. He mentions the following alterations in the blood as peculiar to this affection: An increase in the number and exalted amœboid activity of the white corpuscles; groups of protoplasmic particles of various sizes interspersed among the blood-corpuscles, as well as here and there small pigment-granules. The red corpuscles tend to run together into irregular masses rather than into definite rouleaux, but present no distinctive changes.

Prognosis.—The prognosis is absolutely bad. When fully developed, tubercular meningitis almost invariably marches steadily on to a fatal termination. Delusive lulls not infrequently occur, however, even in the advanced stages, when an unwary practitioner may doubt his diagnosis and raise hopes in the parents which are soon doomed to bitter disappointment.

The possibility of recovery from the early stages of the disease cannot now be successfully denied, although it is not, perhaps, uncharitable to doubt the accuracy of many of the recorded recoveries. Rilliet, Trousseau, and other equally eminent clinicians report cases in which death occurred from a relapse some time after recovery from the first attack; and at the autopsy, old and recent tubercles of the pia could be clearly distinguished. Huguenin does not even accept the revelations of the post-mortem examination as conclusive, and remarks that "pathological anatomy furnishes no information, the correctness of which it would not be possible to doubt."

The isolated exceptions who do survive an attack of tubercular meningitis are nearly always left with impaired mental or physical powers, and sooner or later succumb to a recurrence of the disease.

The writer has seen recovery in one case which was well advanced in the second stage, and in which there could scarcely be a doubt as to the tubercular nature of the disease, but the patient never fully regained his mental faculties, and died in convulsions eighteen months afterward.

Treatment.—Tubercular meningitis is so universally fatal, that but little benefit can be hoped for from the administration of remedies.

In the present stage of our knowledge, the greatest good must come from the adoption of measures to prevent the development of the cachexia in those so predisposed. It is not necessary for us to detail here the special means to be employed; they are set forth at length in other chapters of this Handbook.

In general terms, however, we may say that, in the presence of the diathesis, every influence which tends to develop the nervous system at the expense of the digestive and muscular systems, will increase the liability to the disease.

The violent antiphlogistic measures formerly employed in the treatment are now properly discarded. As soon as the nature of the disease is known, or strongly suspected, the patient should be placed in a darkened room, and all sources of cerebral excitement excluded. An active calomel purge should be at once administered. An ice-cap must be applied to the head, and warm applications to the extremities.

Special symptoms must be met as they arise, by the use of the customary remedies, but our chief reliance in arresting the disease lies in the use of the bromide and iodide of potash. The bromide may be omitted during the pressure stage, unless convulsions ensue, but the iodide must be given until treatment is abandoned.

Sometimes, during the stage of excitement, opium may be advantageously combined with the bromide. Very flattering reports have been recently published from the use of iodoform inunctions, and a Swedish physician, Dr. Warfvinge, in a recent paper, reports five successful cases. These results are, however, so extraordinary as to provoke a certain amount of scepticism, and future trials of the remedy will be eagerly awaited by the profession. The method followed by Dr. Warfvinge consists in shaving the head and annointing it with an ointment consisting of iodoform, one gramme, in vaseline, five grammes. This is applied twice daily, the head being afterward covered with an impermeable cap. The inunctions are continued as long as needed (*Medical Record*, 1886). The inunctions may, of course, be combined with the ordinary treatment outlined above.

W. J. Conklin.

MENINGITIS, SIMPLE CEREBRAL. (Pachymeningitis, παχύς, thick; leptomeningitis, λεπτός, thin; simple, as distinguished from cerebro-spinal and tubercular meningitis; meningitis of the convexity as distinguished from basilar meningitis.) Meningitis, in general, was first recognized as an affection separate from disease of the brain by Morgagni, 1760. Epidemic cerebro-spinal meningitis first attracted the attention of Vieusseux, of Geneva, 1805, and of Strong, North, Fish, Hale, Miner, and Williams, of our own country, 1806–1814, and had been at that early period easily differentiated from affections limited to the membranes of the brain. Parent-Duchatelet and Martinet, 1821, first distinguished inflammation of the dura and pia mater, and Guerin and Guersant, 1836–1839, first distinctly recognized and set apart the tubercular, granular, or basilar form of the disease. The first clear

descriptions of the exclusively "simple" meningitis, from a pathological standpoint, are to be found in the works of Cruveilhier, 1830, and from a clinical standpoint, in those of Andral, 1834, and, of Rilliet and Barthez, 1843. The recognition of the fact that simple meningitis is always a secondary affection is the result of the more accurate post-mortem observations of the last ten years, in the light of the recent investigations concerning infections, and the contributions from otology.

Pachymeningitis, inflammation of the dura mater, presents itself in two forms, external and internal, purulent and hæmorrhagic, representing entirely different disease processes. The first of these forms alone deserves the title or termination of the name, as it alone shows the signs and lesions of an inflammation; pachymeningitis externa, the hæmorrhagic form, being really the result of a degeneration rather than an inflammation; but in the absence of definite knowledge regarding the genesis of this disease, the two forms may be best studied together.

Pachymeningitis Externa.—Accidents or injuries which directly expose the dura, or effect its separation from the bones of the skull, with consequent extravasation of blood, whereby is implied, at least, a "hidden crevice" or some communication of the dura with the air, lead at once to inflammation of the outer lamella which may extend so as to involve all the rest of the membranes of the brain. Carious processes of the ear constitute an even more frequent cause of this condition. A mere microscopic breach in the thin wall of bone that forms the upper covering of the tympanic cavity will bring pus from the tympanum to the dura. So, also, caries of the ethmoid bone (ozæna) or other bones of the cranium (syphilis, carbuncle) may excite this form of meningitis; and even without caries, purulent inflammation of the mucosæ in the ethmoid and frontal sinuses may extend to the dura through natural openings of communicating vessels. This complication has been noticed more especially in erysipelas after "mixed infection," whose nature it is to spread. As purulent pachymeningitis rarely remains confined to the dura, but extends, as a rule, to involve the pia mater, the symptoms, pathology, and treatment of this condition will be further discussed with leptomeningitis.

Pachymeningitis Interna.—The disease of the dura which merits most consideration, from its frequency, limitation, and recognizability in life, is that affection of the inner layer characterized by the extravasation of blood, and subsequent development of an adventitious membrane, commonly known as hæmatoma duræ matris, and technically described as pachymeningitis interna hæmorrhagica. With these characteristics it is plain that internal pachymeningitis does not supply the requisite conditions, nor rise to the nosological dignity of an inflammation in the modern sense of the term. It develops oftenest independently of all infection, and should properly be discussed as a sub-variety of cerebral hæmorrhage.

The pathology of this affection remains as yet obscure. The early anatomists and clinicians were fain content with descriptions of the condition, without venturing to express opinions concerning the nature of the disease. It was commonly held and taught that the disease consisted in the extravasation of blood, and the only question discussed regarded its situation. Thus Abercrombie and Andral, 1807, maintained that the blood was effused between the dura and the parietal layer of the arachnoid, so-called; while Houssard, 1817, located the extravasation in what was then, and for the sake of convenience is still, known as the cavity of the arachnoid. The hæmorrhagic nature of the affection was nearly lost sight of, when Bayle, 1843, considered the hæmatoma as an inflammatory product of the dura, but was again restored by Durand-Fardel, 1854, who believed in the development and organization of a flat blood-clot. Heschl, 1855, regarded the membrane as a highly vascular connective tissue, a view which Virchow, with his predilections for cellular pathology, elaborated into a hæmorrhagic inflammation of the dura as the first process, and a subsequent infiltration of blood as the second. The authority of these pioneers carried these views with almost undisputed conviction up to our own times, when the studies concerning the nature and processes of inflammation and infection naturally diverted attention to the condition of the blood-vessels as prime factors in the production of the disease.

That hæmorrhagic pachymeningitis is not the expression of an ordinary inflammation is shown by the fact that no amount of irritation of the dura will produce it. Injections of ordinary irritants into and beneath the membranes of the brain of lower animals may be followed by purulent, but never by hæmorrhagic, pachymeningitis. On the other hand, the injection of blood with all its constituents sufficed, in the experiments of Sperling, to produce the typical signs and lesions of the disease. The rôle of the fibrine in these cases is evidenced by the fact that a membrane was not developed after injections of defibrinated blood.

Internal pachymeningitis consists, then, in the extravasation of blood, the formation of a blood-clot which, when the effusion is not too great or rapid, is flattened by pressure, to become subsequently organized into a membrane. In the first stage of the disease process, the thin layer of coagulated blood soon begins to show, in the separation of its fibrine, a meshwork which contains multitudinous blood-corpuscles. At this time there is no apparent connection with the dura, whose epithelium remains intact. In the consolidation which continues, the clot assumes the appearance and density of a membrane, which now in reality develops, from the transformation of white blood-corpuscles into spindle-shaped connective-tissue cells, whence the synonym, P. fibrinosa. The red corpuscles now gradually lose their coloring matter, which collects in spots on the surface, and in the texture of the membrane (P. pigmentosa), lose their regular contours, and finally become transformed into masses of protoplasm. Young vessels now connect the dura with the membrane, which becomes gradually more dense, thick, and adherent. In the meantime new layers of blood may be effused into the membrane already in process of formation, which consists thus of superimposed lamellæ—Virchow has seen as many as twenty—for a time separable from each other. The effusion takes place chiefly upon the convexity of the brain, limited, in fifty-four of sixty-five cases collected by Kremiansky, quite precisely to the region covered by the parietal bones. It is rather more frequently bilateral than unilateral, being confined to one hemisphere in but forty-four per cent. of cases.

The source of the hæmorrhage still remains a matter of dispute and doubt. Kremiansky thought it came from the middle meningeal artery, an origin which comports well with the situation of the clot; but Huguenin declares that he has never seen this vessel affected in any of his observations. This author is inclined to find the lesion in the veins which run from the cortex to the longitudinal sinus along the falx cerebri; and Pacchionian vessels have likewise been accused, but all alike without as yet satisfactory anatomical proof.

The chief danger of these effusions is pressure upon the brain, which shows itself in proportion to the amount of the extravasation. Huguenin has seen a hemisphere flattened by a large unilateral hæmatoma, which may be as large as a hen's egg—Eichhorst mentions effusions of five hundred grammes—and in some cases a lateral ventricle has been reduced by pressure to half its size. The great evil of pressure is obviated in many cases by the latitude allowed by atrophy of the brain-substance, a condition rather, as a rule, coincident with hæmatoma of the dura. In fact, the greatest contingent of cases is found in connection with paralytic dementia, and cases independent of some degree of atrophy are comparatively rare.

When, from any cause, a real inflammation is engrafted upon this hæmorrhagic degeneration, serum or pus may be found in connection with the blood which forms the hæmatoma. As curiosities in this direction, Virchow describes a hydrocephalus externus pachymeningiticus, and Weber saw, in a lamellated hæmatoma, blood in one cavity and yellow-green pus in another.

Various changes in the skull membranes and brain

have been observed in connection with pachymeningitis, but none so frequently as to belong to it of necessity. Thus the bones have been found thickened or thinned, with an agglutinated dura at times, the pia anæmic, hyperæmic, and swollen, or cloudy and opaque, separable or adherent to the dura, etc. The frequency with which general atheroma of the cerebral vessels is seen, with thromboses, softenings, apoplexies, scleroses, etc., of the brain, bespeaks the intimate relation of these processes to the development of the disease, in connection more especially with general paralysis, alcoholism, insanity, senile atrophy, etc.

Pachymeningitis is a much more frequent affection than is commonly believed. Savage records its presence in three per cent. of the autopsies made at the asylum at Bethlehem, and when it is remembered that there are more cases of dementia and insanity, not to mention alcoholism, out of than in asylums, it is seen that this percentage is far too low. It is safe to say that most of the cases remain undiagnosticated during life, and death, when it occurs, though perhaps caused by this affection, is ascribed to the disease in the course of which this accident develops. All authors agree in noting three-fourths of all the cases in the male sex, a proportion which corresponds to the relation of the sexes to the affections which produce the disease. For the same reason hæmorrhagic pachymeningitis is a disease of advanced life. Exceptional cases at early periods of life—six months to eight years—have been recorded by Weber, Moses, Steffen, and others, mostly in connection with the venous stases from the strain of asthma, pertussis, etc., or the impoverished nutrition of blood-vessels from scurvy, leukæmia, and more especially pernicious anæmia; and cases have been more abundantly reported during adolescence and maturity in connection with tuberculosis, empyema, valvular lesions of the heart, the various forms of Bright's disease, the various infections (variola, scarlatina, acute articular rheumatism, and typhoid fever), and more especially local injuries of the dura (seventeen of seventy-four cases described by Schneider); but aside from these accidents, pachymeningitis remains a disease of age. The largest number of cases, twenty-two per cent., in the collection of Huguenin, occurred between the ages of seventy and eighty.

Symptomatology.—Internal pachymeningitis exists at times without a symptom to mark its presence. Moses reports such a case in a child, aged seven months, who died of catarrhal pneumonia. At the autopsy there was found a pachymeningitic cyst, which covered the anterior half of the right hemisphere, though no sign of brain disease had ever been manifest in life. Slight extravasations often show no sign because of absence of pressure, or, if slowly effused, because of tolerance, which the brain acquires often in astonishing degree. In other cases the accident is overshadowed by symptoms pertaining to the original disease. These are, however, all exceptional cases. As a rule, the disease may be diagnosticated during life by signs which are not so valuable in themselves as in their etiological relations.

In the majority of cases the disease announces itself suddenly and violently. The patient is stricken with apoplexy. The hæmorrhage may be so great as to cause death by compression of the brain within forty-eight hours. The nature of the disease, or more strictly, the localization of the hæmorrhage, is, as a rule, in such cases impossible to determine. The first attack is not, however, usually fatal. In exceptional cases the patient may recover fully, but as a rule a train of symptoms ensue, which more or less distinctly characterize the disease. These symptoms vary greatly in individual cases, vary according to the locality and extent of the effusion, as well as according to the nature of the original disease; but they do not differ in essential characters from the symptoms of meningitis from any cause. Headache, stupor, which may at any time deepen to coma, monoplegias, hemiplegias, or, in the irritant stage, unilateral twitchings and convulsions, limited at times to one extremity, or confined to the area of distribution of the facial nerve; aphasia, when the region of the language-centre is compressed—these symptoms, together with an irregular or retarded pulse, vomiting, and more especially contracted or dilated pupils irresponsive to light, with little or no disturbance of general sensation, make up a group which as a rule distinguishes the disease.

But, as already intimated, it is not so much the symptomatology of the affection as its etiological relations which strictly define the disease. The general signs of meningitis refer especially to hæmatoma only when they occur in the course of general paralysis, chronic psychoses, alcoholism, chronic Bright's disease, pernicious anæmia, traumata, the affections mentioned in the discussion of the etiology of the disease.

Another distinguishing, but by no means so distinctive, feature to indicate the nature of the affection, is the recurrence of the symptoms. Total or partial recovery from all the general manifestations of meningitis is followed in pachymeningitis, as a rule, by repeated attacks, and though the special symptoms may show great variety in relapses or recurrent attacks, the general character of the new signs is definitely sustained.

The diagnosis of pachymeningitis is based upon these two cardinal points: the existence of an underlying condition or causative disease, and the more or less rapid recurrence of the attacks. Cases are further characterized by suddenness of onset and rapidity of recovery. The writer of this paper has, at the present time, under observation an individual affected with chronic alcoholism, who was suddenly stricken with apoplexy on the streets. The patient was carried comatose to the hospital. The coma subsided in the course of a few hours, to leave a complete right-sided hemiplegia, which entirely disappeared in three days, leaving the individual in better physical and mental condition than for ten years. Many of the cases of so-called "serous" apoplexy characterized by sudden onset, and more especially by speedy recovery, are really cases of pachymeningitis.

The predominance of symptoms indicating cortical lesion is another feature of diagnostic importance. Thus localized convulsions and contractions, monoplegias, contracted pupils, following an apoplectic attack in an individual predisposed to the disease by the factors already emphasized, point almost certainly to pachymeningitis.

The age and sex of the patient must not be overlooked. Basilar meningitis is differentiated by the youth of the patient, the family history, the presence of tuberculosis elsewhere, by its long prodromes, its insidious approach, its general and special hyperæsthesia, opisthotonos, boat-shaped abdomen, etc.

Cerebro-spinal meningitis prefers winter, soldiers, and children, occurs at times in endemic proportions, shows opisthotonos, herpes, and sometimes petechiæ, extreme hyperæsthesia, spinal lesions, and does not recur.

The prognosis is always grave. Recovery without recurrence is possible, but not probable. The patient succumbs, as a rule, in a subsequent attack, if he does not fall a victim in the meantime to the original disease. The immediate prognosis is best established, as after any cerebral hæmorrhage, by frequent observations of the temperature, whereby the degree of the rise after the initial depression incident to the shock, would receive proper interpretation. A sudden or gradual elevation to a high grade (105°) at any time thereafter, independent of the original disease, is a sign of most ominous significance.

Therapy.—The treatment of pachymeningitis does not differ materially from that of any form of meningitis or cerebral hæmorrhage. The application of an ice-bag to the head, the local abstraction of blood by leeches or cups behind the ears or over the temples, "derivation" by purgatives (calomel, senna, croton-oil), constitute the routine plan, which is sanctioned more by time and use than by benefit based upon demonstrable proof. Tranquillity of surroundings, with all the measures which make up a more or less perfect hygiene, are the most effective agents in prophylaxis in the chronic psychoses; while abstention from alcohol addresses the "causa indicationis" in cases dependent upon its abuse. Bright's disease, heart disease, pernicious anæmia, etc., in short,

Meningitis.

the underlying condition calls for appropriate treatment, and paralyses, convulsive manifestations, persistent headaches, whatever symptoms may be left, are to be met with symptomatic treatment.

LEPTOMENINGITIS.—It is possible, as already stated, that a real inflammation may limit itself to the dura mater alone, but such a distinct circumscription is very rare. Inflammation of the dura extends, as a rule, so as to involve the pia mater. The same qualification applies to the pia mater, though a strict limitation to the pia mater is more frequently observed. The subsequent remarks apply more especially to inflammation of the pia mater, with which the dura is, or may be, secondarily affected in greater or less degree. It is taken for granted that cerebro-spinal meningitis and tubercular meningitis, diseases due to special causes, are not included under the title leptomeningitis, which embraces all other kinds of simple meningitis of known or unknown cause.

Leptomeningitis is always a secondary affection. The cases considered idiopathic become, under closer observation, so much fewer every year, that it is more safe to appeal to unknown primary affections than to subscribe to the possibility of a spontaneous or idiopathic meningitis of any kind. A thorough conviction in this regard will alone lead to the searching investigation necessary in many cases to discover the original disease.

Affections of the ear constitute by far the most fruitful cause of leptomeningitis. Of these affections, chronic suppurative inflammations of the tympanic cavity, which constitute over twenty per cent. of all diseases of the ear, most frequently lead to meningitis through caries of the osseous roof of the tympanum. The roof of the tympanum is composed of an excessively thin plate of bone, which is indeed at times congenitally defective, so that the way lies open to invasion of the cranial contents.

A more or less open avenue is also offered in the course of, or along the sheaths of, the facial and auditory nerves, and the vessels which penetrate the petrosal fissure. Communication by caries may be also directly established between the cavity of the cranium and the mastoid cells; while indirect involvement of the meninges may follow phlebitis and thrombosis of the cavernous, transverse, and superior petrosal sinuses, as revealed by dilatation of the veins and local œdema in the region of the mastoid process. Tuberculosis plays a prominent rôle as a special cause in the production of all these processes, while syphilis furnishes a small contingent of cases through caries of the upper meatus of the nose.

Every meningitis whose cause is not obvious should excite suspicion of ear disease, which may reveal itself to the sense of smell in an offensive odor, before or in the absence of visible discharge. So, also, every case of otorrhea should excite the fear of possible meningitis.

Trauma or injury to the cranial bones constitutes a not infrequent cause of simple meningitis. Where compound fracture has occurred, or direct penetration has been effected, the sequence is sufficiently simple. In other cases the meninges, though not directly exposed, become affected through phlebitis, thrombosis, or suppurations occurring in the patulous veins of the diploë, whereby is implied, as previously intimated, some hidden crevice or pre-existent communication with the air. A far more infrequent involvement of the meninges occurs at times, when an abscess in the interior of the brain reaches its periphery, or bursts into a lateral ventricle to come in contact with inflections of the pia mater at the base of the brain. So-called brain "softenings," which consist simply of brain and tissue débris, and simple hyperæmias, the so-called "congestions" of the brain, including sunstroke, could not, with our present knowledge of the nature of infections, produce a leptomeningitis.

Next in frequency to the direct invasion of the meninges from disease of the ear, are the metastatic processes from distant depôts of infection. Any one of the acute infectious diseases may be thus attended or followed by meningitis, which is justly regarded as the most serious complication which can occur—which, indeed, imparts a sudden gravity to an otherwise mild case of disease. Of all the acute infections, pneumonia is the disease in which this complication most frequently occurs. The intimate relations of tuberculosis of the lung and brain in the frequent sequence of basilar meningitis upon tuberculosis pulmonum, prepare us in a measure for the frequent supervention of meningitis in the course of croupous pneumonia. The same connection or relation has been observed also in cerebro-spinal meningitis, and bacteriologists have pointed out the striking resemblance of the micro-organisms found in these two affections. Pyæmia and septicæmia may be said to vie with pneumonia in the production of metastatic meningitis, while endocarditis, empyema, acute articular rheumatism, the exanthematous diseases—more especially variola and scarlet fever (aside from ear disease), and very rarely typhoid fever—diseases mentioned in the order of frequency, furnish exceptional cases. As curiosities equally illustrative, however, of the nature of the process, may be mentioned the cases of meningitis which have followed such trivial infections as vaccinia and mumps.

The morbid anatomy and symptomatology of this form of meningitis do not differ, except in the preference of the convexity to the base in the case of inflammation from metastatic and traumatic causes, from the cerebral signs and lesions of cerebro-spinal meningitis, which have been fully described elsewhere.

The *prognosis* is far more grave than that of cerebro-spinal, but not so absolutely fatal as that of basilar meningitis. The great majority of cases terminate fatally, in coma or convulsions, in the course of from two to ten days.

The *diagnosis* of meningitis in connection with disease of the ear, or trauma of the bones of the cranium, is very easy as a rule, but the diagnosis of metastatic meningitis is often very difficult. High fever and blood-poisoning show symptoms which so closely simulate the signs of meningitis as to render an absolute diagnosis impossible, at least for a time. The persistence of these signs after subsidence of hyperpyrexia sometimes declares the disease. Tuberculosis, pyæmia, scarlatina, variola, erysipelas, and typhoid fever are the affections which oftenest create doubts as to the diagnosis. But if close scrutiny be made of the etiological factors, and close attention be paid to the course of the disease, the diagnosis, as a rule, soon becomes clear. In distinction from tuberculosis and typhoid fever, it may be said that meningitis develops quickly, almost suddenly, with violent pain in the head, active delirium, and often with stiffness of the muscles of the neck, or retraction of the head.

Tuberculosis and typhoid fever show also typical temperature curves, with lung symptoms in tuberculosis, and abdominal symptoms in typhoid fever. In scarlatina, variola, and erysipelas it is rather a question of detecting a complication, as each disease shows characteristic eruptions upon the surface. Here, too, the persistence of cerebral signs after subsidence of the high temperature, is of value. Septic and pyæmic diseases follow wounds, are attended with chills, show joint affections and internal metastases. Ulcerative endocarditis, a septic process, has the same history. Uræmia is recognized by the dropsy, the condition of the urine, and, so far as the nervous symptoms are concerned, by the predominance of convulsions.

Cerebro-spinal meningitis is differentiated by the more prominent disturbances of sensation, by herpes, and by the occurrence of other cases. Basilar meningitis occurs more especially in children affected with tuberculosis elsewhere, or who come of tuberculous stock. It has long prodromes, and a longer duration. Its symptoms are less acute and intense. It more frequently implicates the membranes of the spinal cord. Pachymeningitis is a disease of age. It occurs in drunkards, dementia paralytica, chronic insanity, etc. It shows a more fluctuating course. It must be repeated again and again that the various forms of meningitis are to be separated and recognized more by the etiological relations of the disease than by any difference in symptomatology.

The *treatment* of leptomeningitis does not differ in any way from that of any other form of meningitis; what little may be accomplished in the relief of symptoms has been mentioned under the title Cerebro-spinal Meningitis.

The physician who is thoroughly indoctrinated as to the dangers of disease of the ear, and who is thoroughly familiar with the recent researches regarding the nature of infection, will prevent many cases of meningitis by timely treatment of the ear, and by scrupulous antisepsis in all wounds of the skull. *James T. Whittaker.*

MENORRHAGIA signifies uterine hæmorrhage, or excessive menstrual flow, occurring at the usual time of menstruation; and is to be distinguished from *metrorrhagia* (*q. v.*), where irregular or intercurrent hæmorrhage occurs from the womb.

It is a symptom only—not a disease; and is due to multiple causes, some local, some constitutional. Prominent among these are uterine displacements, metritis, endometritis (especially with fungosities), fibromata, if interstitial or submucous, general plethora, hydræmia, as from prolonged lactation, fæcal impaction with torpidity of the liver, approach of the menopause, heredity. More than one of these causes tend equally to the production of *metrorrhagia,* as when fungous endometritis is found, or where an interstitial or submucous fibroma develops in the uterus.

When it follows abortion, or any of the complications of parturition, it is only through the supervention of some one of the conditions first enumerated.

The etiology may then be obscure, and, clinically, it is often found most difficult to determine it.

The differential diagnosis, which is mainly from metrorrhagia, will be indicated chiefly by its periodicity and by the patient's freedom from any intercurrent flow. But no diagnosis should ever be attempted from the general symptoms alone. If the loss of blood be such as to require medical advice, a local examination should always be made. In conducting this, we should note the position of the womb, the state of the cervix—whether lacerated, with contracted or patulous os, eroded, or otherwise diseased; the condition of the uterine appendages; and, what is most important of all, the state of the uterine cavity.

For this, dilatation of the cervical canal is rarely required, although, in the *treatment* of intra-uterine disease, it is almost always necessary.

In this procedure the patient should always be placed in the left semi-prone position—never on the back—and Sims's speculum used; then, the anterior lip of the cervix being caught with a tenaculum to steady the uterus, a flexible whalebone probe or Sims's silver uterine probe is passed gently through the internal os, the line of uterine deflection ascertained, and the presence of fibromata or other uterine tumors determined. After this, a curette of blunt wire should be passed in like manner, and the state of the endometrium inferred by the smooth or rough sensation communicated to the hand.

The *treatment* will, of course, depend upon the ascertained cause.

In plethoric and indolent subjects a sharp mercurial purge, given before menstruation begins, will often be effectual; and, if this be continued for several months in succession, the menorrhagic habit will, in many cases, be arrested without further treatment.

In feeble and anæmic women iron, or iron and ergot together, will prove the sheet-anchor; but, where fibromata accompany this type of ill-health, cannabis indica (or cannabis indica with nux vomica) will advantageously replace the iron. With either, the *ergot* is equally valuable.

Should the menorrhagia occur during lactation, it will be almost a necessity to give up nursing.

If acute metritis or a displacement of the womb exist, the accompanying malady must be relieved before the menorrhagia will cease.

In all cases of fungous endometritis, with or without fibromata, our main reliance is the curette, which must be applied carefully, but boldly, over all the uterine surface where the least roughness exists. This should always be done antiseptically, after moderate dilatation of the cervical canal, and should be followed by gentle irrigation of the uterine cavity with warm carbolized water. The *free* local use of cocaine (four per cent. solution of cocaine hydrochlorate) locally is preferable to general anæsthesia.

The operation should be done in the patient's bedroom, never in the physician's office, with Thomas's blunt wire curette, instead of the sharp steel curette of Récamier or Sims; the irrigation should be with weak solutions of carbolic acid, as stated—warm or hot—and not with corrosive sublimate, however diluted; and morphia is to be used freely, hypodermatically, if the subsequent pain be severe. This pain may be caused either by uterine colic from retained fluid, or by a rapidly developing metritis.

Where no determining cause of menorrhagia but the approaching menopause can be detected, the favorite modern treatment is by the preparations of manganese, which have been as extensively used for this as for the opposite condition of amenorrhœa. Of these the peroxide of manganese seems preferable to the permanganate of potash, as it produces less nausea and gastric disturbance.

When heredity seems the chief factor in its production, the malady can only be combated by effecting a complete change in the habits of the patient.

Readers desirous of a fuller discussion of the constitutional treatment of menorrhagia are referred to a learned and comprehensive article on this subject, by Dr. Reeve, of Ohio, in Pepper's "System of Practical Medicine," iv., pp. 200 *et seq.* *Charles Carroll Lee.*

MENSES, RETENTION OF THE. This condition must be sharply distinguished from *amenorrhœa,* for while in both there is an absence of the monthly discharge of blood which is peculiar and normal to females between the periods of puberty and the climacteric, in *amenorrhœa* the excretory process or function is entirely in abeyance. In retention of the menses, although the monthly excretion takes place, it simply accumulates, no means of exit existing.*

A definition of *retention of the menses* would therefore be, the accumulation of the menstrual blood within the vagina, the uterus, the Fallopian tubes, or in all these organs, which may go on from month to month for an indefinite period, until it is artificially evacuated, or until, by its pressure, it forces its way through the uterine or vaginal barrier, or, if the resistance at the tubal end is first overcome, until it forces its way into the peritoneal cavity and there excites an inflammation which is usually fatal, unless relieved by appropriate treatment. In exceptional cases the excess of the retained fluid may escape as a transudation from the hæmorrhoidal veins at the anus, through a thin though impervious hymen, or by a so-called vicarious discharge from the vessels of the lungs, the mucous membrane of the nose, or an ulcer upon the surface of the body. Barnes has asserted that this excess of fluid may be forced by uterine contraction through the tissues of the uterus into the abdominal cavity, and this theory has been adopted by Emmet ("Trans. Am. Gyn. Soc.," ii., 437); but it seems to be an entirely unnecessary hypothesis, not to mention the doubt whether such changes are possible, especially when the ample lymphatic supply of the uterus is considered.

The condition in question is a progressive one, which cannot begin until puberty. The recurring symptoms which almost invariably announce the establishment of the menstrual function, if unaccompanied by the menstrual flow, may excite suspicion of the existence of such a pathological condition, but interference with the general physical well-being may be deferred for many months. Its symptoms depend upon a variety of anatomical peculiarities, and these may be either natural or accidental. Natural causes give rise to the greater number of cases, and may be classified as (1) imperforate state of the hymen; (2) atresia or absence of the vagina; (3) occlusion of the os externum, with or without stenosis or occlusion of the cervical canal; (4) occlusion of the os internum; (5) atresia, more or less complete, of the

* If any menstrual discharge whatever occurs, the condition cannot properly be called amenorrhœa. If the discharge is very scanty, the condition may be called *oligomenorrhœa;* and if excreted with difficulty and pain, whether the quantity be small or great, it is *dysmenorrhœa.*

uterine canal above the os internum; (6) such abnormalities as absence of the uterus, or of the uterus and vagina, double uterus, or double uterus and vagina, and occlusion of the os internum and externum. Under accidental causes may be considered: 1. Atresia of the vulva or vagina, or both combined. 2. Occlusion of the os externum, with or without stenosis or atresia of the cervical canal. 3. Occlusion of the os internum. 4. More or less complete atresia of the uterine canal. Among the natural causes, the presence of an imperforate hymen is probably the most common; indeed, of seventy-seven recorded cases during the past ten years, in which retention of the menses has been reported, it has been due to impervious hymen in twenty-five.* The hymen in such cases is usually a thick, fleshy structure, for it can be readily understood that if it were only a thin membrane the pressure of the retained fluid would either rupture it (see Puech, *Gazette Obstetricale*, vii., 321) or cause the less dense elements of the fluid to transude.

Atresia or absence of the vagina, as a congenital deformity, involves the accumulation of the retained fluid within the uterus; and, as an artificial canal, in such cases, must be made with the greatest care and skill in order to avoid contiguous organs and the peritoneal membrane, the condition is one of extreme danger, and the means for overcoming it are very hazardous.

Occlusion of the os externum, with or without stenosis of the cervical canal, is not so frequently a natural cause of retention of the menses as might be expected, considering the large number of women who suffer from undeveloped or badly developed cervix, with accompanying sterility and dysmenorrhœa. There is but a step between such a condition of the cervix and the one which occasions retention. It is also somewhat surprising that occlusion of the os internum is not more frequent as the result of inflammatory conditions in fœtal life or early childhood. Such a condition would almost invariably be unobserved until after the period of puberty, and then a diagnosis of congenital fault would be the best that could be rendered in almost every case. The same is true, though to a less decided degree, of atresia of the uterine canal above the os externum. Unfortunately, the obstacles to the study of pathological conditions in the uterus and vagina in children are insuperable, at least with any means which are, at the present time, available. Were it not so, we might be able to anticipate many of the diseases and deformities of later years, and among them this very condition of retention of the menses.

The sixth class of cases, in which the obstruction is due to natural or congenital fault, includes only exceptional ones; but inasmuch as they are reported by such high authorities as Braxton-Hicks, Oldham, and Kiwisch, their existence can scarcely be disputed.

Retention of the menses from accidental causes offers an interesting field for investigation and comment. Many of the cases by which it is illustrated are the result of prolonged and difficult parturition; and since the development of modern gynæcology, not a few have been caused by the improper use of caustics, or by insufficient care and attention after operations upon the vagina or uterus. Atresia of the vulva or vagina, of accidental origin, may follow extensive laceration and sloughing connected with labor, severe burns, injuries unconnected with parturition in which inflammation, cicatrization, and adhesion occur, uncleanly habits, and inflammation in connection with the exanthemata or diphtheria. Occlusion of the os externum, with atresia of the cervical canal, has been observed after the application of powerful caustics to the mucous membrane, a method of treatment which was much more prevalent a few years ago than now. It has also frequently followed the careless performance of Emmet's operation of trachelorraphy. Occlusion of the os internum not infrequently follows the amputation of the *portio vaginalis* by the actual cautery, or even by the knife or scissors. The accidental atresia of the uterine canal as a cause of retention may also be the result of inflammation. A remarkable case of this kind is reported by Battey ("Trans. Med. Soc. Va.," ii., 432), in which a prolonged labor originated the inflammation.

SYMPTOMS.—The objective symptoms in each case will vary with its anatomical peculiarities. If the retention has continued for a year or more, there will always be an abdominal tumor which may have developed from the vagina, the uterus, or the Fallopian tubes, or from all these organs combined. In very rare instances, as in the cases of Braxton Hicks ("Trans. London Obst. Soc.," xxii., 260) and Haffner (*Berl. klin. Wochen.*, xvii., 346) there may be a tumor though the uterus is absent. The volume of the tumor may be no more than a pint, as in young girls, or it may contain, in extreme cases, four or five quarts of fluid (see Taylor, "Trans. Am. Gyn. Soc.," iv., 404), and it may be roundish, or irregular in outline, according as the uterus alone or the uterus and other parts are involved. If an impervious hymen is the cause, that membrane will tend to bulge outwardly, and will present a fluctuating or boggy feel to the examining finger, or there will be a sensation of greater firmness if the volume and pressure of the fluid are considerable. Examination *per rectum* with the finger, and *per vesicam* with a sound, must not be omitted, as additional information concerning the outline and density of the tumor will thereby be obtained. If the vagina is absent, or has become closed or very narrow, the rectum and bladder still remain as avenues along which the investigation may be conducted. Should the retained fluid be limited to the uterus, the vaginal portion of the cervix will be contracted and drawn up, excepting in the rare cases in which there is atresia of the canal, and the contour of the entire organ will be similar to that which obtains during pregnancy. The bi-manual examination will reveal tenderness, mobility, central position of the uterus, and usually an absence of the urgent objective symptoms which are present in uterine and peritoneal inflammation. If occlusion of the uterine opening exists, as a consequence of parturition, surgical operation, or inflammation from any other cause, examination in Sims's position with Sims's speculum in the vagina, will reveal it to the eye, or it will certainly be ascertained when an attempt is made to pass a uterine probe. Of the subjective symptoms the most important for the formation of a diagnosis are those which are associated with the periodical repletion of the pelvic vessels, and stasis of their contents; and these are common to all cases and ages, whether the cause be natural or accidental. Such symptoms are dragging sensations in the pelvic region, aching pains in the thighs, legs, and sacrum, flushing of the face, headache, nausea, and general *malaise*. In a word, they indicate the ineffectual attempt of the circulation to throw off an uncomfortable burden. Other symptoms are due purely to mechanical causes; these are, pain from the pressure of the confined fluid upon the tissues which surround it; evidences of interference with the functions of the bladder, rectum, or other abdominal viscera, and of obstruction to the free flow of the blood and lymph in the uterus itself as well as in the contiguous organs. All such conditions must react unfavorably upon the system at large. Finally, there are the symptoms of sepsis from the absorption of the confined material, which evidently contains poisonous elements, or of peritonitis from effusion into the peritoneal cavity, with or without rupture of the structures in which the fluid is contained. Concerning the latter accident, rupture of the tubes has frequently been reported. Rupture of the uterus is hardly probable, though I am not prepared to accept Emmet's opinion, that the uterus in such cases undergoes a compensatory thickening, as in pregnancy ("Trans. Am. Gyn. Soc.," ii., 437); in fact, both Taylor and Débrou found the walls of the uterus very thin in their cases (Taylor, "Trans. Am. Gyn. Soc.," iv., 404). Rupture of the vagina is suggested by Thomas ("Diseases of Women," 1880, p. 222) as a possibility, but I find no recorded cases of this accident.

DIAGNOSIS.—This condition would be suspected from the presence of an abdominal tumor, from the absence of the monthly flow, from the existence of periodical symp-

* Matthews Duncan and Emmet believe that in the greater number of the cases in which the hymen is impervious there is also more or less atresia of the inferior portion of the vagina.

toms which are the usual concomitants of menstruation, especially of the dysmenorrhœal type, and from the exclusion of the conditions from which it may be differentiated. It is rendered almost certain by the withdrawal from the tumor, with an aspirator, of a dark, thick, bloody fluid.* It is to be differentiated from pregnancy by its history and symptoms, the symmetrical tumor being its chief point of resemblance. The impervious, or apparently impervious, hymen need not be considered positive evidence against pregnancy, since this condition, as well as atresia of the vagina, have been reported as existing until a late period of that physiological condition, and then have been successfully operated upon. Solid and cystic tumors of the uterus and ovaries must also be excluded, but their history is quite unlike that of retention of the menses, and, as Thomas suggests, the uterine sound can almost always be passed in the former and never in the latter. Hæmatocele has a history of rapid development, often of external hæmorrhage, almost always of great prostration, and may therefore be readily excluded. Tumors of all the other abdominal viscera may be left out of consideration by a similar line of reasoning, and when all these conditions have been eliminated the conclusion may be reached with a fair degree of certainty.

TREATMENT.—If retention of menstrual fluid exists, in the very large proportion of cases there is but one way to treat it, and that is by surgical operation. It is true that cases are recorded in which spontaneous rupture of the hymen has relieved the dangerously engorged organs (Puech, *Gazette Obstetricale*, vii., 321), but such cases are exceptional, and for those in which atresia posterior to the hymen is the efficient cause of the trouble, no such result can be considered possible. The alternative, therefore, is essentially between a let-alone policy and surgical interference. The former will lead, almost certainly, to disturbance of the general nutrition, and possibly to septicæmia or peritonitis. The latter offers, in most cases, a very good chance of complete recovery of health, in addition to the redress of faults of development or of acquired defects of the genital apparatus, which have condemned the individuals who suffer from them to an inferior plane, socially and physically. If an operation is required, apart from the question of the variety of the operation which will be indicated by the anatomical peculiarities in each case, the first point to be considered is, whether the entire volume of the retained fluid should be removed at once, or whether it should be allowed to drain away gradually. Emmet, who has reported twenty-two cases ("Trans. Am. Gyn. Soc., ii., 437) in which he operated for the relief of this condition, and, at the time of his report, had probably had more experience with it than anyone else, is decidedly in favor of completing the evacuation of the fluid at a single sitting. In all of his cases the result from this method of procedure was perfectly satisfactory. West, Von Nussbaum, and many others, are in favor of the same plan. On the other hand, Hewitt, Bernutz, and Thomas recommend gradual evacuation. If the hymen alone is to be operated upon, the opening in the occluding membrane may be made with an aspirating apparatus, with a trocar and cannula, with a cautery instrument, with scissors, or with the knife. If it is designed to empty the tumor rapidly, a large incision must be made, and it may be allowed to flow without restraint, or it may even be encouraged by pressure through the abdominal wall. Some of those who advocate gradual evacuation advise that the cannula or other drainage-tube be left in the opening which has been made; while others allow the subject of drainage to take care of itself. Emmet believes that the fear of reflux of the fluid through the tubes and into the peritoneal cavity at the time of operation is groundless; while equally competent observers, among them Matthews Duncan, Barnes, and Kiwisch, take the opposite view (Duncan, *Med. Times and Gaz.*, 1883, ii., 733). Emmet irrigates the organs, which had been emptied of the retained fluid, with hot water, both at the time of the operation and at suitable intervals subsequently. Taylor thinks such irrigations should be used with much caution, while others object to them, or neglect their use entirely. In the light of the results of antiseptic surgery, it would seem as if there could be no question as to the propriety, and even the necessity, of such a precautionary step. Surely no field of operation could furnish a better soil for decomposition and its entire train of evil consequences than this one, if the long-retained fluid with its broken-down tissues be not removed as rapidly and as efficiently as possible, and the distended and debilitated parts stimulated to resume their normal form and function. It is, therefore, not to be wondered at that, in many of the operations in which no attention to antisepsis is given, the results are bad, and that the patients either have a long and tedious illness, or succumb to the power of infection. If there is atresia or stenosis of a portion of the vagina or of the uterine canal, the same principles should guide one in operating as obtain if the hymen alone is to be penetrated, an incision being required into tissue which is more or less dense, and of greater or less thickness. The plain indication in all such cases is to follow the course of the natural channel, which is demonstrated by the mucous membrane, whether of the vagina or uterus; or, if that has disappeared, to make the incision or dissection as nearly as possible where it (the mucous membrane) should be.

In Battey's remarkable case, in which there was occlusion of the entire utero-vaginal canal following prolonged labor, with symptoms which indicated retention of the menstrual fluid, the ovaries were removed and the distressing symptoms were entirely relieved thereby ("Trans. Med. Soc.," vol. ii., p. 432). If retention is complicated by congenital absence of the vagina, the situation is indeed a grave one, but not necessarily hopeless, as some writers would seem to imply. The list of operators for this condition includes the names of Dupuytren, Amussat, Syme, Key, Brodie, Scanzoni, Emmet, and others, Emmet having the remarkable record ("Prin. and Prac. of Gynæcology," 1880) of seven operations without a failure. The methods by which relief from this accident are obtained are, the immediate one of Dupuytren, by which all obstructions are cut or torn away at a single operation, and the gradual one of Amussat, by which a canal is excavated by repeated efforts of pressure and incision. Puncture through the rectum was practised by Oldham, menstruation being subsequently performed through that viscus (Taylor, "Trans. Am. Gyn. Soc.," iv., 404). Immediate thrust and incision through the obstructing tissue was practised by Syme; puncture with a trocar through the same by Maccormac (Taylor, loc. cit.), and electro-cauterization by Lefort (Thomas, "Dis. of Wom.," 1880, p. 232).

Emmet's method is similar to Dupuytren's, which has given more satisfaction than any of the others, and, as a rule, is to be preferred. In those rare cases, like Braxton-Hicks's ("Trans. London Obst. Soc.," xxii., 260) and Haffner's (*Berl. Klin. Wochen.*, xvii., 346), in which there is an abdominal tumor which depends, apparently, upon retention of the menses, but in which there is no uterus, the diagnosis must necessarily be very difficult. In Hicks's case it was practically impossible without abdominal section, and this operation offers the only satisfactory method by which such cases can be radically treated. Removal of the tubes and ovaries would be indicated.

After any form of operation for retention of the menses severe reaction is possible, and, in the majority of reported cases, has been present. Emmet's experience has been almost unique, for, even after the severer operations, he states that the reaction was usually insignificant. This only proves the value of the method of complete evacuation, followed by the cleansing and stimulating *douche* of hot water. Certainly, in the severer cases (*e.g.*, Maccormac's, in which four or five quarts of fluid were evacuated), it would be unreasonable to make no preparations for inflammatory symptoms; in other words, the most rigid hygienic and antiseptic surroundings should be insisted upon. In addition to antiseptic douching after opera-

* Retained menstrual fluid is usually dark and thick from the absorption of more or less of its liquid contents. Cases have been reported, however, in which it was thin and watery in character.

tions, until all danger of sepsis has subsided, the canal which has been opened, whether it be of the vagina or uterus, should be kept open by the use of a glass or hard-rubber plug. This should be worn constantly until permanent dilatation has been secured. This operation, as well as all others which are performed upon women, should be performed midway between two periods, or as near that time as possible. Should recovery occur, the results are usually all that could be desired. Menstruation will take place normally, if the newly-made canal is prevented from closing, and cases have frequently been reported in which pregnancy and parturition have followed without mishap. It may, therefore, be concluded that, unless visceral disease has been established prior to the removal of the offending material, such removal will signify a restoration to the normal degree of health.

In the following bibliography, which is limited to the past ten years, and beyond which it has not been deemed either necessary or advisable to go, the titles have been grouped mainly with reference to the anatomical characteristics.

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MENSTRUATION. *Menstruation* is a periodic function connected with the female generative organs, whose rhythmical performance occurs normally once in twenty-eight days upon the average. It is associated with phenomena both local and remote. It begins between the average ages of fourteen and fifteen years. It is normally coincident with the liberation of an ovum from a ruptured Graafian follicle in one or both ovaries, and with a discharge of blood, mucus, and degenerated epithelium from the uterine cavity. It is the result of a process called ovulation, or the development and discharge of an ovum which occasions a general vascular congestion of the generative organs. (See article Ovum.) It lasts for one, two, three, or more days, and is usually accompanied by peculiar sensations, such as a feeling of lassitude, pains in the back, slight gastric disturbance, and often by slight mental irritability.

Menstruation is the sign of sexual maturity in the female, and its appearance, coincident with the attendant phenomena of development of the breasts and of the general bodily form, etc., constitutes the condition of puberty, which corresponds to the development in the male of the sexual function. So long as it continues under normal conditions, it is possible for a woman to bear a child. All statistics and comparisons regarding menstruation must be received with careful allowance, for it is an extremely variable function, which is rendered irregular or is abolished by very many causes, often apparently trivial in themselves. The function is suspended soon after conception, and is not usually resumed while active lactation continues. (Compare articles Lactation and Pregnancy.) The cause of the periodicity or rhythm of normal ovulation and menstruation is undetermined.

The *commencement* of menstruation varies chiefly with the climate. In tropical climates it is earlier than in temperate, and in frigid climates it is retarded to the sixteenth year. In tropical countries it occurs as early as the twelfth year. This is partly due to the habit of early marriages and sexual congress, which is a strong stimulus to menstruation. Cases have been known to occur in the first and second years (Susewind). In the United States the average age for the first menstruation is between the fourteenth and fifteenth years. The commencement of menstruation is modified in point of time by mode of life, heredity, social position, exposure, general health, etc. Warmth, good food, luxury, and good hygienic surroundings, all tend to produce it earlier, whereas the reverse conditions may retard it for months or

several years. Chronic diseases, especially phthisis, may retard or even prevent it for years. Brunettes are said to commence earlier than blondes. A few women have been known to menstruate only during warm weather (Barnes). Race influences menstruation somewhat. Jewesses, as a rule, are prolific and menstruate early.

The commencement of menstruation is usually irregular in rhythm. That is, a girl may menstruate once or twice, or more at the normal interval, and then cease for several periods, to again resume the function. The amount and duration of the discharge are also usually less at first than after the function is fairly established.

The *time* of occurrence of menstruation varies. It may occur at any period, but the majority of women are said to menstruate in the first quarter of the moon (Strohl), while in the new or full moon but few perform this function.

The *duration* of a single menstruation varies in different individuals, and in the same person at various times. Its average duration is from three to five days. It may last a week. The discharge commences slowly, increases to a maximum quantity, and declines slowly. The duration is greatly modified both within physiological limits and by diseases, especially disorders of nutrition and assimilation, impoverishment of the blood, and many neurotic, reflex, emotional, and other conditions. In some women menstruation occurs every three weeks, in others every five, without marked disturbances of health; but such cases are exceptional. The regularity of the recurrence of menstruation, and the regularity of its various phenomena, are in general an indication of the individual aptitude for conception. If the menstrual flow be very suddenly stopped, some accident, as cold, disease, or emotional disturbance may be looked for.

The *attendant phenomena* of the commencement of menstruation are: A permanent enlargement of the breasts, accompanied by their increased sensitiveness, and by prominence and pigmentation of the nipple, development of hair upon the pubes and in the armpits; general development of the body, especially of the chest, and deepening of the voice, although the latter is much more marked in males at the age of puberty. There is an alteration in the shape of the pelvis, and in the figure and gait. There is a change in the moral nature, indicated by more reserve and a less romping, childish manner. Slight choreic movements and fever may accompany the first menstruation (Boerhaave). After the function has been fairly established, the usual phenomena which continue to accompany it are malaise, lassitude, pains in the loins and legs, a feeling of constriction, and sometimes tenderness over the uterus and ovaries, alternate subjective sensations of heat and cold, and sometimes a slight increase (0.5° F.) in cutaneous temperature (Kersch). Digestion is retarded, there is apt to be constipation, slightly less urine may be voided, and perspiration may be checked. There is also vascular capillary and venous congestion, which ceases as soon as the blood-flow sets in. The increased nervous reflex excitability is often manifested by yawning, cramps, hiccup, hoarseness, frequent desire for micturition, diarrhœa, anorexia or boulimia, meteorism, palpitation, etc. The quantity of blood is increased, and there is an increase of cardiac action and of general arterial tension (Marcy). Nævi are deeper colored, hæmorrhoids are congested, there may be hæmorrhages beneath the skin, or, more frequently, from mucous membranes, as from the conjunctiva, nose, lungs, stomach, or, more rarely, the kidneys or bladder. If these hæmorrhages attend the menstrual discharge they are called *supplemental* menstruation; if they replace it they are ectopicon, *vicarious* menstruation. The latter may be conservative processes to relieve dangerous cerebral or other congestions. The entire glandular system is stimulated. The sudoriparous, bronchial, and alimentary glands all secrete more actively. The breasts rarely secrete a serous fluid. Pigmentation is excited under the eyes, on the nipples, genitals, or even face.

The above symptoms are by no means constant, and are rarely extreme.

The *menstrual discharge* (menses, catamenia) is at first slimy, but soon becomes thin, dark, sanguineous, acid in reaction, and it has a peculiar and characteristic odor due to fatty acids (Virchow). It consists of blood, serum, ciliated and vaginal epithelium, pigment, disorganized blood-corpuscles and granular detritus, and a débris of uterine mucous membrane, called *decidua menstrualis*. The blood is venous; with this is mingled mucus from the vagina. The epithelium is derived from the uterus principally, and from the vagina to a slight extent. Impregnation may occur sometimes in the absence of the menses, so long as an ovum is liberated.

The *quantity* of blood discharged varies greatly in different individuals, and in the same individual at different times. The average amount is about two hundred grammes. It varies between fifty and three hundred grammes. It coagulates poorly, on account of its admixture with mucus and other secretions of the vaginal mucous membrane, which also alter its color. If a coagulum does form, it is unstable, and readily liquefies again. The blood is poured out so gradually from many minute vessels that it becomes very thoroughly mingled with the mucus. In menorrhagia, when the hæmorrhage is more sudden and extensive, coagulation may ensue. The discharge is at first pale, in the middle deep-red, and at the close of the period again pale, depending upon the amount of blood-pigment present. In chlorosis it is pale and greenish (menstruatio alba).

The discharge of blood may be preceded by a discharge of considerable uterine mucus. It may be followed by a discharge of vaginal mucus.

The *uterus* in menstruation becomes tumefied and congested. Its musculo-glandular layer becomes congested, swollen, and soft, and minute hæmorrhages take place within it. It is thickened from 1.5 to 3 or 5 mm., and the glands increase in diameter from 0.08 to 0.12 mm. (Barnes). The vagina also becomes congested.

The *decidua menstrualis* is developed from the uterine mucous membrane. It is confined to the upper part of the uterine cavity, and does not involve the Fallopian tubes or cervix uteri. Its maximum development immediately precedes the menstrual flow. With the commencement of the flow, or just prior to it, it undergoes rapid fatty and granular degeneration, and is in great part discarded, leaving bare many of the blood-vessels which occasion the hæmorrhagé. There has been much discussion as to just how much of the membrane is cast off at each menstruation, and whether the mucous glands are destroyed or not. It is most generally believed that the deeper layers and glands of the mucosa remain intact, and from them, after a menstrual period is passed, the cast-off superficial layers are regenerated with rapidity—usually within ten days (Kundrat, G. J. Engelmann, *et al.*). Williams and others maintain that the entire mucous membrane, including the glands, is discarded with each menstruation. Ercolani believes that the decidua menstrualis is formed by a rapid growth of cells derived from, and replacing, the uterine ciliated epithelium. This development is so great that the decidual membrane is thrown into convolutions (Tarnier). The decidua is finally cast off in fragments, or sometimes in one or two large pieces. By the eighteenth day after menstruation a new decidua commences to form (Barnes), and the process is then repeated. Menstruation, therefore, marks a destructive process which follows the constructive processes of the growth of the decidua and development of the Graafian follicle, and there is hardly room for doubt that the decidua is formed in preparation for the reception of an ovum (Barnes). Barnes believes that the ovum is discharged into the Fallopian tube long before the menstrual discharge, and that it lingers there for some days, so that the decidua cast off is not the one belonging to the last ovum liberated, but to the one previous to it—that is, an ovum gradually descending to the uterus will be caught, not by the decidua discharged during its descent, but by a new decidua formed between the menstrual periods. Hence he argues that there is no necessary immediate connection between ovulation and the appearance of the menses. Still the two processes of ovulation and men-

strual discharge may occur simultaneously, owing to the general hyperæmia of the generative organs, when the close connection between the ovarian and uterine arteries is borne in mind. The sudden congestion of the thin-walled decidual vessels may be the primary cause of the uterine hæmorrhage (Barnes).

Should impregnation result, the *decidua menstrualis* is converted into the *decidua vera* (see Pregnancy). The *decidua menstrualis* differs in structure from the *decidua vera* in the smaller size of the spheroidal cells found in the inter-glandular tissue.

The *ovaries* are, one or both, congested and enlarged. The enlargement progresses for four days, remains stationary for three days, and then subsides gradually (Oldham). The enlargement commences just prior to menstruation, and subsides after the hæmorrhage (Barnes). In one or both ovaries (usually in but one), prior to menstruation, one of the Graafian follicles becomes very much enlarged, and finally ruptures, discharging an ovum which has developed within it. This, at least, is the normal process. Exceptionally more than one Graafian follicle—very rarely more than two, may rupture in a single ovary, or the follicle may mature in only one ovary, or it may mature and fail to rupture. It is possible for a menstrual flow to take place from the uterus without coincident rupture of a follicle. Conversely, follicles may rupture without being accompanied by any uterine discharge. It is supposed by some that sexual excitement may occasionally cause premature rupture of a follicle, from increased congestion in the ovary, or otherwise. In a healthy menstruating woman several Graafian follicles are usually found in various stages of development in each ovary, but one of these is much larger than the rest. As the menopause is approached, the number and activity of development of the follicles gradually diminishes. After menstruation has ceased, no more follicles form, and eventually the traces of the old ones become more and more indistinct, and the ovary itself atrophies.

The *Graafian follicle*, prior to its rupture, consists of a fibrous sac—the vesicular membrane of Graaf—holding a clear transparent fluid, the liquor folliculi, of a yellowish color, resembling blood-serum, within which is contained the ovum. The wall of the sac is a smooth, vascular, delicate membrane, not over 0.25 mm. thick. It is lined by a layer of granular cells, which undergo great proliferation before menstruation, and constitute the membrana granulosa. At the upper portion of the follicle, nearest the surface of the ovary, these cells are aggregated in a circular mound—the discus proligerus—in which the ovum lies imbedded. (See article Ovum.)

The changes which for some time precede menstruation in a Graafian follicle are, first, a development of its tunica propria, accompanied by the abundant formation of vascular loops which largely fill its cavity and distend it. The follicular wall meanwhile commences to undergo fatty degeneration and becomes more friable. The distention of the follicle may cause a reflex ovarian stimulation which increases the vascularity of that organ and of the other generative organs. This distention causes increased transudation into the follicle, with diapedesis of white blood-corpuscles. The distended follicular wall then ruptures at its weakest and most superficial part, where blood-vessels and lymphatics are absent, and it discharges the ovum, together with some of the cells of the tunica granulosa in which it is imbedded, and a little serum. After the rupture the elastic recoil of the over-distended sac-wall favors the extrusion of the ovum. Possibly the general congestion of the entire ovary increases the pressure upon the sac and favors the rupture. The Graafian follicle, during its development, grows toward the surface of the ovary, where it may be felt as a soft, yielding tumor, sometimes, though not always, elevated a little above the surface, which is thin and transparent at this point. The size of a matured follicle varies very greatly. It is loosely held in the substance of the ovary, and it may be enucleated entire with a pair of forceps, and weighed. It leaves a smooth bed in the substance of the ovary. On the average it weighs about 0.4 Gm., but it may exceed 1.2 Gm. It may weigh much less, especially toward the menopause, or where menstruation has been interfered with by disease, especially of a chronic form, like phthisis. The volume of the follicle varies between 0.7 c.c. and 0.2 c.c. Two follicles maturing simultaneously, one in each ovary, may differ greatly in size, as the ovaries frequently do themselves. The shape of the follicle is round or oval, but its diameters vary very much. Thus it may be eleven millimetres long, by four or five millimetres wide, and only two millimetres deep; or twelve millimetres long, fifteen millimetres deep, ten millimetres wide; or it may have its three diameters more nearly equal. In one case the long diameter measured twenty-five millimetres. The follicle is usually more oval or oblong than round, and is less symmetrical in shape after rupture.

The exact time at which rupture of the Graafian follicle occurs, in relation to the menstrual flow from the uterus, is not known. The weight of evidence favors the view that in most cases it takes place at the commencement, rather than toward the end, of the menstrual period, so that impregnation should be reckoned from the first absent, not from the last present, menstruation.

The *corpus luteum* of menstruatión is the yellowish residue contained within a ruptured Graafian follicle whose activity has permanently ceased. It consists principally of fatty matter and an analogous principle called lutein. It is derived from the enlarged membrana granulosa, which undergoes excessive cellular proliferation and degeneration. It is associated with a central, red-fibrinous blood-clot, which may be enucleated from the sac-wall. The latter appears greatly convoluted from collapse, external pressure, partial absorption of the clot, and thickening. It has a light rosy hue at first, but after some days becomes quite yellow. It fuses more intimately with the ovarian stroma. The corpus luteum is distinctly seen through the transparent tunica albuginea of the ovary, and there is a slight depression found upon the ovarian surface, marking the site of the punctiform rupture of the follicle. This depression appears as a small, dark, stellate cavity, leading to the clot in the follicle, and it is surrounded by a lighter zone, produced by the color of the sac-wall and a small cicatrix. After two or three days the sac-wall becomes greatly thickened, condensed, and convoluted at the bottom, and the thickening gradually extends over the sides. The real thickness of the wall thus becomes double the size before the rupture, but it is apparently eight or ten times thicker, owing to the increase in number and depth of the foldings (Dalton). The color of the sac-wall becomes more and more yellow, and the contained clot becomes decolorized. The wall, moreover, undergoes a granular and fatty degeneration, and becomes so friable, that in a few days it is impossible to enucleate the corpus luteum entire, like the matured Graafian follicle. Eventually, after about four weeks, the corpus luteum is replaced by a cicatrix, which in turn contracts like cicatricial tissue elsewhere. Thus, after several years of menstruation, the ovary is found extensively scarred with the remains of ruptured follicles, while between the cicatrices new follicles are constantly forming. The more frequent menstruation becomes from any cause, the more abundant are the corpora lutea, which are found in a retrograde condition.

It is thus possible, by examination of an ovary, to estimate approximately, from the appearance of the follicles and corpora lutea, at what date the last menstruation took place. A follicle which has only been ruptured for two or three days presents a most unmistakable appearance in the color, consistence, and opacity of its coagulum, and in the smooth condition of the sac-wall, without thickening or folding. The size and weight of the corpus luteum decrease rapidly after rupture, unless the process be retarded by conception (see article Pregnancy). After eleven weeks it may weigh only 0.015 Gm., and its volume may be reduced from 1 c.c. to $\frac{1}{20}$ c.c. ("Human Measurements," Dalton).

Varieties in the appearance of the corpus luteum occasionally occur. The central blood-clot may be replaced by a large gelatinous exudation, which forms the contents of

a smooth ovoid cyst. This condition has been noted in phthisis (Dalton). In about one-third of the ovaries examined, black pigmentation has been found in and around the old corpus luteum, and the central cavity is replaced by a slender black line, due to the pigmentation (formation of hæmatoidin) of the convoluted wall which shows through the transparent remnant of the central clot. Sometimes the atrophied follicle is empty and greatly shrivelled. A follicle may sometimes be ruptured without hæmorrhage (Dalton), or the corpus luteum may contain fluid with no clot. These latter occurrences are exceptional. Hæmorrhage may take place in a follicle without the formation of a corpus luteum (Gerlach).

A *false corpus luteum* is an unruptured Graafian follicle which has passed its stage of maturity (Dalton). Such a body is more deeply seated in the ovary, is connected with no cicatricial tissue, contains no clot, and has a white convoluted wall. It is shrivelled and compressed, whereas the real corpus luteum is superficial, and is always associated with a cicatrix which forms on the surface of the ovary at the point of rupture. By some the false corpus luteum is defined as any corpus luteum which is not accompanied by pregnancy. The surface of the ovary in the neighborhood of the follicles or corpora lutea is frequently somewhat congested, presenting a distinct capillary arborization.

The *Fallopian tubes* during menstruation become congested, and their fimbriæ are erected and touch the ovaries, so as to receive the ova which are discharged. The non-striped muscle of the broad ligament may contract, and thereby constrict the blood-vessels and cause congestion of the Fallopian tubes, which results in their erection (Rouget). It is not known how closely the fimbriæ embrace the ovaries. Possibly they merely touch them at intervals, while the active ciliæ of the epithelium sweep along any ova into the tubes.

The *ovum* is next slowly moved toward the uterus, probably by ciliæ, and it may be soon discharged into the cavity of that organ, and escape in the menstrual discharge, or it may linger in any part of its course, be met and impregnated by the spermatozoa, and subsequently become attached to the uterine wall (see articles Impregnation, Pregnancy), where it develops into an embryo. Its descent through the Fallopian tube and uterus is supposed to occupy from four to eight days. The spermatozoa are supposed to most frequently meet the ova in the Fallopian tubes, when impregnation is to accompany menstruation. The veins in the broad ligament are so much engorged during menstruation, as to be felt as tumors sometimes by vaginal palpation (Richet).

The relation between the discharge of the ovum and the uterine hæmorrhage is obscure. Pflüger supposes that the discharge of a portion of the uterine mucous membrane "freshens" the surface—in the surgical sense—and favors its union with the ovum when impregnation ensues, affording the latter nourishment from a fresh surface.

Reichert, Engelmann, Williams, and others, believe that a sympathetic uterine congestion antedates the discharge of an ovum. The swollen, soft, mucous membrane is rendered in better condition to receive the ovum. If the latter be impregnated, this membrana decidua menstrualis, as it is called, develops into the *decidua vera* (see Pregnancy). If, however, the ovum be not impregnated, the decidua menstrualis rapidly degenerates and is discarded. The uterine hæmorrhage is, therefore, a sign of non-impregnation, so that these observers would date pregnancy, not from the last menstruation, but from a time between the last menstruation and a menstrual period which does not occur.

Removal of both ovaries usually causes the menstrual discharge to cease. Removal of one ovary does not, though it may be diminished in quantity in some cases. Occasionally, after removal of both ovaries a slight menstrual discharge, chiefly of vaginal mucus mixed with a little blood, has continued for a time. This is due either to a portion of ovarian tissue having been left behind, or to the habit of periodic congestion which the blood-vessels have acquired.

The *hygiene of menstruation* is a very extended subject, for a proper consideration of which the reader must be referred to special works. It is only possible here to emphasize a few points. Women are apt during menstruation to be "nervous" or irritable, and to suffer more or less vague discomfort. All over-excitement, exposure, fatigue, strong emotional disturbances, over-exercise, should be strenuously avoided at this period, for the sudden checking of the function may give rise to inflammation or other serious disorder. Care should be taken that the woman be warmly clad, and guarded from chill and wet. The uterus, being congested, is enlarged and heavy, and is, therefore, more subject than usual to displacement (see Versions and Flexions of the Uterus). For an account of the numerous disorders of menstruation see articles Amenorrhœa, Dysmenorrhœa, Menorrhagia, etc.

Menstruation ceases gradually in most cases, but it may stop abruptly from any cause. In a majority of women it ceases between the ages of forty-five and fifty. Contrary to popular belief, those women who commence to menstruate early are apt to continue the function longest, and conversely. Early menstruation may thus indicate greater sexual activity and endurance. Menstruation rarely ceases before the forty-fifty year. It may cease exceptionally as early as the thirty-fifth year, owing to atrophy or "hyper-involution." Women who have given birth at thirty-six or thirty-seven have been known to then cease to menstruate or conceive (Barnes). The period of permanent cessation of menstrual flow is termed the climacteric. Menstruation is familiarly called by various general and colloquial expressions, as the "monthly illness," "periods," "courses," being "unwell," "monthly turns," "sickness," and the like.

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William Gilman Thompson.

MENTAL IMAGERY. Mental imagery is the name given to the process by which the mind reproduces for itself more or less vivid pictures of real objects, scenes, and actions. It is not easy in all cases to discriminate between a normal mental image, or "phantasm" (Osborn), and the phantom of the pathological mental state; but the latter can have no real existence, and it is not judged by reason, while by the "imaging or pictorial power" is meant a faculty by which healthy minds produce phantasms as an aid to the memory of realities. The study of mental imagery is of great value from a psychological standpoint, and is of practical importance in medical science in throwing some light upon the subjects of hallucinal and other forms of insanity, delirium, dreams, amnesia, the physiology of mind, etc., and in explaining some of the errors of memory and imagination which are frequently exposed in medico-legal inquiries in regard to numbers, dates, persons, etc. It is also interesting in connection with methods of instructing the young by object lessons, and in relation to the development of the mind.

The clearness and duration of this visual memory varies greatly in individuals. Familiarity with a certain class of objects leads to the formation of a generic type whose image tends to be visualized by the mind when the idea of a given class of objects is conceived. Mention, for example, the word "boat" to a roomful of people. To the mind of one the image of a small row-boat at once presents itself, to another that of a sail-boat, to another that of a canal-boat, etc., and another mind pictures no distinct boat, but waits for the proper descriptive adjec-

tive. Another pictures only a part of a boat, the mental image being more contracted than the real object. When told that the boat in question is a life-boat, all the images of other boats which presented must be set aside. Obviously, the less vivid the erroneous mental picture has been, the less is the mind hampered in seeing a clear image of the life-boat. Some minds will have gone so far as to have seen passengers in their particular boat, and even to have counted them and noticed how they were dressed. When told that the life-boat was floating bottom up, they find their thought still further removed. Such facts afford valuable hints for literary style, and the proper and most forcible arrangement of qualifying words and sentences (Spencer). The other extreme is found in the German language, where a noun is often anticipated by so long a list of qualifying phrases that the mind is overtaxed in appropriating them. True it is that the image of the same boat may not always arise in the mind of the same individual, but the mind tends to operate in grooves and to reproduce, as a type of a class, the particular image which has originally most strongly impressed it, or which it has most often seen before. Failing this, it produces an image similar in general contour to many different objects of a class previously seen, but exactly like no one of them. The less individuality a doll has, the better a child likes it; it is easier to picture it in new characters and in new clothes. It is conceivable (Galton) that a process goes on in the mind which is analogous to composite portraiture. In the latter the negatives of a number of individuals (say phthisical patients) are placed in brief succession over the same printing paper. The paper thus receives a partial imprint from each negative. The resultant photograph exhibits with intensity the points which the several negatives had in common, while their individual peculiarities are lost. Thus a photograph of a typical phthisical face is obtained which resembles all the original faces, but is exactly like no one of them. As the mind grows, successive pictures of natural objects, received through the medium of the retina, affect a certain portion of the brain. In some cases those objects which are most frequently seen leave the strongest impression; in other cases those do so which are originally the most peculiar, or which are most vividly seen. To reproduce the conception, the mind may be said to go through the reverse process, and project the favorite image or the resultant type of many images before it, in many instances with a distinctness equalling the original impressions, so that other faculties have to be summoned to judge between the mental image and the reality. Children often find difficulty in discriminating between subjective and objective images. Similar to the mental images or phantasms of sight are those of typical sounds (as a drum-note), taste, odors, sensations of touch, and muscular effort, which the mind often makes appear as genuine as the real. Those who have experienced severe thirst, hunger, fever, etc., can often mentally reproduce the sensations with a vividness which far exceeds the ordinary memory of such sufferings.

To aid in recalling or conceiving of numerals and dates, many persons are found to make constant use of a certain mental image or diagram, and the most curious plans are often unconsciously employed to make such conceptions more vivid. Anyone having suddenly to exchange his own mental imagery for that of another, would probably find himself wholly unable to think upon many subjects. Mental imagery is thus merely a pictorial form of memory, which by no means constitutes the entire phenomenon, but it affords a novel means of obtaining a statistical insight into minds. Mental imagery is commonest in children, and more common in women than in men. It is bright and clear in about one person in sixteen. It is dulled by language and book-learning, lost by disuse, and it is weakest in scientific minds, and among those who deal much in generalized and abstract reasoning. It is often inherited; it may be increased by cultivation, as in the case of those who can play chess blind-folded. It is of great service to decorators, architects, landscape-gardeners, inventors, and artists, to be able to see a distinct mental image of what they desire to produce, and to mentally alter and improve it. The same is true of composers, and their mental reproduction of sounds. There are, however, many artists of high rank who are entirely without the faculty.

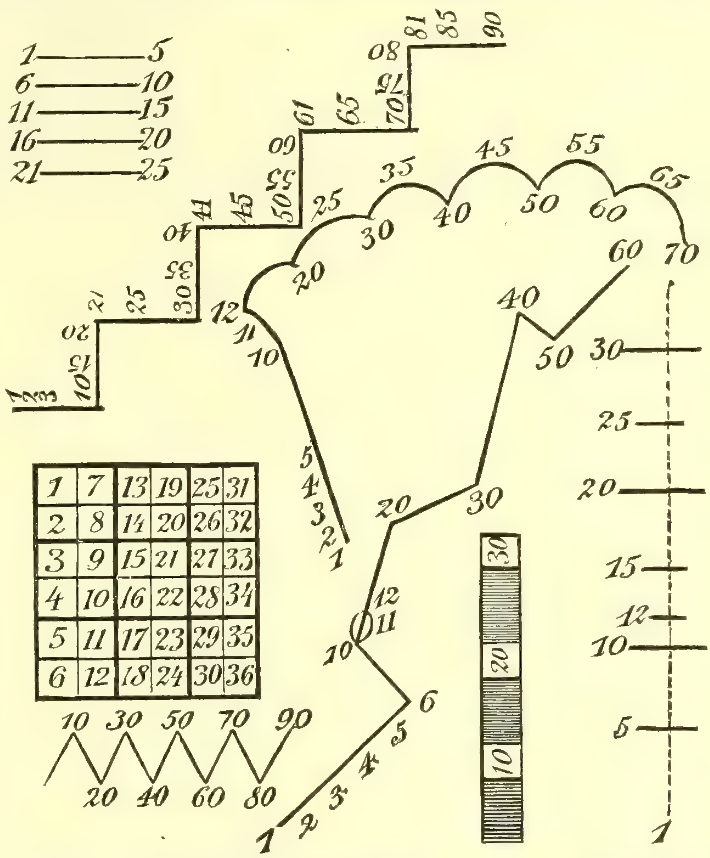

FIG. 2206.—Diagrams of Mental Imagery of Numbers. (From specimens in the writer's collection.) These mental pictures are constantly used by certain individuals to aid their conception of the size of a number. Thus, if such an individual were told that "thirty-five people were present," he would immediately see the number 35 in its relative position in his particular form of diagram. For example, in the diagram composed of squares, this number would be above 36 and below 34. In the step like diagram in another case, it would be seen lying upside down (!) midway upon the second step. In the zig-zag diagram, the number 35 would be seen midway between 30 and 40. In this way does the mind appreciate that 35 is a larger number than 30, and smaller than 40, etc., the ideas of space and relative position being associated together in a definite picture, always the same for the same person, and always used by him in conceiving of numerical size. In mentally counting fourteen dollars, such a person would visualize not the separate dollars, but the number 14 by itself, in its proper position in the diagram.

Mental imagery bears no relation to keenness of vision, nor to dreaming; and it differs from the mental process of identification and the kind of memory which it involves; for a person may recall and identify perfectly a face when met in the street, and yet never afterward be able to reproduce it clearly before his mind. Some persons visualize so clearly as to derive constant pleasure from their mental imagery. There are those who visualize distinctly a whole picture-gallery, or who can mentally hear music upon visualizing the score. A murderer may be led

to confession or suicide by the vividness of his mental imagery. In some cases the vividness of the imagery is a hindrance, as in the case of a man who, in speaking from the visualized written page he had left at home, saw it so clearly, that he stammered over words which he had hurriedly interlined. Persons are always unconscious of their peculiarities in regard to mental imagery. Some people, especially children, who focus their eyes on near objects,

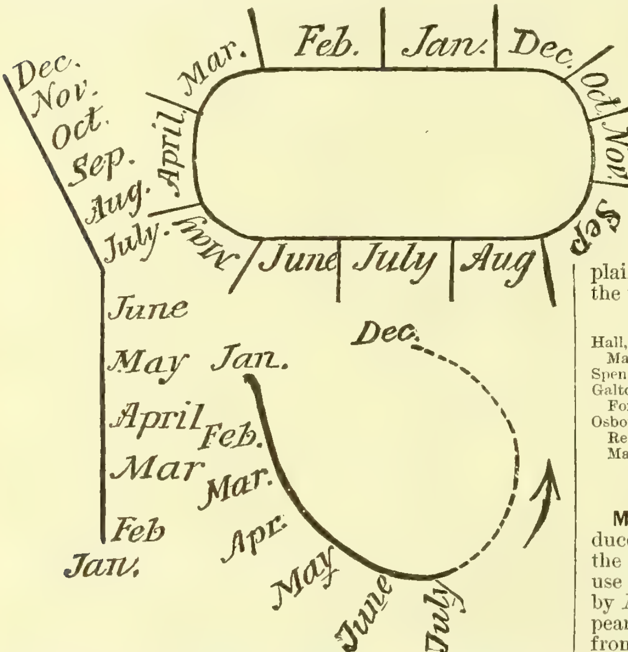

FIG. 2207.—Diagrams of Mental Imagery of Dates. (From specimens in the writer's collection.) If the person employing such a mental diagram as that in the upper right-hand corner of the above cut, be told that a most important event occurred on, say September 3d, he would immediately mentally see the printed word September, lying between November and August, in the lower right portion of an ellipse, and he would further pick out the number 3 from a numerical diagram similar to those in Fig. 2206, which he constantly uses, and by associating the two mental images he would gain the proper conception of the time of year mentioned.

can mentally see around corners, visualize four sides of a cube, or see all around a sphere. To others, mental images may appear transparent, so that they look *through* a sphere to the opposite pole. Some locate the mental image within the brain, others project it in front or to the side, or more rarely behind, at a greater or less distance. Some persons associate in a single mental image impressions which must have been originally received by the brain in very diverse ways. For example, there are those who always, in visualizing letters of the alphabet, see faces with them, or who associate colors with particular sounds, and with letters and numbers; thus the note of a violin is always associated with the imaging of a mass of red color; a drum-note is brown; the letter *u* always appears blue; *a*, is yellow; 4, is green, etc. Such imagery is often hereditary, or it may be traced to the use in childhood of colored blocks, with colored letters and numbers painted upon them. Some persons at once visualize all spoken words as if they were printed before them. The value of associating muscular sense with sight as an aid to subsequent mental imagery, has been recognized for some time, and M. de Boisbaudran taught pupils to trace with the finger in the air the outlines of objects that they were afterward to draw from imagery. Too many different views of a real object often become blended so as to produce a blur, just as is the case with composite photographs, when not concentrically focussed. It is therefore easier for some people to visualize the faces of casual acquaintances than of those with whom they daily associate. Some can visualize the dress and figure of a friend accurately, but the face is a blur. The facial expressions have constantly changed, and have made so many, as it were, overlying impressions upon the brain, that they cannot always be mentally projected. Every mind differs in what might be called its "focussing power" of such repeated impressions. There is a tendency in mental imagery for the first impression to remain the most intense, hence the majority of mental images or phantasms are found in childhood. Some children think almost entirely in mental sounds, pictures, and gestures, which have to them all the intensity of reality, and they are peculiarly apt to associate colors with sounds. Possibly animals think chiefly by phantasms? The mental imagery of some persons compels them to see abstract ideas as definite images before they can grasp their conception. For example, the soul is a "will-o'-the-wisp," a dove, a rod, a sheaf of wheat, a heart, air, etc. This degree of imaging power, when abnormally increased, suggests the origin of fetichism, and explains the habit of savages in applying mental imagery to the forces of nature.

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William Gilman Thompson.

MENTHOL. A stearoptene of the thymol type produced by one or two species of *Mentha*, and separated by the action of cold from their oils. That in most general use under this name is Japanese menthol, and produced by *Mentha javanica*, perhaps only a variety of the European *M. arvensis* Linn.; Order, *Labiatæ*. It is separated from the "Japanese Peppermint Oil" in the manner mentioned above, and is at the present time imported to a very considerable extent from that country.

It comes in handsome, large, brilliant prisms of a pure white color, with a strong, rather harsh, peppermint-like odor. Taste pungent, leaving a sense of coolness in the mouth. It is soluble in alcohol, ether, and in essential oils to any extent, but in not less than one or two thousand parts of water. Rubbed upon the skin it also induces a feeling of coolness, followed by a very mild irritation if the part to which it is applied is a sensitive one, like the face.

The medical uses of this drug are not important; mixed with other oils, etc., it has been considerably used as a liniment for neuralgic affections; it has also been given internally for similar troubles.

Like thymol, menthol has some considerable germicide power, and is occasionally used as an antiseptic. But the most extensive demand for it is in the form of "menthol pencils," etc., that is, short sticks or cones of menthol, often mounted in convenient handles, for rubbing on the forehead, temples, etc., as a remedy for neuralgic headaches. Of its utility in a mild way there is no doubt, but it is so gentle and uncertain that it hardly rises above the "smelling-salts" bottle and other medical toys in its efficiency. The menthol of our peppermint, *M. piperita* Linn., has recently been offered as a substitute for the above; its qualities are similar but milder; its odor is more agreeable. For further information upon both see PEPPERMINT. *W. P. Bolles.*

MENTONE. The town of Mentone (Lat. 43° 46′ 20″ N., Long. 7° 30′ 30″ E.), in the department of the Alpes Maritimes, is situated upon the Mediterranean coast, some fifteen miles northeast of Nice.*

The reputation of Mentone as a health-resort is world-wide; and it is justly celebrated as being perhaps the

* Since the annexation to France of Nice, Savoy, and the communes of Mentone and Roccabruna, in 1860, the town has been known to some writers by its gallicized name of Menton.

most typical of the chain of winter health-stations which are scattered at frequent intervals along the Western Riviera between Nice and Genoa. A general article describing this region, considered as a whole, both in respect to its topography, climate, and sanatory capabilities, will be found, under the title "Riviera," in a later volume of this HANDBOOK. Special local peculiarities and climatic advantages existing, however, in the case of Mentone, and the fame of the town as perhaps the best-known, most frequented, and most carefully studied health-resort of the civilized world, call for a special article setting forth such peculiarities and advantages.

Dr. Sparks tells us that the population of Mentone, according to the census of 1876, was 7,800, but that "during the winter season the influx of strangers raises it to, it is said, upward of 14,000." [1] On page 306 of his valuable work on the Riviera the same writer gives a table illustrating the growth of the town as a winter-resort, as shown by the number of foreign families resident there at the height of the season (about March 15th) in each of the ten years 1870 to 1879 inclusive. Similar figures for four other preceding seasons are also given by him. Adding these four seasons to the other ten, so as to form one common table, we quote Sparks's figures below :

FOREIGN FAMILIES RESIDENT AT MENTONE AT HEIGHT OF WINTER SEASON (Sparks).

1855–56	14	1872–73	1,098
1860–61	98	1873–74	1,112
1865–66	439	1874–75	1,293
1868–69	572	1875–76	1,433
1869–70	591	1876–77	1,498
1870–71 (Franco-Prussian War)	403	1877–78	1,331
1871–72 (Opening of railway)	1,067	1878–79	2,180

The nationality of 2,162 families of foreign residents in 1879 is also given by Dr. Sparks, as quoted from the Agence Tonin Amarante ; and, when we ascertain that no fewer than 137 of these families were from America, while 164 were from Russia, 46 from Sweden and Norway, 41 from Switzerland, 241 from Germany, and 839 from England, it is easy to appreciate the cosmopolitan character of Mentone, and the attractive power which it exerts upon invalids from all the colder countries of the world. That Mentone is popular among the English is plainly visible from the above figures, the English families in 1879 being nearly twice as numerous as the French families, more than three times as numerous as the German, and a little over six times as numerous as the American.

The popularity of Mentone among English people is doubtless very largely due to the long residence there of Dr. J. Henry Bennet, whose interesting and valuable work on the Mediterranean coast-resorts, based upon careful observation, gives the palm to Mentone as the most desirable of all such resorts. Many other writers upon climatotherapy are loud in their praises of Mentone ; and, when we come to consider the local topography, "the lay of the land," at Mentone, we shall see some of the causes of its special climatic peculiarities, and shall be able to understand why it is so popular, not with Englishmen alone, but also with people of many other nationalities.

The general trend of the entire Riviera coast-line is from northeast to southwest ; that of the portion of this coast comprised between the Punta della Murtola (2½ miles east of Mentone) and the Tête de Chien (6⅔ miles southwest of Mentone) is the same. These two capes constitute the seaward abutments of an irregularly semicircular range of limestone mountains, the middle point of the encompassing range being but five and a half miles distant from the shore-line, and the average height of the range being about 3,600 feet. The southwest abutment, the Tête de Chien, is a headland 1,761 feet high ; the precise altitude of the other headland, that of the Punta della Murtola, I do not find mentioned, but it is at least many hundred feet high ; for the peak of the Monte Bellinda, of which it is a buttress or shoulder, and which stands back but a mile and half from the extremity of the point, has an altitude of 1,702 feet ; and the Pont St. Louis, crossed by the Cornice Road on the Mentone or western side of the headland, and after passing which the road ascends considerably before sweeping around the face of the cliff, is 200 feet above sea-level. The little hamlet of Grimaldi, which is perched upon the steep hillside just above the St. Louis bridge, stands at an elevation of 700 feet above sea-level.[2] To illustrate more completely the unbroken character of this great sheltering wall of mountains, it may be mentioned that, at that point where the mountains recede farthest from the sea (5½ miles in a "bee-line"), the carriage-road from Mentone to Turin, after passing to the north along the valley of the Carreï, crosses the range between two peaks having an altitude, the one of 3,932 feet, the other of 4,095 feet ; and that "this pass, which is the lowest point of the amphitheatre of mountains which guards Mentone, is 2,574 feet above the sea." [1] That portion of the mountain wall extending from the pass just mentioned to the Punta della Murtola has a general south-southeast direction, is about seven and a half miles long, and its three chief peaks have altitudes, respectively, of 4,095, 4,478, and 3,575 feet. The western portion of the wall extends almost in a straight line in a southwest direction ; its length from the pass to its termination in the Tête de Chien is about ten miles ; its three chief peaks are the Cima d'Oürs, five miles north-northwest of Mentone, the Mont Baudon, four miles northwest of Mentone, and the Mont Agel, four and a half miles west of Mentone. These have a height, respectively, of 3,932, 4,192, and 3,695 feet.[1] "Except at its eastern and western extremities, the main bulk of the limestone wall does not come nearer the Mentone coast than three miles, the well-known precipices of St. Agnès, nearly northwest of Mentone, representing its southern limit. The lower hills or ridges which run from the mountains nearly to the sea, and at almost right angles to the shore, though in most cases originating in underlying spurs of the limestone, consist almost entirely of a more or less compact sandstone, evidently an old sea-bottom which has been upraised. These hills, to which Mentone largely owes the variety of its scenery and of its excursions, attain a height of from 400 to 700 feet. The valleys between them are watered in rainy seasons by torrents which, at times, attain considerable volume and force." [1] Dr. Bennet, at the close of his description of the Mentone amphitheatre, speaks as follows : "These mountains positively appear to all but encircle the Mentonian amphitheatre in their arms, to thus separate it and its inhabitants from the world at large, and to present it to the blue Mediterranean waves, and to the warm southern sunshine."

"Behind the mountains which thus form the background of the Mentonian valleys are still higher mountains, rising in successive ranges to an altitude of from 5,000 to 9,000 feet. The higher ranges constitute the main chain of the Maritime Alps. They extend from east to northwest far inland, until they mingle with the high Alps of Savoy and Dauphiny. The presence of this second and higher mountain range greatly increases the protection afforded to the coast-line by the lower one, and partly explains its immunity from the winter cold of continental Europe."[2] The lower hills of sandstone, referred to just above, in the passage quoted from Dr. Sparks's book on the Riviera,[1] are evidently those referred to by Dr. Hermann Weber[3] as constituting the third of the three protecting ranges of hills which shelter Mentone from cold winds ("Mentone, nach S. O. gewandt, ist durch drei auf einander folgende Bergreihen, vor den kalten Winden geschützt"). Respecting the proximity to the shore-line of this lower system of hills, of these spurs of the great boundary-wall of the amphitheatre, we shall speak presently. The shore-line, extending from the Punta della Murtola to the Tête de Chien, that is, from one extremity of the mountain bow to the other, has a length of about twelve miles ; and, taken as a whole, describes a double curve, so as to form two shallow bays. The distance from headland to headland, measured in a "bee-line" across both bays, is nine miles ; the depth of each of the two bays is the same, viz., about a mile and a quarter ; in width, also, they are very nearly equal, the eastern bay, that of Mentone proper, being

four and a half miles wide, the western bay, the bay of Monaco, being four and seven-eighths miles in width. The headland which separates these two bays one from the other, and which is called the Cap St. Martin, is a spur of the Mont Agel, extending out into the sea, beyond the general line of the coast, for a distance of a mile and a quarter. With the western bay, the bay of Monaco, between the Cap St. Martin and the Tête de Chien, although it is included within the great Mentonian amphitheatre, we have nothing to do in the present article. The eastern bay alone constitutes the shore-line of the Mentone region proper, and it is this region only which is now under discussion. Limiting our consideration, then, to the Mentone bay, we find that this in turn is subdivided into two minor divisions, termed respectively the East Bay and the West Bay; the little promontory (about a quarter of a mile long) upon which stands the older, more crowded, and more compactly built portion of the town of Mentone constituting the dividing line between them. In point of width the east and west bays are nearly equal; the former, however, is deeper than the latter, and "its centre looks due south; the centre of the west bay, Golfe de la Paix (*Sinus Pacis*), has an aspect nearly due southeast."[1] In the East Bay "the sea runs much further up into the land, so that the carriage-road skirts the shore in nearly a semicircle, instead of in a very shallow curve as it does in the West Bay, and it is squeezed in, so to speak, between the hills and the shore, so that on its inner side there is but scanty space left for houses, especially toward the west."[1] In the East Bay, Dr. Yeo tells us,[4] "the hills come so close to the shore that there is scarcely any room for the town, which consists here of little more than a road and a row of houses and hotels squeezed in between the base of the mountains and the sea-shore; the mountains, however, recede a little, farther east, toward where the road ascends to the Italian frontier." This east-bay portion of the town constitutes the "faubourg de Garavan," and, as Dr. Rabuteau tells us,[5] it is often called "the hothouse of Mentone." It is not only the foot-hills, but also the main chain of mountains, which thus closely approach the sea along the East Bay. Along the West Bay the limestone mountains at no point approach the coast at a less distance than three miles; the sandstone foot-hills also stand further back from the shore than in the East Bay, although the average width of intervening level alluvial land is, even here, not more than a few hundred yards, its greatest width not above half a mile.[1] Moreover, the sheltering wall of foot-hills along the West Bay is broken at three points, where the valleys of three mountain torrents of considerable size come down from the crest of the encircling limestone range to the sea. One of these valleys, that of the Carreï, has been mentioned already; the other two are known, respectively, as the valley of the Borrigo and the valley of the Gorbio. In the East Bay, on the contrary, there are no "considerable valleys . . . to bring cool air down from the mountains."[4] Mountain shelter is the key to the climate of the whole Riviera; in the Mentone amphitheatre such shelter is especially marked; and, so far as the Mentone region proper is concerned, we find that its eastern half, or East Bay, is better sheltered than its western half, or West Bay. Of the Mentonian amphitheatre, the Chevalier Ardoino, quoted by Dr. Yeo,[4] remarks: "There is nowhere else on the shores of Europe so small a locality surrounded by mountains of an equal altitude;" while Dr. Sparks[1] distinctly says of the East Bay of Mentone that it is, "perhaps, more sheltered than any similar indentation on the north shore of the Mediterranean." Reflection of the sun's heat from the limestone rocks plays no unimportant part in raising the temperature of the whole Riviera. In the East Bay of Mentone such reflection is especially powerful as a climatic factor. It is to the climatic contrasts existing between these east and west bays that we wish especially to draw the reader's attention. Mentone's capabilities as a health-station are not a little augmented by this provision of two varieties, two modifications, of the Riviera climate within a radius of less than a mile; and a knowledge of the points of contrast between these east and west bay climates is necessary in selecting the place of residence for an invalid. "The temperature of the East Bay is slightly higher (two or three degrees Fahr.) than that of the West, owing to the reflection of the sun's rays from the limestone rocks by day, and to the heat which they absorb by day and give out gradually at night. There is also less motion in the air on this side of Mentone, though at times the southeast wind makes itself felt pretty severely on the western side of the bay, especially at the turn of the road which leads into the town. According to Sigmund, the East Bay is decidedly damper than the west" (Sparks[1]). "The west bay," says Dr. Yeo,[4] "is not so much protected from winds as the east bay; it is more open to the southwest and to the west, and consequently gets more wind and is somewhat cooler and more bracing. The considerable differences of opinion which have been noticed to exist between the statements of different observers as to the climate of Mentone may, possibly, be accounted for by the circumstance that some have made their observations exclusively in the east bay, while others have made theirs in the west bay." The same writer calls especial attention to the discrepancy existing between the statements of various authorities as to the prevalence of the mistral wind at Mentone, a discrepancy which he attributes to this same cause.

Concerning the direction and force of the prevailing winds at Mentone, much interesting information is given by both Dr. Sparks and Dr. Yeo, and the subject is treated very extensively in Dr. J. H. Bennet's most valuable and entertaining work on the Mediterranean coast resorts.[2] As to the direction of the prevailing winds, Dr. Bennet tells us that "in October and the early part of November, after the autumnal equinox, . . . southwest winds . . . prevail, bringing the heavy autumnal rains. Then the north winds gain the upper hand, and usually, but with occasional temporary exceptions, reign until the spring months, March and April. At this epoch the southwesterly and southeasterly winds seem to have the ascendancy, giving rise to the gales and rains of March." These prevalent southerly winds in March and April "bring genial warmth and fostering showers:" the southerly winds are "generally mild, if not warm:" they may or may not bring rain. As to the southeast wind, Dr. Bennet goes on to tell us that "the southeast (wind) or sirocco, the plague of Southern Italy, all but loses its languor-creating, pernicious character, in autumn and spring, by the time it strikes the head of the Gulf of Genoa. . . . When it arrives at Mentone it has passed over the heights of the Apennines and the high granitic ranges of Corsica, some of the summits of which are covered with eternal snow. It has thus become much cooler than in the south or centre of Italy. Indeed, in the months of February and March the sirocco is so cooled by the great mass of snow on the Corsican mountains that it may reach Mentone, as already stated, as a cold wind, bringing cold rain, and sometimes snow, into the amphitheatre. The only occasions on which I have seen snow within the amphitheatre have been under its influence." As we are told elsewhere by Dr. Bennet, it is only on very exceptional occasions that snow falls on the shore-level at Mentone, and that even then it does not lie upon the ground, but melts as it falls. "The east wind proper is not felt," at Mentone, "except near the shore. . . . At all times the lateral valleys at a short distance from the town afford complete shelter from even a rough east wind. . . . The northeast wind is only felt if very rough; but . . . it is not a common wind on the western Riviera" (Sparks[1]). The northwest wind, or mistral, does occur at Mentone, but it is less common than at some other points on the Riviera: when it does blow it is most felt in the West Bay, particularly along the eastern half of that bay; as for the East Bay, on such occasions, we are told by Dr. Sparks that "it is scarcely touched by it." We have already learned from Dr. Bennet that the prevailing winds during the winter are from the north. All authorities agree that the Mentonian amphitheatre is completely sheltered from these northerly winds, and that they do not strike the surface of the

Mediterranean until a point is reached several miles out from shore. As explained by Dr. Bennet these northerly winds along this part of the Mediterranean coast are of necessity very dry winds, partly because they are continental winds, partly because they must cross the Alps, and, as he aptly puts it, "they have had nearly all the remaining moisture wrung out of them by the extreme cold of the high regions which they have to pass over when crossing the Alpine chains, before they reach the Mediterranean." These dry winds, then, which prevail at Mentone "during the winter months in most years," and which, nevertheless, are not directly felt inside of the Mentonian amphitheatre, prevail not on the surface but far overhead; and, as fully explained in a very interesting manner by Dr. Bennet, they are the real "key" to the climate. They clear the atmosphere, and are thus the direct cause of the intense sunlight for which the Riviera is famous. The mountain-wall prevents them from chilling the air near the surface of the ground, and this air is warmed by the powerful rays of the unobstructed sunlight, and by the sun's heat reflected by day from the sheltering wall of pure limestone rocks, radiated by night from these same rocks, which then give out a portion of that heat which they have absorbed during the hours of sunshine. The Mentonian amphitheatre is virtually a great natural hot-house; the East Bay is the warmer half of the hot-house; the eastern portion of the East Bay, the district called Les Cuses, is the warmest corner of all. The same is true in varying degrees of all points along the western Riviera. "It is a question," says Dr. Bennet, "of fruit-walls in the same orchard, one higher and giving more protection than the others, but all turned to the south." A mid-day sea breeze frequently blows at Mentone, but it is not of daily occurrence. The explanation of this sea-breeze, and the important rôle played by the north wind in its production, are set forth at some length by Dr. Bennet (*op. cit.*), and as his account of the phenomenon will be sure to interest and to instruct the reader, we quote a portion of it as follows:

"Very often when it is very fine and when the sun shines with force on the Mentonian amphitheatre, there is a very decided sea-breeze during the middle of the day, as in tropical countries. The air, becoming heated and rarefied in the mountain basin, rises, and cooler air from the sea rushes in to supply its place. But for a decided sea-breeze thus to rise in winter, there must be a strong wind blowing from some of the northern quarters. When this is the case, in the early part of the day until about eleven o'clock, the north wind, only reaching the sea at some distance from the beach, owing to the mountain protection, leaves the waters inshore calm, or nearly so. The sea air that then rushes in to supply the place of the rarefied land air, pushing angry billows before it, is merely the north wind that, having passed overhead and gone out to sea, is being pulled back by the midday heat. When the air is perfectly calm in the upper and lower atmospheric regions, the calm of the early morning continues all day, because there is then no strong wind and angry sea to be pulled back by the effects of land-heat. . . . In winter, the sea-breeze reigns from about eleven to three. In summer it begins much earlier—before eight. Thus, the seashore of Mentone is decidedly windy, especially in early spring, and this sea-breeze is often cold and searching, for it is the north wind, which has passed overhead, pulled back. This is a fact that invalids ought to remember. They should bear in mind that the gentle breeze that fans them when sitting on the sea-beach on a fine sunny day, may be merely a cruel, treacherous north wind pulled back by the heat, and to be carefully avoided. . . . The sea-breeze . . . modifies, diminishes the extreme dryness of the northerly winds, an important fact for the invalid population. Thus, unless there is a hurricane from the north, the dryness is never extreme."

Elsewhere, Dr. Bennet comments upon the difficulty in estimating correctly the precise direction of the wind at Mentone, as follows:

"The difficulty of recognizing from which direction the wind blows is very great at Mentone when there is a calm in the lower atmosphere, or when northern currents from the northeast or northwest are diverted to the southeast or southwest by the mountains which form the bay. When this is the case, and also under the influence of the sea-breeze, all the weathercocks will point to the south, when, in reality, the weather and climate-influencing wind comes from the north." The way in which the Mentone mountain-wall operates to rob the north wind of its sting, and actually to transform it into a heat-producing agent, is an exceedingly interesting climatic phenomenon. To conclude this discussion of the prevalence and character of the Mentone winds, it may be remarked that at Mentone there is always wind enough for health, seldom enough to cause discomfort; and that upon the occasions when too strong or too chilly a wind is felt along the shore-line, it may be always escaped by the invalid who will take shelter in some one of the torrent valleys opening into the West Bay.

The average temperature at Mentone, from October to May inclusive, is 55.5° F. In the East Bay it is 56.25° F.; in the West Bay it is 54.86° F. These averages are from observations quoted by Dr. Sparks and Dr. Yeo. The figures of the following table illustrate the mean temperature of the East and West Bays for each of the eight months in question; also the mean maximum and minimum temperatures, mean daily range, and the mean relative humidity in the West Bay; and the monthly mean, maximum, and minimum of the rainfall, and the average number of rainy, of very fine, of calm, and of windy days at Mentone. The figures are all taken from a table given on page 270 of Dr. Sparks's book.[1]

METEOROLOGICAL TABLE OF MONTHLY MEANS FOR MENTONE. [From Sparks's "Riviera."]

Authority and Number of Years.	October.	November.	December.	January.	February.	March.	April.	May.
Mean temperature of West Bay, Freeman, 1863–66	62.20	57.20	51.70	49.20	50.30	51.50	58.60	63.10
Mean temperature of West Bay, Andrews, 1873–78	.....	54.1	49.68	49.05	48.63	50.71	56.69	.....
Mean temperature of East Bay, Farina and Castillon, 1861–77	65.30	55.30	50.55	49.90	50.60	53.90	58.70	65.76
Mean maxima, Andrews, 1873–78	.....	61.91	58.01	57.51	57.39	59.38	65.25	.....
Mean minima, Andrews, 1873–78	.....	46.38	41.51	40.63	39.69	42.03	47.97	.....
Mean daily range. Freeman, 1863–68	10.7	9.9	9.2	10.5	11.4	11.8	12.5	.....
Barometer, Freeman, 1863–65	29.84	29.91	30.06	30.03	29.86	29.71	30.01	.....
Relative humidity, Freeman	72.0*	75.0*	72.0*	72.0†	70.0‖	74.0†	74.0†	.....
Rainfall, Freeman and Andrews, 1863–66 and 1873–78	6.37‡	3.73§	3.475§	1.242§	1.45§	3.69§	3.293§	2.37
Highest fall in each month (corresponding period)	13.52	6.94	7.93	2.17	3.26	6.83	6.80	3.90
Lowest fall in each month (corresponding period)	1.55	1.05	0.12	0.03	0.51	0.33	0.09	1.68
Rainy days (corresponding period)	8.0	10.1	7.25	5.1	5.66	9.55	9.33	11.0
Rainy days, De Bréa, 1851–60	9.0	9.4	5.9	7.9	5.5	6.1	7.3	9.3
Very fine days, De Bréa, 1851–60	16.1	15.4	19.5	17.3	16.3	17.7	15.3	15.4
Very fine days. Freeman and Stiege, 1863–68, and Sparks, 1875–78	.....	15.0	15.6	14.8	15.0	12.7	15.0	.....
Calm days, Stiege, 1863–68	.....	22.0	23.0	19.0	20.0	18.0	.....	.....
Windy days, Stiege, 1863–68	.....	8.0	8.0	12.0	8.0	13.0	.....	.....

* Two years. † Three years. ‡ Five years. § Eight years. ‖ Four years.

To insure a more perfect comprehension of the figures of this chart, a portion of Dr. Sparks's comments upon them are herewith quoted: "Andrews," says Dr. Sparks, "has a Stevenson's stand on a grass-plot in a large garden, well removed from trees and buildings, about twenty feet above sea-level, and a hundred yards from the sea itself, and he wishes me to state that his thermometers are in a more exposed situation than any others on the Riviera, or in Italy, as far as he knows, and he has taken some pains to obtain information about them. This fact, he thinks, must be taken into account in comparing his mean temperatures with those of other observers at Mentone and elsewhere."

"Farina gives the mean monthly humidity as ranging from 67–85 during the year. For the winter months, Freeman assigns 73 as its mean value, (three years) and, for a longer period it probably does not exceed 70, but the range is considerable in certain seasons. . . . The rainfall at Mentone, as elsewhere on the coast, has not been much studied until lately, and I believe the statistics of Freeman and Andrews, embodied in the meteorological table, are the fullest that can be obtained. Andrews' means have never before been published. . . . De Bréa counted everything as a 'rainy' day on which any rain little or much fell, so that possibly he includes some days when only a few drops, and not enough to measure fell, or he may, as seems most probable, have neglected days on which at least .01 inch could have been measured." According to Dr. Yeo,[4] the absolute minimum temperature at Mentone during ten consecutive winters was 25.5° F. in March, 1877; the absolute maximum being 77° F. in November, 1874. "The mean daily range of temperature was found to be least in December, 9.2 degrees, and greatest in April, 12.5 degrees. The average rainfall from October to May inclusive is 25.61 inches, but if we omit October and May, for the remaining six months it is only 17.87 inches. The corresponding number of rainy days is 63.8 if we include October and May, 45.15 excluding them. January and February are the finest months, and have the smallest rainfall and the fewest rainy days. October is the wettest month. The average number of very fine days for the six winter months, from November to April inclusive, seems to be about 94.5, rather more than fifteen in each month" (Dr. Yeo[4]). Out of the eight months, October to May, October is the month not only of heaviest rainfall, but also of the heaviest falls of rain, the number of rainy days in that month being fewer than in four of the others—to wit, May, November, March, and April.

Fog never occurs at Mentone. The great heat of the sun has been alluded to already: it is so powerful as to necessitate the use of lined parasols, or sun-umbrellas, not only by ladies but by men as well. The deep blue of the sky at Mentone, and at other points along the Riviera, is notorious. Dr. Bennet[2] sums up as follows the climatic characteristics of Mentone and of the Riviera in general. "Absence of frost, prevalence of northerly winds, moderate dryness of the atmosphere, complete absence of fog, paucity of rainy days, clearness and blueness of the sky, general heat and brilliancy of the sun, a rather cool or chilly night-temperature, and a bracing coolness of the atmosphere throughout the winter, out of the sun's rays. Even when the sun is obscured by clouds, and rain falls, as the wind is then generally from the southwest or southeast, it is not cold at any period of the winter. On the rare occasions, however, when it rains, with the wind from a northern quarter, there may be as miserable and chilly a state of things as in a drizzling November day in England." The abundant lemon crop of Mentone is adduced by Dr. Bennet and by others as proof positive of the great mildness of the winter climate. The testimony borne to this fact (and not only to the heat but also to the dryness of the Mentone climate) by the entire vegetation of the region is discussed *in extenso* by Dr. Bennet and by Dr. Sparks. The charm of this semitropical vegetation, and the great beauty of the scenery at Mentone and along the whole Cornice, can never be forgotten by anyone whose privilege it has been to visit this favored region.

Good hotels, villas, and pensions abound at Mentone, both in the East and West Bays and along the ravines which run northward from the latter. The cost of living is pretty high. The old town itself is not desirable as a place of residence, as its streets are narrow and draughty. The shops of Mentone are good. Board and lodging, at the rate of £1 weekly, is provided for "needy and delicate gentlewomen of any nationality" at the Helvetia, an institution supported by subscription and located on the shore of the East Bay. Dr. Sparks, writing in October, 1879, tells us that "a 'House of Rest' for overworked clergymen and other professional men will be opened this winter at Mentone." The conditions of admission to both these excellent institutions are given in his book (pp. 300–301). The cesspool system of drainage is in vogue at Mentone, and suits the climate and the topographical conditions better than the sewer system. Dr. Sparks recommends earth-closets for use along the coast. Measures for augmenting the water-supply were under discussion when Dr. Sparks wrote his book; yet he does not intimate that at that time there existed any decided insufficiency in the supply. Of the character of the water supplied, I find nothing said one way or the other. I take it for granted that it is good.

Beautiful excursions may be made from Mentone in many directions, both by carriage, on mule-back, or afoot. An objection against Mentone as a residence for a certain class of invalids, and an objection holding good, not in the case of the invalid alone, but also in the case of members of his family, who may accompany him thither, is the very close proximity of Monte Carlo, in the Monaco Bay. The natural, as well as the artificial, attractions of Monte Carlo are very great; its artificial attractions, as the great gambling centre of modern Europe, are notorious, and its evil effects are frequently chronicled in the newspapers of all countries. Monte Carlo is a curse to the Riviera. Says Dr. Sparks: "The evils arising from the gambling establishment are by no means confined to Monaco itself, and both Nice and Mentone, and to a less extent Cannes and San Remo, suffer from its presence both in the class of unwelcome visitors which it attracts from all parts of Europe, and in the ruin it brings on respectable families, members of which are tempted to play and to go on until they have lost their all. Cases of this kind have occurred within my own knowledge. Suicides from gambling losses are by no means uncommon, though, probably, a large number are hushed up by the authorities of the gambling-house." Of the concerts given at Monte Carlo, "nominally for the sake of the invalids at Nice and Mentone," Dr. Sparks complains, on the ground that the room where they are given is so crowded as to be unfit for pulmonary patients; and he pretty distinctly implies, by his manner of speaking, that the said concerts are in reality a mere bait to draw visitors to the *salles de jeu*. Dr. Bennet also has a word to say respecting this morally dangerous neighbor of Mentone; and, in illustration of the motives which induce the princes of Monaco to continue the nuisance, he very aptly quotes the following "motto of Monaco of old:" *

"*Son Monaco sopra un scoglio*
Non semino e non raccoglio
E pur mangiare voglio."

This condemnatory notice of Monte Carlo may, at first sight, appear irrelevant to some readers of this article; yet a moment's reflection will demonstrate its importance in the eyes of any sagacious physician who contemplates sending a patient accompanied, or not accompanied, by family or friends, to Mentone or to any neighboring resort of the Riviera. No apology, therefore, for its introduction is called for.

Prevailing Diseases.—Dr. Sparks devotes no less than five pages of his book to an interesting discussion of the prevalence of various forms of disease among the inhabitants of Mentone and of the surrounding region.

* "Monaco (French, *Monegue*), the smallest of the sovereign principalities of Europe, with an area of 8.34 square miles, a population (1878) of 7,049, and an army of 72 men."—Encyclopædia Britannica.

The result of his investigations appears to demonstrate that epidemic diseases, such as small-pox, scarlet fever, typhoid fever, measles, whooping-cough, and mumps, are all of infrequent occurrence, and when occurring are mild in type and not productive of large mortality. Malarial fever is practically unknown. Facial neuralgia is "very common;" influenza and pleurisy are "not uncommon;" bronchitis is "not infrequent;" acute tonsillitis is "by no means uncommon;" laryngitis is "excessively rare." "Diphtheria had not been seen at Mentone for twenty-three years until 1872, when about thirty-six cases occurred between December of that year and April, 1873. The second epidemic occurred almost at the same period in the winter of 1873. Both the winters of 1872 and 1873 were more or less damp and cold, and diphtheria was prevalent along the whole coast of the Riviera in the direction of Genoa." At Castellar, 1,000 feet above sea-level, pneumonia is of very frequent occurrence. Pulmonary phthisis is very rare, the statistics of the Mentone hospital for twenty-two years showing, out of a total of 3,189 cases of all kinds, only forty-five cases of this disease. "On the whole," says Dr. Sparks, "the native population of Mentone is a very healthy one. Sickly children or adults are rarely met with, and there is a large proportion of old people among the inhabitants both of the town and the neighboring villages."

Climatotherapy.—A discussion of the all-important question as to who should, and who should not, be sent to Mentone, is practically a discussion of this same point as applied to the entire Riviera, Mentone being, as it were, only an intensified Riviera. Suffice it to say, therefore, that Dr. Bennet, an acknowledged authority in the matter, recommends Mentone most strongly to phthisical patients who are in the first and second stages of the disease. "After ten winters passed at Mentone," he says, "I am surrounded by a phalanx of cured or arrested consumption cases." As to patients in the third or last stage of the disease, he recommends that they should either stay at home or resort to such a winter climate as that of Madeira. (See article Madeira.) For neuralgia he considers the Mentone climate unsuitable, unless the neuralgia be merely dependent upon derangement of the digestive organs, or of the "constitutional state." For asthma he does not consider the climate especially good. For kidney diseases he commends it, and he extols Mentone as a winter-resort for weak, sickly children and for aged persons. Dr. Hermann Weber pronounces the East Bay of Mentone to be perhaps better suited than any other known resort in Europe to cases of pulmonary phthisis of a not very erethitic type in the first and second stages of the disease. The necessary close proximity to the shore in the East Bay causes some persons to be disturbed by the noise of the waves, while others object on other grounds against living constantly so very near to the salt water; and for others, again, the intense sun heat and comparative stillness of the atmosphere in the East Bay are a source of discomfort. Many such will find themselves more comfortable at one of the hotels, villas, or pensions of the West Bay, or of its tributary torrent valleys. Dr. Rotureau recommends that among phthisical patients, those of a torpid or lymphatic temperament should take up their residence in the East Bay; those of an erethitic temperament in the West Bay. The immediate proximity to one another of these two bays will enable the patient readily to determine his residence in the one or the other by actual experiment, provided always that he arrives at Mentone early in the season, and before the crowd sets in. The advice of the local physicians, of whom there are several well worthy of the patient's confidence, may wisely be taken in the matter.

This is not the place to descant at length upon the great beauty of the scenery at and about Mentone. No reader of this Handbook who has ever visited the Riviera will require information on this point; the place once seen is never forgotten. To the reader who has not enjoyed this privilege, the delightful and lengthy descriptions contained in Dr. Bennet's book, or in Dean Alford's "Riviera," may be cordially commended, as being not only instructive, but also highly enjoyable, reading.

Huntington Richards.

[1] The Riviera, by Edward J. Sparks, M.A., B.M. Oxon.

[2] Winter and Spring on the Shores of the Mediterranean, by J. Henry Bennet, M.D.

[3] Ziemssen's Handbuch der Allegmeinen Therapie, art. Klimatotherapie, by Dr. Hermann Weber.

[4] Climate and Health Resorts, by J. Burney Yeo, M.D.

[5] Dictionnaire Encyclopédique des Sciences Médicales, 2e Série, tome 6, art. Menton, by Dr. A. Rotureau.

MERAN is situated in the Austrian Tyrol, about forty-five miles south of Innsbruck and twelve miles north of Botzen, in a well-sheltered valley, at an elevation of about 1,100 feet above the level of the sea. It may be reached by way of Botzen or of Innsbruck. The road from Innsbruck passes over the Brenner, one of the highest mountains in the Tyrol, and the ride of fifteen hours in public conveyance is often, in winter, very cold and trying to invalids.

Meran is a health-resort of a threefold character, and has three distinct seasons, which, combined, embrace nearly the entire year, with the possible exception of the mid-summer, when the weather is sometimes excessively hot. The three varieties of treatment practised here may with advantage be considered separately.

A Winter Health-resort.—The town of Meran, with the neighboring villages of Obermais, Untermais, and Gratsch, lies in the beautiful Etschthale, well protected from the north, east, and west, and exposed only to the southerly winds. The mean annual temperature is about 54° F. It is colder here in winter than it is in most of the health-resorts of Southern Europe, but the place has the advantage of a very equable temperature, and of a very unusual number of clear or cloudless days. Although frost and snow are not unknown, the cold is never intense nor of long continuance, and there is a great deal of warm sunshine. The valley is so well protected from the cold winds that the invalids and other visitors are able to take exercise in the open air nearly every day. The air, in addition to being mild and of an equable temperature, is very dry, and the rainfall is comparatively slight. The following table, arranged from figures given by Knauthe, in the article on Meran in "Eulenburg's Real-Encyclopädie," shows the average temperature for the fall and winter months. These temperatures are not given as strictly accurate, but will serve to indicate approximately the winter climate of this resort.

	Morning.	Noon.	Evening.
	Fahr.	Fahr.	Fahr.
September	58.3	69.8	64.4
October	51.8	60.8	57.4
November	37.2	45.7	37.4
December	30.0	37.2	29.0
January	29.0	36.0	29.0
February	30.0	40.0	34.7
March	39.6	54.3	45.5

Vegetation begins again in February, and the winter, strictly speaking, is limited to the three months of November, December, and January, and the first-named is the only one in which the weather is at all apt to be disagreeable,

By reason of the climatic advantages just enumerated, of a rather cool, bracing atmosphere combined with equability of temperature, plenty of warm sunshine, and absence of moisture, Meran is frequented during the winter by numbers of invalids suffering from chronic catarrhal affections, especially those accompanied by profuse mucous expectoration of the respiratory passages. As a further indication, it may be mentioned that invalids of this class who seem to derive the greatest benefit from a stay at this resort, are those of a scrofulous diathesis, and of a languid or even lazy disposition. Persons suffering from pulmonary phthisis in its early stages are often much benefited by a winter at Meran, but a residence here is said to be contra-indicated for those in whom the tubercular process has advanced to softening and breaking down of the lung-tissue, with the forma-

tion of cavities. People of an excitable, nervous temperament, who are suffering from insomnia and nervous tension caused by over-work, anxiety, or excesses of any kind, often experience a great amelioration of their condition during a few weeks or months spent in the mild, dry, equable climate of this valley. The winter season extends from the first of November, the end of the grape-cure, to the first of April, the beginning of the whey-cure season.

The Whey-cure.—Whey is made from cows' and goats' milk chiefly. It consists of the serum of the milk remaining after the separation of the fat and casein, and is little more than a watery solution of sugar of milk and of various salts, chiefly chlorides and phosphates of sodium and potassium. It is made by adding rennet to milk warmed to a proper temperature, and precipitating the suspended casein by the addition of a small amount of albumen. The whey used at Meran is prepared at a neighboring village, and brought thence, every morning, in bottles kept in warm water (from 97° to 100° F.) so as to prevent the temperature of the whey from falling below the prescribed degree during its transport. The whey is dispensed in a large building, resembling the Trinkhalle or pump-room of a German spa. The usual time for drinking the whey is from six to eight o'clock in the morning. A large glass is taken about once in fifteen minutes until from four to seven have been consumed, the drinkers meanwhile walking about slowly. About an hour after the last glass has been drunk, a light breakfast, consisting usually only of coffee and a roll, is taken. No acids nor uncooked food are allowed during the whey treatment, and milk, butter, and cheese are also forbidden. These raw-milk products are stricken from the dietary, because they contain precisely the ingredients of the milk which have been abstracted in the production of the whey, and it is regarded as irrational to give with one hand what has been taken away with the other. The whey is taken pure, or it is mixed ("cut," as it is called) with some mineral water, or the expressed juices of certain herbs are added.

The Herb-juice Cure.—This is a mode of treatment practised at many health-resorts on the Continent, especially in various parts of Germany and Austria. The juices of various herbs, usually wild plants growing in the neighborhood, are extracted from the fresh plant by pressure, without the aid of water, and are then drunk by the patient. The juice of one herb alone is taken, or those of several are mixed together and prescribed, according to the supposed indications of the individual case. The following are some of the plants from which the juice is expressed and drunk, with their alleged therapeutic properties: *Achillea millefolium*, milfoil or yarrow; has been used in flatulent dyspepsia, and also by the Italian peasants in intermittent fever. *Allium sativum*, garlic; diuretic, diaphoretic, expectorant, and alleged also to be emmenagogue. *Apium petroselinum*, parsley; diuretic and aperient. *Cardamine pratensis*, meadow cress; said to possess antispasmodic properties. *Fumaria officinalis*, called also *Herba melancholifuga*, fumitory; has a popular reputation in the treatment of eczema and various other skin affections. *Glechoma hederacea*, ground ivy; expectorant and tonic. *Leontodon taraxacum*, dandelion; diuretic, aperient, and an hepatic tonic. *Menyanthes trifoliata*, water trefoil; has an intensely bitter taste, is tonic, diuretic, and cathartic. *Tussilago farfara*, coltsfoot; expectorant and demulcent, a popular remedy in coughs. *Veronica beccabunga*, water speedwell; supposed to be alterative and tonic. Many other plants are also used, each locality drawing upon the flora of its own neighborhood.

At Meran the most commonly used herbs are the dandelion, water trefoil, speedwell, and cress. The juices are usually prescribed in conjunction with the whey treatment. The whey is taken in the morning, in the manner described, and in the evening, between five and seven o'clock, from one-half to two ounces of herb-juice are drunk. At the beginning of a course of whey and herb-juice treatment, the patients are made to rest most of the time, but after a week or so they begin to exercise according to a fixed daily routine, often counting the steps taken, as is the custom in so many establishments of this kind.

Patients suffering from chronic gastritis, certain forms of dyspepsia, hepatic congestions, anæmia, and chlorosis, are not infrequently greatly benefited by the fine climate, and by the regular mode of living enjoined upon those who submit themselves to the whey-cure. Patients with respiratory catarrhs or incipient phthisis, who have passed the winter at Meran, often remain in the spring to take a course of the whey treatment. The season for the whey-cure extends from the first of April to the middle of June, although by some it is extended through the summer, until the grape-cure season begins.

The Grape-cure formerly enjoyed a greater reputation as an efficient therapeutical measure than it does at present, but it is nevertheless still employed to a considerable extent. Grape-juice contains a varying proportion of grape-sugar, vegetable albumen, and a number of organic acids existing alone or in combination with inorganic bases. The immediate effects of the ingestion of a large quantity of grapes are a little lightness of the head and slight dyspeptic symptoms, followed soon by rather active movement of the bowels and increased diuresis. This action on the bowels tends to reduce the blood tension in the internal organs, especially those in close anatomical relation to the intestinal tract.

At Meran the grapes are eaten in the vineyards or in the large building, resembling an ordinary German Trinkhalle, where, earlier in the season, the whey is drunk. The daily dose of grapes is from two to four pounds in the morning, before breakfast, and about one pound after each of the two principal meals. The season extends from the first of September to about the end of October.

The grape-cure is recommended in the treatment of habitual constipation, hæmorrhoids, passive congestion of the abdominal viscera, some forms of chronic diarrhœa and dysentery, cardiac troubles, gout, chronic bronchitis, and even commencing pulmonary tuberculosis. Those who intend to pass the winter at Meran, because of threatened or beginning lung troubles, are often advised to go there a little before the regular winter season begins, in order to take a course of the grape-cure.

In addition to the therapeutic methods of which mention has just been made, Russian baths and mud-baths are much used, and fresh milk or kumyss is employed to a considerable extent throughout the year.

Meran is a most attractive place for the ordinary tourist in search of pleasure, as well as for the invalid seeking health. It lies in a beautiful valley, and in the neighborhood many agreeable walks may be taken to points affording a view of picturesque scenery, or to the numerous castles, many of them in ruins, for which this part of the Tyrol is famous. A large dike, erected to protect the town from the destructive inundations which used, in former times, to cause serious damage to property and loss of life, is the favorite promenade for the inhabitants and visitors. The hotels and boarding-houses in Meran are numerous, and are, as a rule, clean and well kept, while the cost of living is not very high. At the casino may be found newspapers from all the leading countries. There are numerous churches, and persons of the Catholic, Protestant, or Hebrew faith will find opportunities to worship according to their own belief; there are, also, services for the accommodation of English-speaking Protestants. There are many competent resident physicians in the place.

Thomas L. Stedman.

MERCURIALIS ANNUA Linn. (*Mercuriale annuelle*, Codex Med.). The fruit or plant of *Mercurialis annua* Linn.; Order, *Euphorbiaceæ*. It is a native of Europe, where it grows as a weed in waste places. It has a nauseous odor and disagreeable taste, and is, in full doses, an energetic cathartic. It has been given also for amenorrhœa, scrofula, gout, etc., with doubtful benefit. The active principles are the liquid alkaloid *methylamine*, which is accompanied by a small quantity of *trimethylamine*.

Allied Plants, etc.—See Castor-Oil.

W. P. Bolles.

MERCURY. I. General Medicinal Properties of Compounds of Mercury.—All mercurials capable of gaining entrance into the circulation are competent for a certain peculiar influence over nutrition, as follows: In small dosage the tendency is, as in the case of iron, to increase the quantity of hæmoglobin present in the blood—an effect trifling in the case of a person in good health, but distinctly marked in an anæmic syphilitic patient. In the syphilitic, furthermore, the specific eruptions and inflammations due to the cachexia tend to lessen in severity and shorten in course as the influence of the mineral is declared. In large dosage, or in too rapidly pushed small dosage, the mercurial effect upon nutrition, which was before in the direction of healthy ways, now becomes morbid, and deterioration of the quality of the blood—lessening of amount of albumen and of fibrin, and impairment of coagulability—degeneration and absorption of tissue, and inflammation of certain glands and other structures result. These phenomena, constituting general mercurial poisoning, may lead to long-continued impairment of health, or even to death. In the medicinal induction of the constitutional mercurial influence, or *mercurialization*, as it is commonly called, it may be necessary, for the gaining of the full therapeutic benefit, to push the dosage until the verge of poisoning be reached, but never further. The symptoms of incipient mercurial poisoning thus become of clinical importance, and are as follows, taking their character from the fact that the salivary glands and buccal structures are peculiarly obnoxious to the poison: *Subjectively*, there are noticed a metallic taste in the mouth, and a little soreness in the sockets of the teeth on bringing the jaws sharply together. *Objectively*, the gums are observed to suffer from a slight inflammation, of which the signs are, first, but very transiently (often escaping notice altogether), an unnaturally white appearance from unduly rapid proliferation of epithelium. This aspect soon gives way to the more commonly observed classical picture of red, swollen, and spongy gums, and along with the development of this condition begin an increased flow of saliva and a little tenderness, perhaps even swelling, of the parotid glands. Simultaneously with these pathognomonic local symptoms there may be a deranged stomach, relaxed bowels, and general mild malaise with a trifle of fever, and unnatural susceptibility to "catching cold." All these symptoms disappear readily and completely on stopping the medication. Beyond them, the effects belong wholly to the category of the poisonous, for the discussion of which see the following article.

An important point of obvious clinical bearing is that in childhood ages—and the younger the more marked—the symptoms of incipient poisoning differ from the picture just given in that the salivary apparatus is comparatively insensible to the mercurial irritation. In other words, *children* are not easily *salivated* in the strict etymological meaning of the word. But while this is literally so, it does not follow, and in point of fact is not true, that children are not proportionately as much *blood-poisoned* by mercury as are adults. Rash over-mercurializing of children, because of the false security drawn from the non-appearance of salivation proper, may therefore lead to disastrous effects.

The deranging effect of mercury, as thus sketched, upon the human organism, is but a single exemplification of a general tendency which the metal has to poison all living things, animal or vegetable, high or low in the organic scale, alike. Few poisons, indeed, are so universally and so intensely obnoxious to life generally as is mercury. To the low organisms especially, that are associated with the processes of putrefaction and fermentation, mercury is powerfully poisonous, and the soluble mercurial preparations are therefore highly antiseptic.

As regards *local* effects, next, there is great difference among the individual mercurials. In general the *mercuric* compounds are more or less decidedly irritant, without, as is the case with so many of the compounds of the heavy metals, being astringent; while the *mercurous* compounds and the preparations containing mercury in the metallic state, are either locally quite bland or but mildly irritant only. Of local effects in the alimentary canal upon swallowing, there is, with all mercurials, a decided tendency to relax the bowels, which, with the large doses possible with the milder mercurials, may develop into full purging. In such case the stools are mucous in quality, and are notable for the considerable amount of bile which they contain. By the very virtue of this purgative effect a mercurial purgative dose is itself hurried along the intestines and discharged per anum before time has sufficed for absorption. The *mild insoluble mercurials* are thus possible of application as simple laxatives or cathartics. The *irritant* mercurials, taken internally, even in small medicinal dosage, have an annoying tendency to irritate the stomach as well as the bowels, and loss of appetite, with epigastric uneasiness and tenderness, and perhaps nausea, often follow so quickly the beginning a course of a mercuric salt that the medication has to be discontinued or changed. In large doses the *mercuric* compounds are powerful irritant poisons—the more soluble ones, such as corrosive sublimate, even intensely so. Death may follow in the case of poisoning by the latter compound, by sheer irritation, before the mineral has time to work any specific constitutional mercurial effect (see article Mercury, Poisoning by).

Therapeutically, mercurials are of manifold application. *Constitutionally*, general mercurialization is well-nigh universally applied in the treatment of syphilis, and in older times, more than now, also enjoyed the reputation of being curative in other cachexiæ. *Locally*, in the alimentary canal, by mercurial medication, vomiting can both be induced and quelled, purging be accomplished, and, probably in part by virtue of antiseptic power, many digestive disorders, even of diverse clinical aspect, be corrected. *Externally*, parasites, vegetable and animal, can be destroyed, ulcers and sores coaxed to healing, and eruptions (especially if syphilitic) to disappearance, and wounds successfully treated on so-called "antiseptic" or "aseptic" principles.

II. The Medicinally Used Preparations of Mercury.—The compounds of mercury affording mercurial medicines, officinal in the U. S. Pharmacopœia or in common use, are set forth in the following table, together with their common synonyms:

Table of Chemical States of Mercury Availed of in Medicine.—1. *Mercury Uncombined.* Metallic mercury, in bulk; metallic mercury, in fine subdivision, by trituration with an excipient.

2. *Mercurous Compounds.* Oxide (*Black Oxide, Protoxide, Suboxide*); Chloride (*Subchloride, Protochloride, Mild Chloride, Calomel*); Iodide (*Protiodide, Green Iodide*); Tannate.

3. *Mercuric Compounds.* Oxide, in crystalline scales (*Binoxide, Peroxide, Red Oxide, Red Precipitate*); Oxide, in amorphous powder (*Binoxide, Peroxide, Yellow Oxide*); Chloride (*Bichloride, Perchloride, Corrosive Chloride, Corrosive Sublimate, Sublimate*); Iodide (*Biniodide, Periodide, Red Iodide*); Cyanide (*Bicyanide*); Sulphide (*Bisulphide, Persulphide, Red Sulphide, Cinnabar*); Basic Sulphate (*Subsulphate, Yellow Sulphate, Turpeth Mineral*); Nitrate; Oleate; Ammonio-chloride (*Ammoniated Mercury, White Precipitate*).

Mercury Uncombined.—Mercury in bulk is not ordinarily affected by any of the fluids of the skin or digestive tract, and so is without medicinal effect. Its only therapeusis is to possibly mechanically overcome an intestinal obstruction, which it has in some cases succeeded in doing. For such purpose, from a few ounces to a pound or two of the metal is to be swallowed at a draught. Rarely, constitutional effects have followed such administration, but generally the metal passes down the alimentary canal unchanged.

Mercury in fine subdivision—"extinguished"—by thorough trituration with some excipient, operates, in general feature, like the mercurous compounds, producing specific mercurial effects, local and constitutional. Undoubtedly, therefore, the metal in these trituration-preparations suffers conversion into some soluble mercurial salt by the juices of the part to which it comes to be applied, but what the reaction or reactions are, is

very obscure. The trituration-preparations of the U. S. Pharmacopœia are as follows:

Massa Hydrargyri: Mass of Mercury, "Blue Mass," "Blue Pill." Metallic mercury is triturated with honey of rose and glycerin until "extinguished;" liquorice and marshmallow roots in due proportion are then added, and the whole again subjected to trituration "until globules of mercury cease to be visible under a lens magnifying ten diameters" (U. S. Ph.). The product is a dull indigo-colored pill-mass, containing one part in three of mercury. No weight of individual pills, be it observed, is directed by the U. S. Pharmacopœia. Blue mass is of course only used for internal medication, and behaves like calomel in milder degree. In single large dose it is mildly laxative, producing bilious stools; in small repeated dose it affects the system at large, mercurializing promptly and efficiently, but yet with a tendency to relax the bowels. Therapeutically, blue mass is applied to correct disorders of the alimentary apparatus, or to mercurialize generally, in treatment of syphilis. For the former purpose a single dose is given, generally at night, ranging from 0.30 to 1.00 or even 1.50 Gm. (from five to fifteen or twenty grains). If the smaller of these quantities be prescribed, a brisk purge is commonly ordered to be taken the following morning on rising, to insure the discharge of the mercurial from the bowel; but if the larger doses be given, the blue mass may "work itself off" by its laxative power in such quantities. To *mercurialize* by means of blue mass, from 0.30 to 0.60 Gm. (five to ten grains) of the medicine should be a day's allowance, broken up into at least three doses, equidistant in time; the administration being continued either until the therapeutic point is gained, or until the forerunning symptoms of salivation warn to stop. Should the bowels become unduly relaxed, 0.01 Gm. (one-sixth of a grain) of opium should be added to each pill. Blue mass is prescribed in pill, commonly so ordered as that each pill shall weigh three grains, equivalent to one grain of mercury.

Hydrargyrum cum Cretâ, Mercury with Chalk, "Gray Powder." Mercury is triturated with sugar of milk and chalk, moistened with ether and alcohol, "until globules of mercury are no longer visible under a magnifying power of ten diameters, and the powder is of a uniform gray color and dry" (U. S. Ph.). The product is a smooth powder of a light gray color, consisting of, in a hundred parts, thirty-eight of mercury, twelve of sugar of milk, and fifty of chalk. Of these ingredients the sugar of milk alone dissolves in water. This preparation is naturally very mild, yet in some samples causes irritation, an effect that may possibly be due to contamination with arsenic or antimony, but which probably is more commonly caused by the slow conversion of a portion of the mercury into mercuric oxide. This contamination with mercuric oxide may be detected by treating a portion of powder with dilute hydrochloric acid, and adding stannous chloride to the resulting clear solution. If mercuric oxide be present a precipitate falls. And for safety's sake, if a sample of mercury with chalk be kept for any time, this test should occasionally be applied.

The action of mercury with chalk is substantially that of blue mass, but weaker, and with a less tendency to relax the bowels. The influence of chalk, indeed, is to constipate, and so it comes about that in the average dose little laxative effect is produced by gray powder. Constitutionally, despite its mildness, the preparation is competent to mercurialize, and for the very reason of its mildness is particularly serviceable when the object is to maintain a gentle mercurial influence, steadily, for a considerable time, as in certain methods of treating syphilis. For such purpose two or three centigrammes (from one-third to one-half a grain) should be prescribed three times daily. If rapid and sharp mercurialization be called for, a more active preparation must be resorted to. But the commonest application of mercury with chalk is for the correction of disorders of the alimentary apparatus, particularly those, so common in children, where the prominent symptoms are mal-assimilation of the food with fermentation of the same and diarrhœa, or where clay-colored stools occur, whether with diarrhœa or with constipation. In such affections gray powder may be given, best in quite small but frequently repeated dosage, such as a centigramme or two (one-sixth to one-third of a grain) every hour for a day, unless improvement be sooner effected. Such medication should, of course, not be persisted in beyond a day or so, else mercurialization will ensue. The medicine can be taken clear, as a powder, being of little taste, or it may be put into any convenient mixture. The pill-form is bad for gray powder, since by too much pressure the globules of mercury in the preparation are apt to run together.

Unguentum Hydrargyri, Mercurial Ointment, "Blue Ointment." Metallic mercury and its weight of a mixture in equal parts of lard and suet, are thoroughly triturated together, the extinguishment of the mercury being facilitated by the addition of one per cent. of a previously-made sample of the ointment, and less than the half of one per cent. of compound tincture of benzoin. The trituration is, as usual, to be continued "until globules of mercury cease to be visible under a magnifying power of ten diameters" (U. S. Ph.). The process of trituration is very tedious, and the preparation is generally made by machinery on the large scale, and bought by the dispensing pharmacist from the wholesale manufacturer. In the making, the commonest fraud is in the matter of the quantity of mercury present, which is often found, in commercial samples, to be greatly below the standard.

Mercurial ointment is of analogous color to mercurial pill-mass—a dull indigo slowly darkening with time. By far the greater quantity of the mercury contained in this ointment is in simple mechanical subdivision, but yet a certain small proportion has probably become converted into mercurous oxide, and this in turn has reacted upon the lard, or upon certain products of the decomposition thereof. And to these undetermined secondary compounds some are disposed to ascribe the medicinal activity of the ointment.

Mercurial ointment is the mildest of the officinal ointments containing mercury. It does not irritate the sound skin unless rubbed in, and that, too, repeatedly at the same spot. Medicinally, it fulfils, mildly, the local therapeutics of mercurials, and, also—its most valuable property—when applied by inunction in some way gains entrance to the general circulation and mercurializes the whole system rapidly, thoroughly, and, because of its avenue of access, with a minimum of disturbance of stomach and bowels. Just how, and in what chemical combination, the mercury enters the blood in such case has been a subject of much speculation and theory, but the matter is still unsettled, and is one of no practical bearing. The uses of mercurial ointment are for the purely local purposes of mercurial applications generally, to destroy parasites, or to set up healthy action in sores, eruptions, or glandular indurations not far below the skin-surface, and also to mercurialize in syphilis, especially when the need is for a particularly speedy and thorough development of the mercurial influence. For simply local effects, the ointment is applied in the common way of that class of dressings, but to mercurialize the system at large a special procedure is requisite, of which the point is that the preparation is to be thoroughly rubbed into the skin, until absorption of the mercury takes place through the tissue of the same. To insure speedy absorption, the areas of skin commonly selected for the inunction are those where the structure is thin and where, at the same time, there is not much subcutaneous fat. The inner aspect, respectively, of the upper arm, and of the thigh, and the sides of the trunk, are thus appropriate sites. At least four, and, better, six sites should be used in succession, in order to save the irritation that follows too frequent inunction upon one spot. The practical proceeding is as follows: At night the selected site is well cleansed with soap and water, and dried. Then, preferably before a fire, weather and circumstances favoring, the quantity of from 2.00 to 4.00 Gm. (half a drachm to a drachm), according to the urgency of the case, is rubbed in until the ointment has apparently disappeared. The part is then bound up in flannel, and is not washed until

the following morning. This manœuvre is repeated nightly, or, possibly, even twice a day, until either the desired therapeutic effect is obtained, or until beginning of soreness of the gums enforces discontinuance. One or the other result is commonly attained inside of a week. If the patient require to have the inunction done by someone else, the hand of the rubber must be protected by a glove of caoutchouc or other device to guard against self-mercurialization. In the case of infants, as in the occurrence of inherited syphilis, a piece of the ointment of the size of a pea may simply be smeared upon the skin of the axilla, or of the popliteal space. The ceaseless natural motions of the child then suffice for the rubbing.

Emplastrum Hydrargyri, Mercurial Plaster. Metallic mercury is triturated with a previously made mixture of olive-oil and resin, until the globules cease to be visible, and the mass is then incorporated with lead plaster, melted. The resulting plaster contains thirty per cent. of mercury, and possesses to a slight degree the local specific virtue of mercurials, in addition to the usual properties of plasters.

Metallic mercury is also an ingredient of the plaster entitled *Emplastrum Ammoniaci cum Hydrargyro*, Ammoniac Plaster with Mercury; for whose composition see Ammoniac.

Mercurous Compounds.—The series of mercurous salts which come next for discussion are all insoluble in water, and so locally bland. Internally, with the exception of the *tannate*, in single full dose they are purgative; in small repeated dose they mercurialize rapidly, with especial tendency to produce the specific features of salivation, in the restricted sense of the word.

Mercurous Oxide, Hg_2O. Mercurous oxide, the so-called *black oxide* of mercury, is a dingy, dark-olive powder, insoluble in water and alcohol. Though formerly officinal in the U. S. Pharmacopœia, it is now no longer so; yet it merits a word, since it is the form in which mercury exists in certain preparations, most notably in the so-called *black wash*, so largely used as a mild mercurial lotion for syphilitic sores. This wash is practically mercurous oxide diffused through water. To obtain it, calomel is mixed with lime-water, generally in the proportion of 4.00 Gm. (one drachm) of the former to 500.00 Gm. (one pint) of the latter. Reaction occurs, the lime abstracting the chlorine from the calomel to form calcic chloride, which remains in solution, and giving oxygen in exchange, so that the white powder of the mercurous chloride changes to the dusky one of the oxide. On standing, the precipitate of the oxide, of course, rapidly settles to the bottom of the vessel containing the wash, so that it must be remembered to shake the mixture well before using. Black wash is not officinal in the U. S. Pharmacopœia, although it is in the British.

Mercurous oxide is apt to form in small quantity in the trituration-preparations of mercury above described, and some have thought that the activity of such preparations is wholly due to the presence of this compound, but this is undoubtedly not so.

Mercurous Chloride, Hg_2Cl_2. Mercurous Chloride is officinal in the U. S. Pharmacopœia, under the title *Hydrargyri Chloridum Mite*, Mild Chloride of Mercury. It is also known, in the terms of a former chemical nomenclature, as *subchloride* or *protochloride* of mercury, and, more commonly yet, in the vernacular, as *calomel*. Calomel is bought by the dispensing pharmacist from the large-scale manufacturer, its preparation—to be done well—requiring special apparatus. The principle of the process is to subject to sublimation a mixture of mercury, mercuric sulphate, and sodic chloride. By a preliminary trituration of the mercury and mercuric sulphate mercurous sulphate forms, and, upon heating, this mercurous sulphate exchanges acid radicles with the sodic chloride, with the forming of mercurous chloride and sodic sulphate. The calomel sublimes, and, according to different methods of preparing, condenses either in a crystalline cake or as an impalpable fine powder. If obtained in cake, this requires pulverization in order to submit the calomel to a thorough washing with water, for the removal of traces of mercuric chloride that form along with the calomel. If condensed as powder, it is through the agency of steam (Jewell's or Howard's process), which, as it determines condensation, also very thoroughly accomplishes the necessary washing. Calomel made by the latter process is the most esteemed, and can be distinguished by its snowy whiteness, as compared with the yellowish tint of calomel obtained by the other method.

Calomel is a "white, impalpable powder, permanent in the air, odorless and tasteless, and insoluble in water, alcohol, or ether. When strongly heated, it is wholly volatilized, without melting" (U. S. Ph.). The most dangerous impurity to which calomel is liable is corrosive sublimate (mercuric chloride), for which the test is to wash the calomel with warm distilled water, and then add to the washings some water of ammonia. If any corrosive sublimate have been dissolved by the washing, a white precipitate (ammonio-chloride) will now fall. Next, there may be contamination with this same ammonio-chloride. To detect such, shake the calomel with acetic acid, filter, and treat the filtrate with hydrogen sulphide, and with solution of nitrate of silver. Coloration by the one and the forming of a white precipitate with the other, indicate the presence of the ammonio-chloride. Other likely impurities are not dangerous.

The reactions of calomel that have a bearing, real or supposititious, upon its medicinal employment, are first, that free bases decompose the compound with the formation of mercurous oxide, and secondly, that ammonic chloride, and to lesser degree potassic and sodic chlorides, in sufficient concentration and at a proper elevation of temperature, tend to gradually convert the mercurous into the mercuric chloride—to change, that is, calomel into corrosive sublimate. Great stress has been laid upon the latter reaction. It has been made to do duty in accounting for all the medicinal activity of calomel, the same being ascribed to the corrosive sublimate into which the calomel is assumed to be changed by the alkaline chlorides present in the contents of stomach or bowels; and for fear of undue rapidity and completeness of such conversion, the taking of common salt during a course of calomel medication has been often warned against. On the other hand, it is asserted that the commonly occurring degree of concentration of the alkaline chlorides in the alimentary canal, and the temperature therein, are inadequate to any but a trivial production of the reaction in question. Pending the definite settlement of the question, it is just as well to avoid the joint taking, in any marked quantity, of calomel and ammonic chloride, or even of calomel and either of the less active potassic or sodic chlorides. Other substances alleged to have the power of converting calomel into corrosive sublimate, are *hydrocyanic acid*, *citric acid*, and *sugars*. Of these substances the first need never be prescribed with calomel, and the averred potency of the other two is far from established.

The action of calomel is locally absolutely bland, so long as the salt preserves its integrity, but after swallowing, effects, local or constitutional according to circumstances of administration, declare themselves—which effects, because of the great insolubility of calomel, must be ascribed to some as yet undetermined compound into which calomel is changed in its course along the alimentary canal. The effects differ profoundly, according to whether the medicine is taken in single full dose, or in small repeated doses continued for some days. In the former case, with or without nausea, according to size of dose and sensitiveness of the stomach, and with or without griping, as the case may be, there follows, in about eight hours or so, a call to stool, and mucous passages, brown, yellow, or even green in color, result—green stools being particularly common in the case of children. Such purging, if free, commonly constitutes the whole outcome of the dose, but if not free, constitutional symptoms, showing absorption of the mineral, may follow. The marked coloring of calomel stools has for years been held to be due to an unusual proportion of bile therein contained, and though this has been denied, yet some

chemical analyses, as well as many clinical considerations, make it strongly probable that the venerable assumption is correct. In explanation of the considerable charge of bile in calomel evacuations, many theories have been propounded. The oldest is that excess of bile *excreted* must mean excess *secreted*, and that therefore it must be taken for granted that calomel in purgative dose in some way stimulates the liver to increased rate of secretion of bile. But against this theory are urged the results of experiments upon animals, upon whom biliary fistulæ have been artificially established, such results being that in such animals dosing with calomel is not followed by increased delivery of bile. In rebuttal, however, it is pointed out that the very fact of the establishment of a biliary fistula so changes the ordinary condition of things *in re* liver, bile, and bile's normal intestinal career, that the experiments go for nothing. Apart from this controversy, another theory of the biliary stools following a calomel purge, is that they result as a natural consequence of an assumed action of calomel in rushing down, as it were, the contents of the duodenum, and so preventing that reabsorption of a considerable portion of the bile present in the intestinal contents which is claimed to be a normal occurrence. The latter theory certainly accounts more readily than the former for the well-known corrective effects of calomel-purging in so-called biliousness, but both theories are theories yet, and neither is essential to the intelligent clinical use of calomel in the condition referred to.

In small repeated dose calomel mercurializes speedily, and with a maximum tendency to excite stomatitis. And even with such small doses the bowels are prone to relaxation.

Of morbid conditions, calomel may quell vomiting, and has the advantage for such purpose that, once swallowed in the condition of powder, calomel is difficult to dislodge, and so may continue its action despite an occurrence of vomiting shortly after the taking. Calomel may, and commonly does, readily dissipate the symptoms of that digestive disorder called, rather vaguely, "biliousness," particularly when constipation is associated with clay-colored stools. It may also prove an efficient anthelmintic. Locally, calomel is among the standard remedies for the relief of itching.

The *therapeutics* of calomel consist in the above-described applications. As a purge, the dose for an adult is from 0.30 to 1.00 Gm. (from about five to fifteen grains), given at night, and followed in the morning, if purging do not sooner occur, by some brisk cathartic, such as a dose of salts. Very often, instead of being given alone, calomel is associated with some other purgative such as jalap, in which case its dose must be proportionally reduced. As a corrective in bowel disorders not requiring purging, calomel may be given in centigramme doses (one-sixth of a grain) hourly throughout a single day; yet it may be noted that sometimes this method of dosage results in free purging—as free as if a full cathartic dose had been taken. For anthelmintic purpose, full purgative doses are to be given. To mercurialize, from 0.10 to 0.20 Gm. (about three grains) should be prescribed to be consumed daily, divided into at least four doses, and the laxative tendency neutralized by a trifle of opium with each dose. Salivation should be carefully watched for, and the medication discontinued, or the dose reduced, at the first signs of soreness of the gums. Calomel may be administered in powder or pill. Externally, for the relief of itching, calomel is best prescribed in extemporaneous ointment, of ten per cent. strength.

A special application of calomel is to mercurialize by the process of *fumigation*, so called. This process is based on the fact that calomel sublimes without change, and that when so sublimed and allowed to condense on the naked moist skin, it in some way rapidly gains access to the general circulation, and so mercurializes with great promptness and certainty. At the same time, because of the avenue of introduction, the digestive organs are spared derangement. Under circumstances, therefore, where there is a call for both a prompt and powerful mercurial impression, as in some sudden and severe syphilitic inflammation, the method by fumigation is a thoroughly reliable one. The objections to the method are its troublesomeness, and the exposure of the patient to detection of his malady—objections which, while often annoying, should not condemn the use of the method if the necessity be serious. The process is as follows: By any convenient arrangement—as by laying upon a bit of sheet-metal properly supported—the quantity of from two to four Gm. (from thirty grains to a drachm) of calomel is exposed to the heat of an alcohol lamp, while at the same time a small vessel of water, such as the tin cup of a nursery-lamp, is set to boil alongside. These contrivances are arranged under a chair upon which the patient sits, naked, with a blanket extending around his person and the chair, tightly clasped about his neck. In this way a small confined chamber is made, within which all the patient's body, excepting the head, is exposed to the combined action of steam and subliming calomel. Free perspiration is soon induced, and in the moist, relaxed condition of the skin thus brought about, the calomel condensing upon the surface, finds easy access to the circulation. The sitting lasts from ten to twenty minutes, or until all the calomel has disappeared from the metal plate, and then the patient, donning his night-dress without washing, gets into a warm bed for the night. In the morning a bath may be taken. Such fumigations may be made every other day, or, in urgent cases, daily, until the gums begin to show signs of soreness.

Calomel is an ingredient of the pharmacopœial *compound cathartic pills* (see Colocynth), and *compound pills of antimony* (see Antimony).

Mercurous Iodide, Hg_2I_2. Mercurous iodide, the *subiodide* or *protoiodide* of the old chemistry, is officinal in the U. S. Pharmacopœia under the title *Hydrargyri Iodidum Viride*, Green Iodide of Mercury. The salt is formed through direct union of its elements, by the process of triturating mercury with an alcoholic solution of iodine. By subsequent evaporation of the alcohol the iodide is obtained in the solid state. Mercurous iodide is a "dull green to greenish-yellow powder, becoming more yellow by exposure to air, and darker by exposure to light, odorless and tasteless, almost insoluble in water, and wholly insoluble in alcohol or ether. When strongly heated, the salt is volatilized without residue" (U. S. Ph.). In the process of forming this compound some red iodide (mercuric iodide) forms along with the green, but is practically all removed by washing the product with alcohol. But if this same washing be imperfectly done, some red iodide will remain and will constitute a dangerous contamination. The pharmacopœial test for such contamination is this: "If 10 C.c. of alcohol are [*sic*] shaken with 1 Gm. of the salt and filtered, the filtrate should not produce more than a very faint, transient opalescence, when dropped into water; and when 5 C.c. of the filtrate are [*sic*] evaporated from a white porcelain surface, not more than a very faint red stain should remain behind (absence of more than traces of mercuric iodide)" (U. S. Ph.). Mercurous iodide is acted upon by air and light, and hence should be preserved in well-stopped phials kept darkened.

The action of mercurous iodide is closely similar to that of calomel, and in the doses of it possible in medicine, the iodine it contains is in too small proportion to exert any appreciable degree of its peculiar influence. Mercurous iodide is, therefore, like most of the iodides of the heavy metals, practically but a representative of the medicinal virtues of the metal. Mercurous iodide is used exclusively as a means of mercurializing by the mouth, and is a favorite preparation with many practitioners in the mercurial treatment of syphilis. The quantity of from 0.06 to 0.20 Gm. is to be given daily, in divided doses, with due watch kept on the gums. The medicine is most conveniently given in pill, and the important incompatibility must be remembered that potassic iodide decomposes this salt—metallic mercury, and the far more potent *mercuric* iodide, being the products.

Mercurous Tannate. Quite recently, under the title *Hydrargyri Tannicum Oxydulatum*, Sigmund Lustgarten has proposed for medicinal use the salt *mercurous tan-*

nate. Mercurous tannate forms upon adding to a solution of mercurous nitrate an excess of solution of sodic tannate. The salt so forming appears as a yellow precipitate which quicky turns green. Washed and dried, it then presents itself as a green powder, insoluble, tasteless, and odorless. Its important chemical peculiarity is that it is readily decomposed by weak alkalies—even such as are normally present in the intestinal contents—and in such decomposition yields metallic mercury in exquisitely fine subdivision, which metallic particles are then capable, in some way, of gaining speedy access to the general circulation. By reason of its properties, actual and potential, mercurous tannate thus seems to afford a mercurial which is, on the one hand, locally bland and of little proneness to salivate, while being, on the other, of first-rate antisyphilitic potency. Mercurous tannate is commonly given in pill, and the dose is stated as 0.10 Gm. (about a grain and a half) twice or thrice daily. The salt is incompatible with alkalies, however weak, and also *potassic iodide* should not be given in immediate conjunction.

Mercuric Compounds.—Mercuric Oxide, HgO. Mercuric oxide is obtainable in two ways, namely, by decomposing a nitrate of mercury by strong heat, or by precipitating a solution of mercuric chloride by solution of potassa. The several products of these two processes, though identical chemically, differ in their physical features, and are both officinal in the U. S. Pharmacopœia under distinctive names, as follows:

Hydrargyri Oxidum Rubrum, Red Oxide of Mercury, "Red Precipitate." This is the oxide made by the former of the processes described above. The preparation is nearly pure oxide, but with a trace of undecomposed nitrate still present. It appears as "heavy, orange-red, crystalline scales, or a crystalline powder, becoming more yellow the finer it is divided, permanent in the air, odorless and tasteless, insoluble in water or alcohol, but wholly soluble in nitric or hydrochloric acid. When strongly heated it turns darker, without emitting reddish fumes (absence of nitrate); at a higher temperature it is decomposed, giving off oxygen and separating metallic mercury, and is finally volatilized without residue" (U. S. Ph.)

Hydrargyri Oxidum Flavum, Yellow Oxide of Mercury. The oxide obtained by precipitation as described above. "A light, orange-yellow, heavy, impalpable powder, permanent in the air, and turning darker on exposure to light, odorless and tasteless, insoluble in water or alcohol, but wholly soluble in nitric or hydrochloric acid. When strongly heated it assumes a red color; at a higher temperature it is decomposed, giving off oxygen and separating metallic mercury, and is finally volatilized without leaving a residue" (U. S. Ph.).

Mercuric oxide, despite its insolubility, is, like all the mercuric compounds, decidedly irritant, enough so to produce dangerous irritant poisoning if swallowed in overdose. Yet, compared with the other mercuric compounds used in medicine, it is less harsh than the majority. Of the two forms of this oxide, the red is the more irritating because of the mechanical action of the sharp-edged crystalline grains of which it is composed.

Mercuric oxide is used exclusively as a local medicine, to obtain the specific mercurial irritant influence in affections of the skin or of exposed mucous membranes. It is most commonly employed in one or other of the two officinal ointments, *Unguentum Hydrargyri Oxidi Rubri,* Ointment of Red Oxide of Mercury, and *Unguentum Hydrargyri Oxidi Flavi,* Ointment of Yellow Oxide of Mercury. Both ointments are of similar composition —ten per cent. of the mercurial thoroughly incorporated with the pharmacopœial preparation called simply "ointment." The yellow oxide is also much used in the form of lotion, consisting of the compound suspended in water. This unofficinal lotion is commonly called *yellow wash,* and is obtained by prescribing to be mixed together 2.00 Gm. (thirty grains) of mercuric chloride and 500 Gm. (one pint) of lime-water. As in the case of the so-called *black wash* made from calomel, the mercurial chloride is decomposed by the lime and the oxide precipitated. Yellow wash is more irritant than black wash in the proportion in which mercuric exceeds mercurous oxide in intensity of action.

Mercuric Chloride, $HgCl_2$. Mercuric chloride, formerly known as *bichloride* or *perchloride* of mercury, is officinal in the U. S. Pharmacopœia under the title *Hydrargyri Chloridum Corrosivum,* Corrosive Chloride of Mercury, and is universally known by the familiar name *corrosive sublimate,* or simply, *sublimate.* The salt is made on the large scale by subliming a mixture of mercuric sulphate and sodic chloride, and is bought by the pharmacist from the manufacturer. Mercuric chloride occurs in "heavy, colorless, rhombic crystals or crystalline masses, permanent in the air, odorless, having an acrid and persistent, metallic taste, and an acid reaction. Soluble in 16 parts of water and 3 parts of alcohol at 15° C. (59° F.); in 2 parts of boiling water, in 1.2 part of boiling alcohol, and in 4 parts of ether. When heated to about 265° C. (509° F.) the salt fuses; at a higher temperature it sublimes unchanged, and without residue" (U. S. Ph.). The most important contamination of corrosive sublimate is by arsenic, the test for which is the following, quoted from the U. S. Pharmacopœia: "If 1 Gm. of the salt be dissolved in boiling water, then mixed with 5 C.c. of strong solution of soda (sp. gr. about 1.260) in a long test-tube, and about 0.5 Gm. of fine aluminium wire, cut into small pieces, be added (a loose plug of cotton being pushed a short distance down the tube), the generated gas should not impart any tint to paper wet with test-solution of nitrate of silver,* and kept over the mouth of the test-tube for half an hour (absence of arsenic)." Calomel may be another adulteration, easily detected by its non-solubility in water or alcohol; and all other likely contaminating substances will reveal themselves by non-volatility on subjecting the suspected sample of mercuric chloride to sublimation.

The reactions of corrosive sublimate that are important to the prescriber are as follows: The salt forms double salts with ammonic and with sodic chlorides, which double salts are of the same physiological potency as the simple sublimate, but, differing from the simple salt, dissolve very freely indeed in water. Practically, therefore, any desired concentration of aqueous solution of corrosive sublimate can be effected by simply adding sal-ammoniac or common salt to such aqueous mixture. Next, corrosive sublimate in aqueous solution *decomposes* by the following agencies: Simple keeping under exposure to light, whereupon calomel and hydrochloric acid separate out; or the addition to the solution of any of the following substances, viz., alkalies or their carbonates, the alkaline earths, soap, tartar emetic, silver nitrate, lead acetates, potassic or sodic sulphides, sulphydrates, soluble iodides, and many animal and vegetable substances. Mercuric chloride, thus, has a wide range of incompatibility.

In its action, mercuric chloride is, broadly, intensely inimical to life of all varieties and grades, and, largely probably because of this fact, is a powerful antiseptic. Tissues immersed in a sublimate solution become tough and shrunken, whitish in color, and proof against putrefaction. On the living human system the salt combines the properties of an active mercurial with those of a most intense irritant, and even caustic if in concentrated application. Yet, withal, there is no astringency, as is so commonly the case with soluble metallic salts. Taken internally in small, repeated dosage, corrosive sublimate is competent to produce general mercurialization, with, on the one hand, a minimum proneness to salivate, but, on the other, a maximum tendency to disorder the stomach; epigastric uneasiness and soreness, with loss of appetite or even nausea, very commonly being the annoying consequences of a course of the medicine. In comparatively small overdose, the salt is a dangerous poison, and is one of the things most commonly used for poisoning purposes. (For Toxicology, see next article.)

Medicinally, corrosive sublimate is used both externally and internally; and in the latter way both for local

* Five per cent. solution in distilled water.

effects upon the alimentary apparatus and for constitutional mercurializing. Externally, the mineral is most commonly used in solution, for the destruction of parasites, or for the specific influence of mercury, when a sharp impression is wanted upon skin eruptions, or again, as an antiseptic in the treatment of wounds. Sublimate lotions may be of a water or an alcohol basis, but should not exceed the strength of one-half of one per cent. of the mercurial in solution, lest undue irritation, or even, in extensive application, enough absorption to determine sharp constitutional poisoning, result. As an antiseptic, mercuric chloride is unrivalled in power, experimental research[1] showing that 1 part in 20,000 is the germicidal peer of 1 part in 833 of the next most potent agent. This potency makes the salt available for efficient antisepsis in the treatment of wounds, in solutions of non-irritant and non-poisonous strength. A solution of one-tenth per cent. is used for the wetting of sponges, compresses, and absorbent dressings, a strength of one-quarter per cent. for the gauze, and a strength of one per cent. for silk sutures or catgut. Internally, frequently repeated minute doses of corrosive sublimate, such as 0.001 Gm. (about $\frac{1}{64}$ of a grain) are often of happiest effect in bowel derangements with fermentation of the food. Such small doses are commonly given in simple aqueous solution. To mercurialize, the average dose is 0.004 Gm. (one-sixteenth of a grain) three times a day, in solution or in pill with crumb of bread—the pill-mass to be made up with particularly thorough trituration. Mercurialization thus induced is not very speedy, and, if rapidity of impression be a necessity, the present compound is a poor one to select, since, because of its poisonous nature and irritant property, it cannot be pushed in dosage. Even at best, indeed, gastric and intestinal derangement are apt to ensue in continued medication with corrosive sublimate—a derangement which a little associated opium may in part control, but which in some cases may, in spite of all measures of relief, require the drug to be abandoned. Corrosive sublimate has also been given by hypodermatic injection for treatment of syphilis, about 0.005 Gm. (one-twelfth of a grain) being injected every other day in aqueous solution. But since such injections, as might be supposed, cause severe pain, and at the same time do not yield any unique therapeutic potency, the practice has, very naturally, not gained favor as a common procedure.

Mercuric Iodide, HgI_2. Mercuric iodide—"biniodide," "periodide"—is officinal in the U. S. Pharmacopœia under the title *Hydrargyri Iodidum Rubrum*, Red Iodide of Mercury. The salt forms by double decomposition on mixing the several solutions of mercuric chloride and potassic iodide, and falls as a scarlet precipitate. Collected and dried, it appears as a "scarlet-red, crystalline powder, permanent in the air, odorless and tasteless, almost insoluble in water, soluble in 130 parts of alcohol at 15° C. (59° F.), and in 15 parts of boiling alcohol; also soluble in solution of iodide of potassium, or of mercuric chloride. When heated, the salt turns yellow, but reassumes its red color on cooling. On ignition it is wholly dissipated" (U. S. Ph.). Mercuric iodide may be contaminated by a little undecomposed mercuric chloride or potassic iodide, whose presence can be detected by washing the sample with water, filtering, and testing the filtrate with a five per cent. aqueous solution of silver nitrate. Any soluble iodide or chloride will then precipitate the silver. The most important reaction of mercuric iodide is that it forms double salts with the iodides of the alkalies, which salts dissolve freely in water, yielding colorless solutions. This reaction will take place in the officinal process for making mercuric iodide, if the potassic iodide be taken in excess, the scarlet precipitate that falls on adding the solution of mercuric chloride instantly redissolving on slight agitation, giving, in colorless solution, the potassium double salt. This same potassio-mercuric iodide, under the name of *iodohydrargyrate of potassium*, has been used in medicine, with the claim for it of remarkable powers, but its effects are substantially those of the simple mercuric iodide—just as a solution of the salt itself is substantially but a solution of mercuric iodide in excess of potassic iodide. The physiological properties of mercuric iodide are practically identical with those of the chloride—locally irritant even to corrosiveness, constitutionally mercurializing in the manner just detailed under mercuric chloride. The salt is not much used, yet some practitioners are partial to it for the purposes of a constitutional mercurial, the giving being in doses and with observances identical with those employed in the giving of mercuric chloride. The iodide may be given in pill, or in solution of potassic iodide. If wanted in the latter way, it may be obtained by prescribing an equivalent quantity of mercuric *chloride* to be added to a solution of *potassic iodide*. By reaction red iodide then forms and remains in solution as double salt, in the manner set forth above.

Mercuric iodide is an ingredient of the officinal preparation entitled *Liquor Arsenici et Hydrargyri Iodidi*, for whose discussion see under Arsenic.

Mercuric Cyanide, $Hg(CN)_2$. The salt is officinal in the U. S. Pharmacopœia under the title, *Hydrargyri Cyanidum*, Cyanide of Mercury. It occurs in "colorless or white, prismatic crystals, becoming dark-colored on exposure to light, odorless, having a bitter, metallic taste, and a neutral reaction. Soluble in 12.8 parts of water and in 15 parts of alcohol at 15° C. (59° F.); in 3 parts of boiling water and in 6 parts of boiling alcohol" (U. S. Ph.). The important chemical facts concerning mercuric cyanide are, that the salt is decomposed in aqueous solution by hydrochloric acid with evolution of hydrocyanic acid; but that, on the other hand, unlike so many mercurials, it is not precipitated by alkalies or organic matters. In action, this salt is highly irritant and intensely poisonous, uniting to the usual virulence of mercuric salts the poisonousness of the soluble cyanides. Its sole medicinal use has been to mercurialize, as in syphilis, by giving by the mouth, for which purpose mercuric cyanide has been a favorite with some practitioners, under the claim that it mercurializes in chronic affections after the non-salivating type of corrosive sublimate, but with less tendency to irritate stomach and bowels than in the case of the latter compound. But, with the majority of physicians, the extreme poisonousness of the cyanide has very naturally been a bar to its common employment. The dose is the same as with corrosive sublimate.

Mercuric Sulphide, HgS. This salt is the well-known substance *cinnabar*, which, in fine pulverization, constitutes the pigment *vermilion*. The sulphide is officinal in the U. S. Pharmacopœia under the title *Hydrargyri Sulphidum Rubrum*, Red Sulphide of Mercury, and appears as "brilliant, dark-red, crystalline masses, or a fine, bright, scarlet powder, permanent in the air, odorless and tasteless, insoluble in water, alcohol, nitric or hydrochloric acid, or in dilute solutions of the alkalies. . . . When heated the salt becomes brown and then black, but on cooling it reassumes its red color. At a higher temperature it takes fire, burns with a bluish flame, emitting the odor of burning sulphur, and is finally volatilized without residue" (U. S. Ph.). In this burning the products are sulphur dioxide ("sulphurous acid gas") and vapor of mercury. From its great and general insolubility, cinnabar is of no use as a mercurial in any of the ordinary methods of administration, but yet has been employed to mercurialize by the procedure of throwing about 2.00 Gm. (thirty grains) on hot coals and subjecting the patient's body to fumigation by the products of the combustion. But from the irritant nature of the sulphur dioxide evolved, fumigation by mercuric sulphide is very properly made to give place to fumigation by the subliming of calomel.

Basic Mercuric Sulphate, $Hg(HgO)_2SO_4$. This sulphate, commonly called *turpeth mineral*, is officinal in the U. S. Pharmacopœia under the title *Hydrargyri Subsulphas Flavus*, Yellow Subsulphate of Mercury. To make this salt, normal mercuric sulphate, formed by direct action of sulphuric acid upon mercury, is subjected to the action of boiling distilled water in abundance. By this means the salt is decomposed into an acid sulphate which dissolves in the water, and a basic salt which falls as an insoluble yellow precipitate. The

latter is then collected, washed, and dried. This basic sulphate is a "heavy, lemon-yellow powder, permanent in the air, odorless and almost tasteless, insoluble in water or alcohol, but soluble in nitric or hydrochloric acid" (U. S. Ph.). Probably because of its solubility in hydrochloric acid, this salt is promptly active when swallowed, with the feature that its irritation speedily excites reflex vomiting—a vomiting that pretty thoroughly evacuates the stomach, with but trifling nausea and depression. In such vomiting the mercurial is itself discharged, and no further effects ensue; but if for any reason vomiting does not come on, then irritant mercurial poisoning results, whose severity depends jointly on the quantity of the mineral swallowed and the degree of acidity of the gastric contents. Turpeth mineral is almost exclusively used as an emetic, and is particularly employed in the emetic treatment of croup, where the non-depressing character of the vomiting is held as a recommendation. But the poisonousness of the salt must be remembered. The average quantity required to vomit a child is from 0.12 to 0.20 Gm. (two or three grains). The medicine may be given in powder.

Mercuric Nitrate, $Hg(NO_3)_2$. Mercuric nitrate is used medicinally only in the two following pharmaceutical preparations:

Liquor Hydrargyri Nitratis, Solution of Nitrate of Mercury, "Acid Nitrate of Mercury." Mercuric oxide is dissolved in excess of dilute nitric acid, whence results a dense, clear, nearly colorless, strongly acid liquid, of specific gravity 2.100, and containing in solution "about fifty per cent. of mercuric nitrate with some free nitric acid" (U. S. Ph.). This liquid is highly corrosive, and is used solely as a searching caustic for surgical purposes. It is applied to the part in full strength, and should be used only when a rather spreading action is allowable or desirable.

Unguentum Hydrargyri Nitratis, Ointment of Nitrate of Mercury, Citrine Ointment. Lard-oil, heated, is dosed with nitric acid, whereby the olein of the oil is changed to elaidin. To this mixture, when nearly cold, is added a solution of mercuric nitrate obtained by dissolving metallic mercury in nitric acid. The product is a yellow ointment, decidedly irritant, and exerting powerfully the local specific medicinal powers of the mercuric compounds. Citrine ointment is thus available to destroy parasites, or to excite a healing action in indolent ulcers or eruptions. Unless a strong effect is needed, the ointment should be diluted with lard in equal parts.

Mercuric Oleate. Formula of normal oleate, $Hg(C_{18}H_{33}O_2)_2$. The only condition in which an oleate of mercury is officinal in the U. S. Pharmacopœia, is in the preparation entitled *Oleatum Hydrargyri*, Oleate of Mercury. The quantity of ten per cent. of dried yellow oxide of mercury is dissolved in hot oleic acid. The product, if oleic acid of standard quality have been used, is a transparent, yellowish, oily liquid; but if an impure commercial acid be the basis, the product is a soft semisolid. The preparation is liable to slow change with deposition of metallic mercury, but keeps better, the better the quality of the oleic acid used in the making. It represents ten per cent. of a mercuric oleate in solution in excess of oleic acid. The properties of this "oleate" are those of a moderately irritant mercuric salt, made highly diffusible by the peculiar attributes of oleic acid. Rubbed into the skin, the mercurial is absorbed as in the similar application of mercurial ointment, only now even more rapidly and thoroughly, and constitutional mercurialization is thus easily procurable. Lightly brushed upon a part, local mercurial effects are producible, and from the diffusibleness of the preparation, greater thoroughness of medication can be attained by its means than is possible with ordinary ointments or aqueous lotions. For destroying the vitality of the ova of lice, or of vegetable parasitic organisms, the present preparation is unsurpassed. The uses of oleate of mercury are such as may be deduced from the foregoing statement of the powers of the preparation. To produce constitutional mercurialization the oleate is used, in manner and dose, as described under mercurial ointment. For such application the oleate is superior to the latter preparation in speed, effectiveness, and cleanliness; but being more irritant, has the objection of causing soreness, or of even raising an eruption on tender skins at the site of inunction. To neutralize this tendency, so far as possible, a good plan is to order one per cent. of morphine—the pure alkaloid —to be dissolved by gentle heat in the oleate. For local effects the oleate of mercury is lightly applied to the part by a camel's-hair brush, and, if the skin be tender, the same device of charging with morphine may here also be resorted to.

Mercurammonic Chloride, NH_2HgCl. This salt, commonly known as *white precipitate*, is officinal in the U. S. Pharmacopœia under the title *Hydrargyrum Ammoniatum*, Ammoniated Mercury. The preparation is obtained by precipitating an aqueous solution of mercuric chloride by water of ammonia in slight excess. Collected and dried, the precipitate appears as "white pulverulent pieces, or a white powder, permanent in the air, odorless and tasteless, and insoluble in water or alcohol. At a temperature below a red heat, the salt is decomposed without fusion, and at a red heat it is wholly volatilized" (U. S. Ph.). Ammoniated mercury is irritant and poisonous. It is used only externally for the usual purposes of the irritant mercurials, and almost invariably in the form of the officinal *ointment of ammoniated mercury*, consisting of ten per cent. of the salt incorporated with benzoinated lard.

Besides the foregoing, various other preparations of mercury have been suggested or actually tried therapeutically, the aim generally being to find some form of mercurial that shall be practically available for *hypodermatic injection* in the treatment of *syphilis*. To this end the following compounds have been experimented with: A *formamide* of mercury has been proposed by Liebreich. This preparation is readily soluble in water, is neutral in reaction, does not coagulate albumin, and excites but little pain upon hypodermatic injection. It is presumed to undergo decomposition after absorption, yielding its mercury in simpler form, available for the usual therapeutic operation of the metal. In some hands the formamide has produced salivation. From ten to twenty drops of a one per cent. solution has been injected twice or thrice daily. The *albuminate* of mercury, dissolved in water by the agency of common salt, has been suggested by Bamberger.[2] This preparation may be made by the following formula: Dissolve one part of mercuric chloride in twenty parts of water; to this add forty parts of a mixture of egg-albumen and water in equal proportions; shake well, and add a solution of two parts of sodic chloride in sixty parts of water; shake, filter, and add water till the mixture weighs one hundred and thirty parts. One centigramme (about one-sixth of a grain) of albuminate of mercury is represented by 1.30 Gm. (about twenty minims) of solution, and the same may be regarded as a dose. This preparation is reported[3] to produce little or no pain upon hypodermatic injection, and, persistently used, to produce abatement of syphilitic manifestations with little derangement of the system.

III. General Therapeutics of Mercury Compounds.—As has appeared in the discussion of the several compounds of mercury, the therapeutic uses of the mineral are many and incongruous. Some of these are fulfilled by a single preparation only, but others, and the majority, are possible for several of the compounds. Concerning these latter some practical points present themselves for consideration.

Constitutional Mercurialization.—This procedure was in former practice resorted to, in a routine way, in all cases of acute inflammations, especially of serous membranes, generally also in the continued fevers, and, in mild grade, in the various cachexiæ. Nowadays, however, this medication has fallen into disuse, except in the treatment of the single disease syphilis. In this affection its avail is most important, as will be found discussed in the article on Syphilis. General mercurialization can be effected by giving mercurials by the *mouth*, by *inunction*, by *fumigation*, and by *hypodermatic injection*. In general,

concerning these methods, the points may be noted that administration by the *mouth* is most convenient, is reasonably prompt and efficient, except in cases of most urgent haste, but subjects the digestive organs to a maximum of derangement. The *inunction* method is rapid and potent, peculiarly applicable therefore to cases of urgency; saves the digestive organs, but is troublesome, dirty, and exposes the patient to detection of his malady. The *fumigation* process has all the features of the inunction method, with an extreme of troublesomeness. The *hypodermatic* procedure also is prompt, powerful, and saving to the digestive organs, but, with the preparation hitherto most used for the injection, corrosive sublimate, the method has the profound objection of being painful, and even risky of leading to abscess. Should any of the more newly proposed compounds of mercury for hypodermatic injection prove themselves, upon extended trial, reasonably bland, and at the same time efficient, the method will doubtless be much more used than at present is the case. To mercurialize by the *mouth*, if the object be a long-continued, gentle impression, mercury with chalk or blue mass, or small doses of the green iodide, are commonly selected from among the mild mercurials. For a less continuous action, but still one short of full therapeutic saturation, the *mercuric* compounds, chloride, iodide, or possibly cyanide, may be employed. Between the respective action of the two groups, the important points of difference are that the *mild* mercurials are most apt to salivate and provoke looseness of the bowels; and the *irritant* to unduly irritate the stomach. For the rapid production of the full limit of mercurialization by the mouth, the more potent of the mild mercurials —calomel, blue pill, or the green iodide—should be given in generous dosage. For just such purpose, however, is it that the other methods are theoretically to be preferred. For *inunction*, mercurial ointment and the oleate are the two available preparations, of which the latter is the more elegant and cleanly, but also the more irritating. For *fumigation*, calomel, the black oxide, and the red sulphide are possible, but the first named is decidedly to be preferred. For *hypodermatic injection*, corrosive sublimate has been the preparation most experimented with, and is to be condemned for the irritation its injection entails. By any method and for any purpose, modern practice enjoins that mercurialization must be limited in degree to the development of the mildest grade of stomatitis.

Digestive Disorders.—The correction of digestive disorders is one of the prominent applications of mercurials. The efficacy is one of wide range, and in it the antiseptic virtues of mercury probably play a part. The derangement in which the mineral has the oldest reputation is that whereof the main symptoms are constipation, with clay-colored stools, loss of appetite, with a bitter taste in the mouth, and perhaps even nausea, and a muddy or even distinctly jaundiced skin and conjunctiva. In such condition of things, as soon as a free passage from the bowels can be secured by a mercurial—calomel or blue pill, or, in the case of children, mercury with chalk—the various symptoms very commonly promptly subside. And even if there be not constipation, mercury, now not necessarily in purgative dose, will still more often than not work a cure. Next, entirely apart from the matter of clay-colored stools, many cases of vomiting from digestive disorders, and still more commonly diarrhœal or dysenteric symptoms apparently arising from the same cause, are more or less controllable by mercurials. The selection is commonly calomel or mercury with chalk for vomiting, and mercury with chalk or corrosive sublimate for bowel affections. In all cases the dose is small, as, for instance, 0.01 Gm. (one-sixth of a grain) of gray powder, or 0.001 (one-sixtieth of a grain) of corrosive sublimate, frequently repeated.

The Killing of Parasites.—A purgative dose of calomel is anthelmintic, but it is particularly for the destruction of external parasites that mercury is used, a purpose for which mercurials are pre-eminent. The forms selected are usually corrosive sublimate in solution, white precipitate ointment, citrine ointment, mercurial ointment, or the oleate. The last named is the preparation probably to be preferred, especially where the *ova* of lice are to be dealt with.

The Treatment of Skin Affections.—The surface disorders of syphilis are with great advantage treated by mercurials, locally applied, as an adjunct to constitutional treatment; but also non-syphilitic skin affections are often benefited by the same measures. Recognizing that the applications are irritant, the principle obtains to graduate the irritation of the application to the condition of irritability of the part—a raw surface, tender and painful, taking a mild application, and an unbroken skin or an indolent ulcer a comparatively harsh one. In the order of their intensity of action, beginning with the mildest, the preparations in common use as local applications are as follows: *Calomel*, applied as powder or in ointment; *black oxide*, in the form of black wash; *mercurial ointment; ointment of the yellow oxide; ointment of the red oxide; ointment of ammoniated mercury; oleate; ointment of the nitrate;* lotions of *corrosive sublimate.*

The other prominent therapeutic uses of mercurials are generally unique, and the points concerning them have already been sufficiently discussed in connection with the individual preparations. *Edward Curtis.*

[1] Sternberg: American Journal of the Medical Sciences, April, 1883.
[2] Zeissl: Centralblatt für Med. Wiss., June 9, 1883.
[3] Gourgues: Bull. Gén. de Thérapeutique, January 30, 1882.

MERCURY, POISONING BY. It is doubtful if mercury is directly poisonous when taken into the stomach in the ordinary liquid form. A number of cases are reported in which it has been administered in doses of one to eight ounces (31.1 to 248 Gm.), sometimes repeated for several successive days, without producing any injurious effects. In rare instances its administration has been followed by salivation or other constitutional effects, as a result, probably, of the conversion of a portion of the metal into a soluble compound within the alimentary canal. When administered in the finely-divided form, as in blue pills or gray powder (mercury with chalk), it may be absorbed with considerable rapidity. Even medicinal doses of these preparations have been known to give rise to disagreeable symptoms. When inhaled in the form of vapor, the metal has frequently given rise to more or less severe constitutional effects. Mercury boils and is converted to vapor at about 350° C.; but it is slowly volatile even at the ordinary temperature of the air. The effects of inhaling the vapor have been observed, especially among those engaged in mining and smelting the ores of mercury, and among those engaged in employments in which the metal is used—as gilders, manufacturers of mirrors, thermometers, barometers, percussion-caps, etc. Two severe cases of acute poisoning, the result of inhaling the vapors of mercury, are recorded (Leiblinger, Ferrand). One of these was fatal in ten days. Fürbringer's experiments show that absorption takes place when the metal, finely divided by trituration with gum and glycerine, is injected subcutaneously. The ready absorption of mercury, when in a state of minute subdivision, may be attributed to the increased susceptibility of the metal in this form to oxidation or to the solvent action of the fluids of the body.

All the compounds of mercury are more or less poisonous. One of the most active of these, and the most important from a medico-legal point of view, is corrosive sublimate (mercuric chloride). Most of the reported cases of acute poisoning by this salt have been suicidal. Cases of accidental and criminal poisoning are rare, since the acrid metallic taste of the salt directs immediate attention to its presence.

Acute Poisoning.—*Symptoms.*—The most common source of acute poisoning is corrosive sublimate, which may, therefore, be considered as the type of mercury compounds. This salt is a violent irritant, and, in the concentrated form, corrosive. When a poisonous dose has been taken the symptoms appear immediately, or, at the latest, within a few minutes. A disagreeable acrid and metallic taste is perceived in the act of swallowing. If the solution is concentrated, there is often an involun-

tary contraction of the muscles of the throat, which may prevent the whole of the poison from being swallowed. There are burning pains in the mouth, throat, œsophagus, and stomach, soon followed by violent vomiting. The vomited matters consist at first of mucus, but later usually contain blood, and sometimes shreds of mucous membrane. Severe abdominal pains and profuse purging soon follow. The discharges are at first serous in character, later mucous, and frequently contain an abundant admixture of blood and shreds of intestinal mucous membrane. They are usually attended with painful tenesmus. The lips, tongue, and the mucous membrane of the mouth and throat are white, corroded, and swollen, owing to the caustic action of the poison. As a result, swallowing may be difficult or even impossible, and respiration impeded. In severe cases collapse soon occurs; the pulse is small and frequent, the countenance pale and anxious, the skin cold and clammy, and the respirations diminished in frequency. The urine is usually very much diminished in quantity, and may be entirely suppressed for three or four days. It frequently contains albumen, and sometimes blood. Death may be preceded by syncope, coma, or convulsions. If the patient survives two or three days, some of the constitutional effects of mercury may be manifested—as salivation, stomatitis, fetid breath, swelling and inflammation of the salivary glands. One-half to three-fourths of the cases terminate fatally. In those cases of severe poisoning which terminate favorably, convalescence is usually very slow. The patient sometimes suffers from some of the constitutional effects of the poison for a long time after recovery from the acute symptoms.

When a small overdose of corrosive sublimate has been taken, the symptoms do not differ materially from those which follow small overdoses of other metallic irritants. But if the dose is a large one, the symptoms are, as a rule, much more severe than in poisoning by other metallic irritants. In poisoning by corrosive sublimate the symptoms appear much earlier, the taste of the poison is more pronounced, the sensation of burning and pain in the throat, œsophagus, and stomach is more severe; blood in the vomited matters and stools is more constant and abundant; finally, in poisoning by most of the other metallic irritants the lesions of the mouth and throat are wanting.

Other compounds of mercury, such as calomel, white and red precipitates, turpeth mineral, the cyanide, the sulphocyanide, and the pernitrate have occasionally given rise to severe or fatal cases of acute poisoning; usually accidental or suicidal. The symptoms produced by the pernitrate of mercury are similar to those of poisoning by corrosive sublimate. It is much more corrosive than corrosive sublimate, and consequently more rapid in its action. The other compounds mentioned, with the exception of calomel, are more or less severe irritants. They do not produce any corrosive effects in the mouth and throat; but in other respects they resemble corrosive sublimate in their action. Calomel has probably caused more fatal cases of poisoning than any of the compounds of mercury, with the exception of corrosive sublimate. Occasionally its administration has been followed by symptoms of irritant poisoning. But clinical experience shows conclusively that it does not in itself possess any irritant properties. Its effects are more frequently manifested by constitutional symptoms. Its mode of action is, therefore, best discussed in connection with this form of mercurial poisoning.

Effects of External Application.—Corrosive sublimate is readily absorbed, even through the unbroken skin. A number of cases are recorded in which its external application has been followed by fatal results. The symptoms in such cases have usually made their appearance in from four to eight hours, sometimes earlier; and do not differ materially from those observed in cases of poisoning by the internal administration of corrosive sublimate. The salt has in addition a local irritant effect on the skin, manifested in mild cases by simple redness of the parts; in severe cases by vesication or even ulceration. The effects, both local and constitutional, are more severe when the poison is applied in the form of ointment or alcoholic solution than when applied in the form of an aqueous solution. A case is reported in which the external application of the acid nitrate of mercury was followed by the usual symptoms of acute poisoning, and death on the ninth day. Analysis of the liver showed the presence of mercury (reported by Dr. Vidal, 1864). The constitutional effects of mercury may be produced by the external application of the metal itself in the finely divided form, as in mercurial ointment. Leiblinger relates three fatal cases, the result of rubbing the body with an ointment containing metallic mercury, for the cure of itch. Analysis of the organs of the bodies showed the presence of mercury. The metal in such cases is doubtless oxidized, and converted to a soluble compound before it enters the blood-vessels.

Fatal Period.—This is variable. The most rapidly fatal case yet reported is one recorded by Taylor, in which death took place in less than half an hour. A few cases have proved fatal in from three to twelve hours. But usually life is protracted for from one to five days. Falck states that, of 36 cases of poisoning by corrosive sublimate in which the fatal period was given, 11 died on the first and second days; 11 on the fourth and fifth days; the remaining 14 in a period varying from six to twenty-six days. Two cases of poisoning by the pernitrate are reported, in which death took place in about two and one-quarter hours.

Fatal Quantity.—The minimum fatal dose of corrosive sublimate cannot be stated with accuracy. Taylor speaks of a case in which 0.195 Gm. (3 grains) proved fatal to a child; and another, in which there was reason to believe that 0.13 Gm. (2 grains), or not more than 0.195 Gm. was fatal to an adult. Quantities ranging from 0.32 to 0.65 Gm. (5 to 10 grains) have caused death in a number of cases. Severe symptoms have been observed to follow the administration of 0.022 Gm. (one-third of a grain) in an adult. On the other hand, recovery has taken place after doses varying from 1.94 to 31.1 Gm. (30 grains to 1 ounce). In most of these cases there was early vomiting. Cases of poisoning have not been sufficiently numerous to warrant any statement as to the fatal dose of any of the other compounds of mercury.

Appearances.—In cases of poisoning by the corrosive preparations of mercury, lesions in the mouth, throat, and œsophagus are seldom wanting. The mucous membrane of the mouth has a white or slate-gray color, and may be so soft as to be easily removed; or it may be reddened and injected, or partially corroded. Similar appearances are usually found in the throat and œsophagus. The tongue is frequently swollen, and its papillæ very prominent. The mucous membrane of the stomach is reddened and injected. There is frequently an effusion of blood beneath the membrane, which is soft and easily removed. There may be ulceration or gangrene. Perforation is rare. Similar appearances may be found in the intestines, especially in the cæcum and at the sigmoid flexure. In some cases the mucous membrane of the stomach has a slate-gray tint, which has been attributed to the presence of finely-divided mercury; or, if decomposition has set in, to the sulphide of mercury. Sometimes there are evidences of irritation in the larynx, trachea, and bronchi; and the lungs have been found congested. The bladder is usually empty and strongly contracted. The compounds of mercury have an irritant action on the kidneys, causing hyperæmia, or in some cases acute nephritis; and after death, changes characteristic of one or another of these conditions will usually be found. No constant changes are found in the other organs. The appearances in the stomach, intestines, and kidneys are the same whether the poison has been taken internally or applied externally.

Treatment.—Vomiting should be encouraged, if necessary, by the use of emetics. Albumen in the form of white of egg mixed with water is the most efficient antidote, converting the soluble mercury salt into the albuminate of mercury, which is comparatively insoluble. It should be administered in large quantity, and should be followed by an emetic. In the absence of eggs, milk,

wheat flour, or gluten, may be of service. The after-treatment depends upon the symptoms.

Chronic Poisoning.—This form of poisoning, called also constitutional mercurial poisoning, is usually the result of the frequently repeated introduction into the system of small doses of mercurial preparations administered medicinally; or of long-continued exposure to the vapors of metallic mercury. Vapors of the compounds of mercury may also give rise to severe constitutional effects if inhaled.

Calomel is one of the most insoluble of the preparations of mercury which are used medicinally; yet a number of cases are recorded in which severe constitutional symptoms, and even death, have resulted from comparatively small doses. Opinions differ as to the way by which it enters the system. A theory which has been quite generally accepted, is one which assumes that the calomel is first converted to corrosive sublimate by the hydrochloric acid or chlorides of the gastric juice. Mialhe, however, was never able to obtain more than one-sixteenth of a grain of corrosive sublimate by the action of the gastric juice upon calomel; and Jolly found that when one gram of calomel was digested for six hours, at a temperature of 40° C., in one hundred grams of water to which 0.2 Gm. hydrochloric acid had been added, only 0.003 Gm. corrosive sublimate was formed. In a similar mixture containing 0.5 Gm. sodium chloride in the place of hydrochloric acid, only 0.001 Gm. corrosive sublimate was formed. Bucheim, Oetingen, Winkler, and Jeannel state that the conversion of calomel into corrosive sublimate does not take plaee at all under the influence of the gastric juice at the temperature of the body.

Cases have been observed presenting all the characteristics of poisoning by corrosive sublimate, after the use of powders composed of calomel and sugar, which had been prepared for some time. It has been suggested, therefore, that corrosive sublimate may be formed from calomel by the action of sugar, or some substance contained in sugar as an impurity. Slop, Langbeck, and Jolly have found that in powders made of pure sugar no such change takes place; but that in mixtures of calomel and raw sugar corrosive sublimate is formed. They attribute the formation of corrosive sublimate to impurities, especially alkalies, in the sugar; and Jolly found, in his experiments, that an appreciable amount of corrosive sublimate was formed under the influence of alkaline hydrates or carbonates.

Jeannel's experiments show that calomel is decomposed by alkaline carbonates with the formation of oxide. If a fatty oil is mixed with the alkaline solution, a considerable portion of the mercury compound is dissolved. He suggests, therefore, that the calomel is decomposed by the alkaline secretions in the intestines, and dissolved by the fatty matters present. The symptoms which are observed in cases of poisoning by calomel are not always the same. In some cases they resemble those produced by corrosive sublimate; in others the constitutional effects are more prominent. It is probable, therefore, that its solution and absorption is not always effected in the same way. That it is converted to some more soluble form before it is absorbed can hardly be questioned. If, for any reason, this conversion and absorption take place very rapidly, symptoms of poisoning may result. In a certain number of cases, however, these effects of the drug are due to idiosyncrasy. They may also be explained in certain cases by the existence of some disease, such as Bright's disease, which interferes with the elimination of the mercury.

Symptoms.—The first symptoms of the action of mercurial preparations, when they are administered so as to produce the constitutional effects, consist of a disagreeable metallic taste, slight fetor of the breath, soreness of the teeth when they are brought forcibly together, and redness of the mucous membrane of the mouth. The gums beeome swollen and spongy, and bleed easily; and there is an increase in the secretion of saliva. If the use of the drug is persisted in, the symptoms in the mouth all increase in severity. The inflammation may extend to the throat and pharynx; the pain is frequently so severe as to interfere with swallowing; the tongue is swollen; the teeth gradually become loosened and fall out; and the saliva is very much increased in quantity, sometimes amounting to several kilograms per day. In some cases salivation is the most prominent symptom, and may even be the cause of death. It may in rare cases be intermittent. Although salivation is one of the prominent symptoms of slow poisoning by mercury, still it is not always present. When present it cannot be accepted as proof of mercurial poisoning, since it may come on spontaneously, or it may follow the administration of other substances besides mercurial preparations. The saliva is one of the important channels for the elimination of mercury. In doubtful cases, therefore, it should always be examined chemically.

The action of mercury may be still further manifested, in severe cases, by more or less extensive ulceration of the mucous membrane of the mouth and of the salivary glands, and, in exceptional cases, by gangrene, and necrosis of the jaw-bone, accompanied usually by hæmorrhages. In addition to the symptoms in the mouth, there may be nausea, vomiting, loss of appetite, abdominal pains, diarrhœa alternating with constipation, and various disturbances of nutrition.

One of the most important symptoms of chronic poisoning is mercurial palsy (tremors). It is rarely, if ever, seen as a result of poisoning from the medicinal use of the compounds of mercury, but occurs almost exclusively as a result of inhaling the vapors of the metal. It is not, as a rule, preceded by severe salivation or stomatitis. It usually appears first after an exposure of months, or even years, and is frequently preceded by a certain amount of gastro-intestinal irritation, anæmia, and possibly slight salivation or stomatitis. The tremors attack first the upper extremities, soon extending to the lower extremities. Finally, all the voluntary muscles may become more or less affected. The tremors increase till they become convulsive in their character. The patient has no control over his muscles, and is completely helpless. In severe cases there may be paralysis of the affected limbs. In certain cases neuralgic pains are frequent. If the exposure continues the patient falls into a state of cachexia characterized by gradual emaciation, the result of disturbances of nutrition. Such cases may end fatally in spite of treatment.

Treatment.—Prophylactic measures are of first importance in the case of workmen exposed to the influence of the vapors of mercury. The workshop should be well ventilated. Cleanliness on the part of the workmen should be enforced. Meyer recommends, as a prophylactic, the sprinkling of the floor of the workshop with ammonia every evening, after the day's work is done. If symptoms of poisoning have appeared, the further introduction of the poison into the system should be prevented, if possible. Symptoms should be treated as they arise, and measures should be taken for promoting the elimination of the poison. Stomatitis is best treated by frequent washing with cold water, and the use of potassium chlorate. The tremors usually yield to electricity, provided the exposure is not continued. They sometimes persist for years, however, in spite of treatment. The elimination of the poison may be promoted by diuretics and mild purgatives. Iodide of potassium may also be employed for this purpose with benefit.

Absorption and Elimination.—Mercury may be detected after death in all the organs of the body. Bergeret and Mayençon found the largest amount in the liver and kidneys, in animals poisoned by corrosive sublimate. Riederer also found that in animals, after taking calomel, the largest amount was contained in the liver (0.0066 per cent. of the fresh tissue).

Elimination takes place through all the secretions. Mercury has been found in the saliva, perspiration, milk, urine, bile, fæces, the seminal fluid, in pus, etc. Byasson found the metal in the urine within two hours after the administration of the poison, and in the saliva within four hours. After the administration of a single dose elimination is completed very quickly; in twenty-four

hours, according to Byasson ; in four days or less, according to Bergeret and Mayençon. If, however, the drug is administered frequently, elimination continues longer, but ceases before all is discharged. The urine, fæces, and saliva appear to be the most important channels of elimination.

Elimination is not completed for a long time after the cessation of a mercurial treatment. Oberländer states that elimination with the urine may be detected for as long as one hundred and ninety days ; and that its course is irregular and marked by remissions, or even by temporary pauses, of variable duration. According to Schuster, mercury is found regularly in the fæces, in relatively large quantities, during treatment by inunction. He could detect it as late as five and a half months after the inunctions were discontinued. It was found in the fæces in all cases in which it was found in the urine. On the other hand, it was frequently not present in the urine when it was found in the fæces. He infers, therefore, that elimination by the fæces is regular and continuous. Mercury has been detected in the liver when none had been taken for a year before death. *William B. Hills.*

MESENCHYMA is a term introduced by the brothers Hertwig to designate the non-epithelial portions of the mesoderm. See Fœtus and Germ-layers.

MESENTERY. The *mesentery* is a serous membrane, which may be regarded as a fold or extension of the peritoneum. The membrane is double, and between its two layers lie numerous blood-vessels, lymphatic vessels and

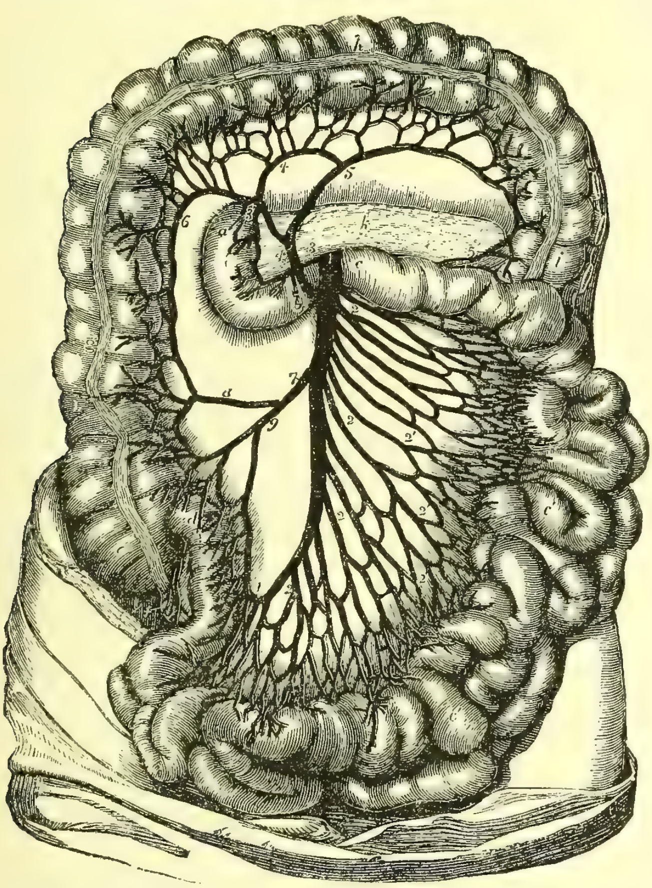

FIG. 2208.—Superior Mesenteric Artery and its Branches. (Tiedemann.) 2', 2', loops in mesentery ; *a*, *b*, duodenum : *c*, jejunum ; *c'*, *c'*, jejunum and ileum ; *k*, pancreas ; *l*, trunk of super. mesen. art.

glands, and occasional collections of adipose tissue. In addition to supporting these structures, the function of the mesentery is to afford attachment for the small intestine.

The *mesentery* is attached posteriorly over the spinal

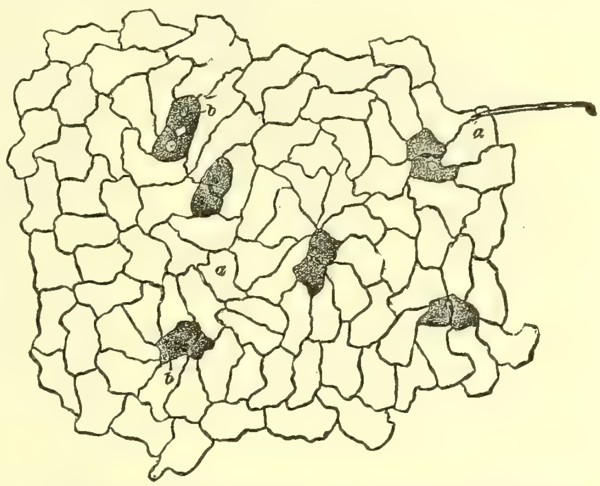

FIG. 2209.—Mesentery of Frog. (Klein.) *a*, Surface endothelium; *b*, cells surrounding a true stoma.

column by the *radix mesenterii.* It extends transversely from the level of the left side of the second lumbar vertebra to the right sacro-iliac articulation. From this root it spreads out very broadly, to be attached along the entire length of the jejunum and ileum. It occupies principally the umbilical region of the abdomen. At its widest part the transverse diameter measures 10 to 15 ctm. between the vertebral and intestinal borders.

The *superior mesenteric artery* is given off from the anterior surface of the aorta, just below the cœliac axis. It descends behind the pancreas, and appearing from beneath it, passes between the two layers of the mesentery and divides into twelve or more branches, the *rami intestini tenuis,* which run parallel to each other for some distance, and then each branch bifurcates and inosculates with its neighbor, forming in this manner a series of large loops. These loops again branch and form series of smaller and smaller arches, to the number of four or five. The branches from the smallest arches spread out and embrace the intestine. This artery supplies the whole of the small intestine beyond the duodenum, and half of the large intestine where its branches anastomose with some of the branches of the inferior mesenteric artery.

The *mesenteric veins,* in general, follow the corresponding branches of the superior mesenteric artery. They finally unite into one large trunk, the superior mesenteric vein, which passes in front of the duodenum, goes in behind the pancreas, and joins the splenic vein to form the vena porta. The blood from the small intestine (and also from the ascending and transverse portion of the colon), thus passes directly to the liver. This venous blood differs from venous blood elsewhere in that it is more watery, is of lower specific gravity, contains more albumen, fewer red corpuscles, and its clot is less firm. During intestinal digestion it contains those ingredients of the chyle which are not appropriated by the lymphatics—principally peptones and hydrocarbons.

The *superior mesenteric nerve plexus* is derived from the solar plexus. Its nerves are white and firm. The plexus surrounds the superior mesenteric artery, and receives a prolongation from the junction of the pneumogastric nerve with the cœliac plexus. Severe blows over the umbilical region have been known to cause death in man, from the inhibitory

action of the vagus upon the heart, intensified by stimulation from the mesenteric plexus. Ganglionic masses,

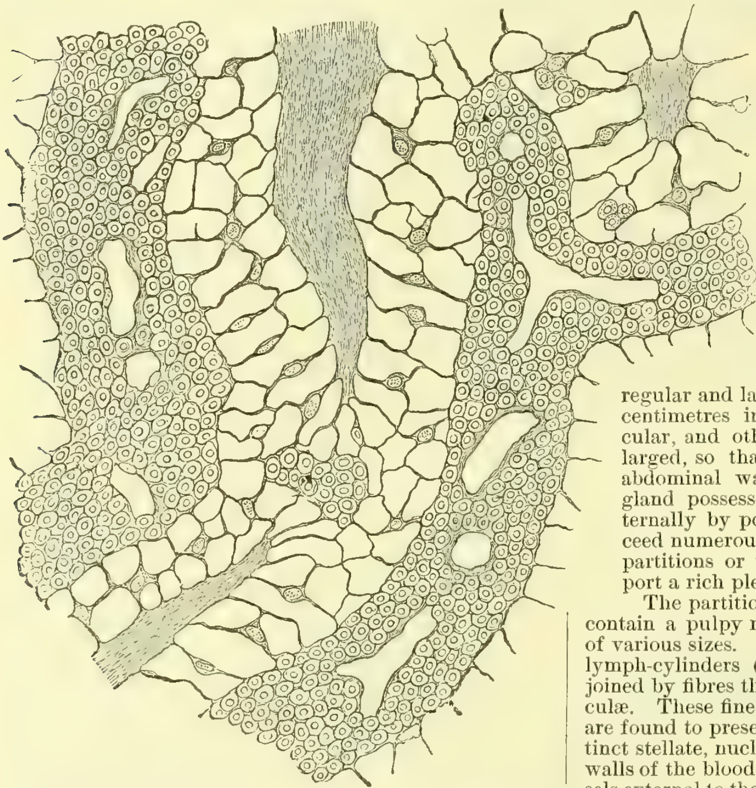

FIG. 2210.—Mesenteric Gland of Ox; Medullary Substance. (Klein.) Showing lymphatic cylinders containing blood-vessels, surrounded by closely-packed lymph-corpuscles; the finely fibrous trabeculæ, and cells between them. The blank spaces between trabeculæ and cylinders represent the system of lymph-sinuses whose corpuscles have been shaken out.

gangliones meseraicæ, occur in connection with the larger nerves of the plexus. The nerves accompany the arteries, and, as a rule, follow their method of division, though they are less regular. When near the intestine they leave the arteries and lie in the spaces between them. Their termination in the intestine has been described (see article Intestine, Anatomy of). Pacinian corpuscles have been found distributed in the mesentery in man, in connection with the nerve-terminations.

The *epithelium* covering the mesentery is squamous, large, often tessellated, often wavy in outline. The cells have large, distinct nuclei with nucleoli. Between the cells are occasional minute openings or stomata communicating below with lymph-sinuses. Pseudo-stomata are also described (Klein), which are apparently stomata filled by large branching cells, one process of which pushes up between the epithelial cells. The epithelial cells surrounding the stomata and pseudo-stomata are smaller and more granular than they appear in the intervals between.

The *lymphatics*, after leaving the intestinal wall, divide into abundant plexuses between the folds of mesentery, and they communicate with large sinuses and with the mesenteric glands. After traversing the latter, they unite into larger and larger trunks, which are finally reduced in number to two or three, rarely six. Such a large lymphatic vessel is called a *truncus intestinalis*. The vessels pass from the root of the mesentery into the thoracic duct. It is a mooted point whether the lymphatic sinuses possess a rhythmical, contractile, and suction force of their own, or whether they are filled by the movements of intestinal peristalsis, or simply by force of osmosis. The complicated plexiform arrangement of lymphatic vessels retards the lymph flow and gives more time for its elaboration, which, it is supposed, takes place to some extent in the lymphatic glands of the mesentery (Fig. 2210).

The *mesenteric glands* resemble lymph-glands elsewhere, but their medullary structure is proportionally greatly developed. They number between one hundred and two hundred for the small intestine. They are not found nearer to the intestine than three to five centimetres.

Near the intestine they are arranged in three rows and are small. Near the root of the mesentery they are irregular and large. In health they seldom exceed two centimetres in diameter, but in scrofulous, tubercular, and other affections they readily become enlarged, so that they may even be felt through the abdominal wall in a thin subject. A mesenteric gland possesses a membranous capsule, covered externally by polygonal cells. From the capsule proceed numerous bundles of fine parallel fibres forming partitions or trabeculæ within the gland, which support a rich plexus of capillary loops (Fig. 2211).

The partitions divide the gland into alveoli which contain a pulpy matter composed chiefly of lymph-cells of various sizes. Between the trabeculæ are found large lymph-cylinders (with endothelial lining), which are joined by fibres that appear to be offsets from the trabeculæ. These fine fibres interlace, and at their nodes they are found to present swellings containing nuclei, or distinct stellate, nucleated cells. Similar fibres also join the walls of the blood-vessels of the gland, and along the vessels external to the gland are occasional nodular swellings formed of close aggregations of lymph-cells.

Functions of the mesentery.—The blood-vessels of the mesentery are capable of accommodating a large quantity

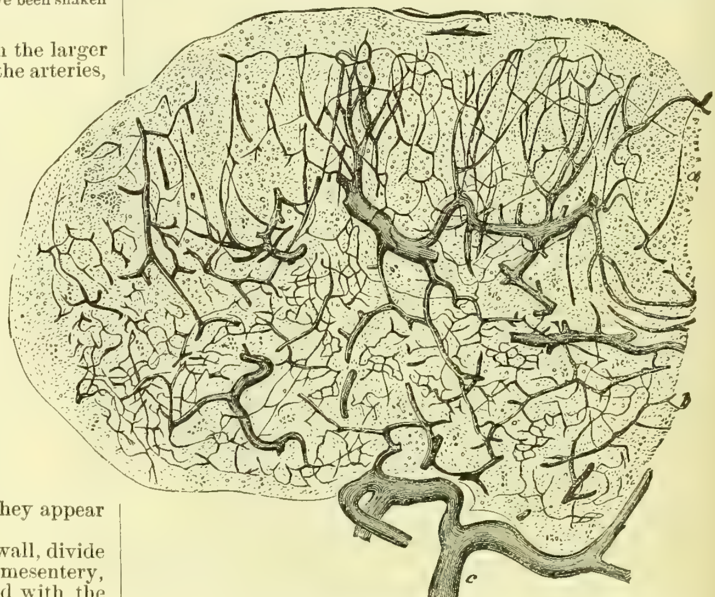

FIG. 2211.—Vertical Section of Injected Mesenteric Gland of Guinea-pig, showing Blood-vessels. (Klein.) *a*, Cortical layer; *b*, medullary layer; *c*, large vessels of hilus.

of blood during digestion. This is very necessary, as the absorption of chyle greatly increases the volume of blood with which it is mingled. The portion of the chyle ab-

sorbed by the lacteals (see article Intestine, Functions of), may undergo some chemical changes in the lymph-sinuses and glands. It is possible that white corpuscles are formed to some extent in the mesenteric glands.

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William Gilman Thompson.

MESODERM is the middle layer of the body of the embryo (see Fœtus and Germ-layers). Mesoblast is also used as a synonymous term; sometimes, however, the term mesoblasts is applied to the large cells in the segmenting ova of certain lower animals, from which the mesoderm proper is produced. A few writers have sought to alter the application of the term mesoderm, but it is almost universally used as above described, and to use it otherwise would now cause unnecessary confusion. *C. S. Minot.*

MESOTHELIUM is a term introduced by Minot to designate the epithelial portions of the mesoderm, which line the body cavity, *cf. Cœlom*, including the myotomes (*protovertebræ, auct.*).

METACHLORAL. This body is polymeric with chloral (not chloral hydrate), having the formula $C_6H_3Cl_9O_3$. It is formed from chloral by the action of concentrated sulphuric acid, and is a solid body distinguishable from chloral hydrate by being insoluble in water. It appears to have an influence over animal physiology akin to that of chloral hydrate, but it is not an officinal medicine.

Edward Curtis.

METALLOSCOPY AND METALLOTHERAPY. Metalloscopy (μέταλλον used here in the sense of the Latin metallum, a metal, and σκοπεῖν, to examine) is the art of determining by external application what metals or metallic substances act most easily and favorably upon a given person. It is intimately connected with metallotherapy in the narrower sense (μέταλλον and θεραπεία, medical treatment), which, although it is sometimes still used in its broad and literal signification to denote simply treatment by means of metals or metallic substances, has gradually acquired a more special meaning, and denotes the special system and methods practised by Dr. Burq and his followers in the treatment of patients by means of the external and internal application of metals, known respectively as external and internal metallotherapy. It is in this more restricted sense—in the sense of Burq's metallotherapy—that we shall consider the subject here.

HISTORY.—The use of metals and metallic substances in the treatment and cure of disease has been practised from the earliest times, but the special system, now commonly known under the name of metallotherapy, is modern. In 1848, Dr. Burq, then an interne of the hospitals in Paris, for the first time applied brass, in the form of a plate and of belts or rings, directly to the surface of the body (trunk, limbs, and head) of a patient with chronic hysterical paralysis, for the purpose of treatment. The experiment, made at the Hôpital Cochin, proved so successful that he was induced to pursue the subject, and in 1848–49 he tried the effects of the direct application of metals to the external surface of the body (external metallotherapy) in the cases of six hystero-epileptic females in the service of M. Charcot at the Salpêtrière. After this he continued his researches in various hospitals in Paris for a time, and in 1851 went to England, where he became more or less intimate with Dr. Elliotson, the champion of animal magnetism. The first notice of Dr. Burq's discoveries was a communication made by him to the Académie des Sciences, in February, 1850, which was followed a year later by his thesis on anæsthesia and amyosthenia, "considérées au point de vue des Symptômes, du Diagnostic, des Causes, et du Traitement des Maladies Nerveuses en général et de l'Hystérie en particulier." After his trip to London Dr. Burq seems to have turned his attention more toward other classes of patients than the hysterical, and this possibly, together perhaps with his intimacy with Dr. Elliotson, then the object of much distrust professionally, caused his views to be neglected for a time, and set aside as unworthy of serious notice.

Thus it was not until 1876 that a committee, consisting of MM. Charcot, Luys, and Dumontpallier, was appointed by the Société de Biologie to investigate the reality of the phenomena claimed to exist by Dr. Burq, as a result of the external application of metals in cases of hemianæsthesia, and the value of external and internal metallotherapy in the treatment of such cases. The first report of this committee was made in 1877, and was strongly in favor of the existence of the phenomena claimed. This brought the subject directly to the notice of the profession, and the conclusions of the committee were tested and confirmed by so many able and independent observers that the reality of such phenomena can no longer be considered a subject of doubt. Westphal and Eulenburg, in Germany, Sidney Coupland, Althaus, Hughes Bennett, and many others, in England, all obtained essentially the same results. Sidney Coupland, writing in 1877, says: "Whatever the interpretation of these facts, they cannot be dismissed as chimerical because those experimented on are the subjects of hysteria; for the surprising result was obtained by that commission, of the application of the metals being effectual in restoring sensibility to cases of anæsthesia dependent on organic lesion."

The second report of the committee, made in 1878, dealt with the question of internal metallotherapy, and was likewise favorable. In the abstract of this report, given in the *Union Médicale*, it says: "It is, then, allowable to conclude, after several months of investigation ("expériences"), that during the administration of the metals indicated, by external application, the health had been notably improved, and that the general and special sensibility and the muscular force had been recovered."

METALLOSCOPY AND EXTERNAL METALLOTHERAPY.—These two subjects are so closely connected that, for the sake of convenience, they can best be considered together. In the very beginning of his experiments Burq discovered that the application of certain metals to the external surface of the body, in the case of certain patients suffering from hysterical paralysis and hystero-epilepsy, not only relieved the general symptoms, but in cases of hemianæsthesia, when applied to the anæsthetic part, acted locally, causing a return of sensibility; at first, perhaps, only directly under or in the immediate neighborhood of the metal, but gradually extending from it, as from a centre, until, in many cases, sensibility was restored over the whole side. He was thus led to pay special attention to this symptom, the return of sensibility, especially as it was found that the muscular vigor and the temperature of the limb increased *pari passu* with it. He, moreover, shortly discovered (1850) that different patients were affected in this way by different metals.

The art of determining what metal was suited to the special patient under treatment was termed *metalloscopy*. To ascertain this, plates of metal are placed upon the skin of the anæsthetic region. If, after the lapse of a moderate time, twenty minutes or half an hour—sometimes, but rarely, a longer time is needed—no effect be produced, the metal may be considered inactive, or "neutral," as regards this patient. In such case these plates must be removed and some other metal tried, until the active or "positive" one be found. Plates of different metals should not be placed upon the skin at the same time, because a neutral metal may neutralize or render latent the effect of a positive metal. For this reason two or three days should intervene between the application of plates of the different metals.

The return of sensibility is ushered in by a sensation of heat, usually felt first underneath the metal; then a sensation of weight follows, and finally the anæsthesia and paresis disappear, and the blood-vessels of the limb become again normally dilated.

The most common metals to produce these results are, according to Burq, given in the order of frequency with

which they act: Iron or steel, copper, zinc, brass and bronze, tin, gold, silver, nickel, and finally platinum. Various standards of gold and silver should be applied.

In regard to *metallotherapy*, Burq propounded the two following propositions: First, "that in certain states of the nervous system plates of metal placed upon the skin have the power of altering general and special sensation and cutaneous vascular supply, and that the susceptibility of individuals to the metals generally used varies, a patient sensitive to one metal being insensitive to another;" second, "the external metallic aptitude being known, the same metal administered internally should determine the same results as its external application." These positions were practically indorsed by the committee of the Société de Biologie.

In considering the facts in these cases, it must be remembered that, first, they are only *proved* to apply to cases of hemianæsthesia. As a rule, they occur, moreover, only in cases of hysterical hemianæsthesia. In hemianæsthesia from organic disease, and in that of toxic origin, they do also sometimes occur, but with certain differences, to be mentioned later. Burq claimed the value of external metallotherapy in many other diseases, and more especially that of copper in cholera; but these claims have not yet been substantiated. Second, in spite of the undeniable existence of the facts to be enumerated, the comparative value of metallotherapy as a means of *cure* in cases of hysterical hemianæsthesia is by no means settled.

The phenomena induced in external metallotherapy are as follows:

1. In cases of hysterical hemianæsthesia the application of a certain metal to the skin of the anæsthetic side will cause a return of sensation in the region to which it is applied, and a *transfer* of anæsthesia to the corresponding region of the previously healthy side. (Phenomena of return of sensation and of transfer.) The metal which will thus act varies according to the individual patient.

2. The return of sensation with the proper metal usually occurs in from two to ten or fifteen minutes (Burq) in the space under the metal. The German observers have found that in their cases a longer time was necessary. The patient, as sensation returns, first feels a sensation of heat, then of weight.

3. The return of sensibility invades the limb, starting from the metal as a centre, and at the end of twenty, thirty, or forty minutes will be generalized over the whole of the previously anæsthetic side.

4. The skin underneath, and in the neighborhood of, the metal becomes redder than before. The temperature of the affected limb, which is usually below normal, rises in proportion as sensation returns, and may even become higher than that of the corresponding portion of the originally healthy side. The affected region, which, as a rule, is bloodless, and will not bleed in many cases, even when a pin is thrust deeply into the subcutaneous and muscular tissues, now bleeds readily, and even, at times, copiously.

5. The return of the special senses may likewise be produced with transfer phenomena. Sight, hearing, smell, and taste have thus been restored on the anæsthetic side. In cases of achromatopsia, or loss of the sense of color in one eye, the perception of color may likewise be restored in the affected eye, while simultaneously there is a loss of the color-sense in the previously healthy eye. Moreover, the perception of the different colors is restored in a special order, and the loss of them also occurs in the inverse order, neither being that of the colors of the prism. The chromatic scale for sight runs from the centre to the periphery of the field of vision, as follows: violet, green, red, orange, yellow, blue—red and blue sometimes exchanging places. The loss of the color-sense always extends from the centre to the periphery, and its return takes place in the opposite direction, the more peripheral colors returning first in regular sequence. These peculiar phenomena of the color-sense have been brought forward as proof of the impossibility of deception on the part of the subject.

6. Together with the return of sensibility to the affected side there is a concomitant return of the muscular force. Rarely, the latter only returns.

7. Sometimes certain forms of sensation only return. Usually analgesia disappears first, then there is a return of the general sensation, and finally of the temperature-sense. Cases have been known where the only effect of a metal was the return of the temperature-sense.

8. The return of sensibility to the affected side has also been produced in this way in cases of cerebral organic hemianæsthesia, and in cases of hemianæsthesia from poisoning. In these cases the transfer phenomena do not appear. Moreover, the effects of this return, though temporary in hysterical patients, are more or less permanent in cases of organic disease. In one patient, who was hemiplegic from cerebral hæmorrhage, and who had suffered from hemianæsthesia and hemichorea for several years, the sensation was restored by iron.

9. *The Return Phenomenon.*—After the removal of the metal (in hysterical patients), or sometimes even while it still remains in contact with the skin, if such contact be long continued, the anæsthesia returns. Hence, if after the application of the metal and the subsequent return of the anæsthesia the metal be not reapplied, the patient will, after a time, return to the condition existing before the application of the metal. If, however, the application of the metal be renewed within a moderate time—twenty-four hours—the remaining effect of the preceding application will tend to enhance the result produced. Thus, by proper applications the patient may be permanently cured.

10. *Post-metallic Insensibility.*—After the anæsthesia has entirely disappeared, apparently permanently, from the affected side, it may be brought back by the application of the positive metal to that side. This is called the phenomenon of post-metallic insensibility. A permanent cure cannot be considered to have been effected until this action has ceased.

11. *Phenomenon of Fixation.*—When, as occurs in certain cases, the sensibility alternately rapidly disappears and as rapidly returns under the metal plate, the condition of sensibility in the affected region may be fixed (rendered constant) by superimposing a neutral metal over the positive metal.

12. *Phenomenon of Arrest* (Dumontpallier).—This consists in arresting the production of post-metallic insensibility, by placing a neutral metal between the positive metal and the nervous centres.

Similar phenomena may be produced, not only by magnets and by solenoids, but also by non-metallic substances, as bone (Westphal), and disks of wood (Hughes Bennett, McCall Anderson). Metallic plates covered with varnish or sealing-wax, and even sinapisms, may produce a return of sensibility with transfer phenomena.

In regard to INTERNAL *metallotherapy* there is little to be said. There seems to be no doubt that hysterical hemianæsthetics who are benefited by the external application of a certain metal likewise derive advantage from the administration of the same metal internally. Whether it will ever be shown that in cases of other diseases metalloscopy is of value, as an aid in determining what drug can be administered internally to the best advantage, seems extremely doubtful.

THEORIES OF ACTION.—Various theories have been expressed by competent authorities in regard to the physical causation of these phenomena, but none of them seems to be entirely satisfactory. The theory of simple deception on the part of the patient is untenable, because, not only have a large number of most experienced specialists taken every precaution to avoid giving the patient any possible opportunity for anything of the sort, and to foresee and provide against any chance which might occur, neither allowing the patients to know for what purpose the metals were placed upon the skin nor what results were to be expected therefrom, but also because, even supposing the patients to be desirous of deceiving and of having abundant opportunity to do so, they could not produce some of the effects witnessed, such as the rapid rise of the temperature of the anæsthetic limb to the extent of eight, or even ten degrees (Thompson),

or the rapid production of bleeding in limbs previously so ischæmic that needles could be thrust into them without the production of blood.

A large number of unprejudiced observers have been inclined to consider these phenomena as the results of *expectant attention*. It is well known that a person, by fixing his attention firmly on some portion of his body, can cause a pain or an itching therein, and it seems probable that, by attracting the attention of these nervous patients to their anæsthetic regions, we may succeed in producing some actual change in them. This view has been held by many of the best English physicians, such as Hack Tuke, Hughes Bennett, Broadbent, Carpenter, and others. Yet it is not wholly satisfactory, inasmuch as it has not yet been shown that any amount or fixity of attention, even in hysterical patients, can so affect the temperature and the blood-circulation.

The theory of the action of very feeble currents of electricity, such as Reynard's experiments have shown to exist in metallic plates in contact with the skin, cannot be supported, in view of the fact that sinapisms, and even diaphoresis, produce the same effect, at least so far as regards the more important symptoms.

Althaus, in 1877, wrote: "To my mind the characteristic feature of these cases is unilateral spasm of the vaso-motor centre in the medulla oblongata, which can by certain proceedings be made to disappear on the side on which it existed, and caused to appear on the opposite side."

At the present time, and with the imperfect knowledge which we now possess, the theory of expectant attention is, perhaps, the most plausible one, but it cannot be accepted until many further observations in this direction have been made.

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Hughes Bennett: Brain, October, 1878.

William N. Bullard.

METHYLENE BICHLORIDE. *Methylenic Chloride, Dichloromethane*, CH_2Cl_2. This body, as it is closely related to chloroform chemically, so also closely resembles that substance in physical characteristics and in physiological properties. Methylene bichloride is a heavy, colorless, ethereal fluid, of specific gravity 1.344, and boiling-point 40° C. (104° F.), and of neutral reaction. Its odor resembles that of chloroform. It mixes freely with chloroform, ether, and alcohol. The medicinal importance of methylene bichloride lies in the anæsthetic powers of the vapor of the drug, which closely resemble those of chloroform both in kind and degree. This anæsthetic is one of Dr. B. W. Richardson's numerous proposed substitutes for chloroform, and has been quite extensively used by many surgeons, notably by Mr. Spencer Wells. The only possible advantage of this substance over chloroform would lie in greater safety; but since several deaths have unquestionably been caused by methylene bichloride, the anæsthetic must rank among the dangerous group. Dose and method of administration are substantially the same as with chloroform, the only difference between the two bodies affecting the mode of administration being a lower boiling-point, and so higher volatility in the case of methylene bichloride.

Edward Curtis.

METHYLIC ALCOHOL. Methylic alcohol, $CH_3(OH)$, known to the chemist also as *carbinol* and *methol*, is more popularly known under the several names of *pyroligneous spirit, pyroxylic spirit, wood spirit, wood alcohol*, and *wood naphtha*—names taking origin from the fact that methylic alcohol occurs as one of the ingredients of crude wood vinegar, the fluid product of the destructive distillation of wood. Methylic alcohol, when pure, is a thin, colorless fluid, much resembling common (ethylic) alcohol in taste and smell, but, obtained from wood vinegar and unpurified, has both a rank and offensive flavor and odor. Methylic alcohol resembles ethylic alcohol in the further qualities of volatility, inflammability, and free miscibility in all proportions with water and ether. The two alcohols also mix freely with each other. *Physiologically*, the effects of methylic alcohol are probably very similar to those of common alcohol, but exact experimental researches are wanting. *Therapeutically*, this alcohol has been given, with no very obvious purpose, in a number of diseases; but it is now little used, and it is not officinal in the U. S. Pharmacopœia. It has been administered in doses of from five to forty drops, taken in water. Methylic alcohol is useful in the arts as a solvent.

Edward Curtis.

METHYLIC IODIDE, *Moniodomethane*, CH_3I. Methylic iodide is a colorless, heavy, ethereal fluid, of specific gravity 2.199 at 0° C. (32° F.), and boiling-point 43.8° C. (111° F.). When pure its vapor is anæsthetic after the manner of that of chloroform, but this iodide is easily decomposed, and so is apt to incite the irritant effects due to free iodine. In consequence of this disadvantage the methylic iodide has never been given a place among accepted anæsthetics. It was originally proposed by Dr. Richardson in 1868. *Edward Curtis.*

METHYLIC OXIDE. Methylic oxide $(CH_3)_2O$, commonly called *methylic ether*, is the same compound of the radicle *methyl* that common ether is of the radicle *ethyl*. Methylic ether is a gaseous body at all ordinary temperatures (condensing only at a temperature of −21° C. [−5.8° F.]); is colorless, and of a not unpleasant ethereal odor. Methylic ether is a powerful and rapid anæsthetic, and was experimented with by Dr. B. W. Richardson, in 1867, with a view to its possible practical employment as an anæsthetic in surgery. Dr. Richardson used a saturated solution of methylic ether in absolute ethylic (common) ether, the solution being effected at the temperature of 0° C. (32° F.). The preparation, however, has never come into general use.

Edward Curtis.

METRIC SYSTEM OF MEASURES. The metric or centigrade system of linear measurements, which has been adopted by most civilized nations, except the United States, England, and Russia, and which, even in these countries, is employed very generally in scientific writings, is based upon the circumference of the earth. The distance from the equator to the pole is taken as the standard, and is divided into ten million equal parts, one of which, called the metre, is taken as the unit of measure. The words denoting multiples or divisions of this unit are formed by prefixing the Greek and Latin numerals respectively. Thus:

Ten metres make a *deka*metre.
One hundred metres make a *hecto*metre.
One thousand metres make a *kilo*metre.
Ten thousand metres make a *myria*metre.
One-tenth of a metre makes a *deci*metre.
One-hundredth of a metre makes a *centi*metre.
One-thousandth of a metre makes a *milli*metre.

In microscopical measurements the unit is one-millionth of a metre; this is called a micromillimetre, and equals, roughly, one twenty-five-thousandth ($\frac{1}{25000}$) of an inch. There are, practically, several units employed, according to the relative size of the objects or distances described. Thus, as was just stated, for microscopical work the micromillimetre is the unit; for small objects, the millimetre, roughly $\frac{1}{25}$ inch, or two lines; for larger objects, the centimetre = $\frac{2}{5}$ inch; for short distances, the metre = $3\frac{1}{4}$ feet; and for long distances, the kilo metre = $\frac{5}{8}$ mile. The International Committee of Metric Weights and Measures has recently adopted the follow-

EQUIVALENTS IN BRITISH LINEAR MEASUREMENTS OF THE MOST COMMONLY USED METRIC MEASURES.

Metric System.	British System.		Metric System.	British System.		Metric System.	British System.		Metric System.	British System.	
Metres.	Feet.	Inches.	Metres.	Feet.	Inches.	Metres.	Feet.	Inches.	Metres.	Feet.	Inches.
.001		.039	.071		2.795	.510	1	8.079	400.	1,312	4.320
.002		.078	.072		2.834	.520	1	8.472	500.	1,640	5.400
.003		.118	.073		2.874	.530	1	8.866	600.	1,968	6.480
.004		.157	.074		2.913	.540	1	9.260	700.	2,296	7.560
.005		.197	.075		2.952	.550	1	9.653	800.	2,624	8.640
.006		.236	.076		2.992	.560	1	10.047	900.	2,952	9.720
.007		.275	.077		3.031	.570	1	10.441	1,000.	3,280	10.800
.008		.315	.078		3.071	.580	1	10.835			
.009		.354	.079		3.110	.590	1	11.228			
.010		.394	.080		3.149	.600	1	11.622			
.011		.433	.081		3.189	.610	2	0.016			
.012		.472	.082		3.228	.620	2	0.409			
.013		.511	.083		3.268	.630	2	0.803			
.014		.551	.084		3.307	.640	2	1.197			
.015		.590	.085		3.346	.650	2	1.591			
.016		.630	.086		3.386	.660	2	1.984			
.017		.669	.087		3.425	.670	2	2.378			
.018		.708	.088		3.465	.680	2	2.772			
.019		.748	.089		3.504	.690	2	3.165			
.020		.787	.090		3.543	.700	2	3.559			
.021		.827	.091		3.583	.710	2	3.953			
.022		.866	.092		3.622	.720	2	4.346			
.023		.905	.093		3.662	.730	2	4.740			
.024		.945	.094		3.701	.740	2	5.134			
.025		.984	.095		3.740	.750	2	5.527			
.026		1.024	.096		3.780	.760	2	5.921			
.027		1.063	.097		3.819	.770	2	6.315			
.028		1.102	.098		3.858	.780	2	6.709			
.029		1.142	.099		3.898	.790	2	7.102			
.030		1.181	.100		3.937	.800	2	7.496			
.031		1.221	.110		4.331	.810	2	7.890			
.032		1.260	.120		4.725	.820	2	8.283			
.033		1.299	.130		5.118	.830	2	8.677			
.034		1.339	.140		5.512	.840	2	9.071			
.035		1.378	.150		5.906	.850	2	9.464			
.036		1.418	.160		6.299	.860	2	9.858			
.037		1.457	.170		6.693	.870	2	10.252			
.038		1.496	.180		7.087	.880	2	10.646			
.039		1.536	.190		7.481	.890	2	11.039			
.040		1.575	.200		7.874	.900	2	11.433			
.041		1.615	.210		8.268	.910	2	11.827			
.042		1.654	.220		8.662	.920	3	0.221			
.043		1.693	.230		9.055	.930	3	0.614			
.044		1.733	.240		9.449	.940	3	1.008			
.045		1.772	.250		9.843	.950	3	1.402			
.046		1.812	.260		10.236	.960	3	1.795			
.047		1.851	.270		10.630	.970	3	2.189			
.048		1.890	.280		11.024	.980	3	2.583			
.049		1.930	.290		11.418	.990	3	2.977			
.050		1.969	.300		11.811	1.	3	3.370			
.051		2.009	.310	1	0.205	2.	6	6.741			
.052		2.048	.320	1	0.599	3.	9	10.112			
.053		2.087	.330	1	0.993	4.	13	1.483			
.054		2.127	.340	1	1.387	5.	16	4.854			
.055		2.166	.350	1	1.781	6.	19	8.224			
.056		2.206	.360	1	2.174	7.	22	11.595			
.057		2.245	.370	1	2.568	8.	26	2.966			
.058		2.284	.380	1	2.962	9.	29	6.337			
.059		2.333	.390	1	3.356	10.	32	9.708			
.060		2.363	.400	1	3.749	20.	65	7.416			
.061		2.402	.410	1	4.143	30.	98	5.124			
.062		2.442	.420	1	4.537	40.	131	2.832			
.063		2.481	.430	1	4.930	50.	164	0.540			
.064		2.520	.440	1	5.324	60.	196	10.248			
.065		2.559	.450	1	5.718	70.	229	7.956			
.066		2.599	.460	1	6.112	80.	262	5.664			
.067		2.638	.470	1	6.505	90.	295	3.372			
.068		2.677	.480	1	6.899	100.	328	1.080			
.069		2.716	.490	1	7.293	200.	656	2.160			
.070		2.757	.500	1	7.685	300.	984	3.240			

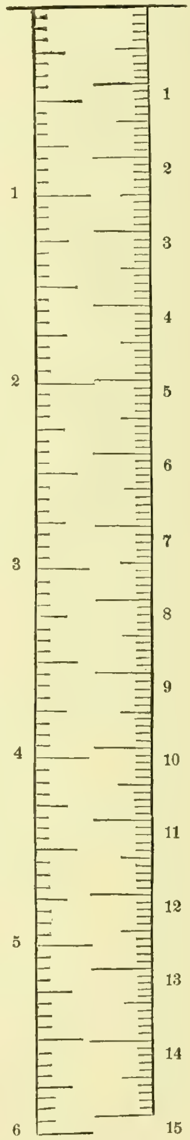


FIG. 2212.—Comparative Scale of British and Decimal Linear Measures.

ing system of abbreviations: Italics are employed, with the exponents 2 and 3 to denote square and cubic measures respectively: Micromillimetre = μ, millimetre = *mm.*, centimetre = *cm.*, metre = *m.*, kilometre = *km.*, metre square = m^2, metre cube = m^3. The unit of weight is the gramme = Gm., or, according to this newly adopted system of abbreviations, *g*. This is the weight of a cubic centimetre of distilled water at 4° C. (39.2° F.), and is equivalent proximately to 15 grains, or in fluid measure to 15 minims. (See article Weights and Measures.)

For convenience of reference the table on page 752 has been prepared, giving the equivalents in British linear measurements of the most commonly used metric measures. In the column of metric measures the millimetres, centimetres, and other fractional parts or multiples of the unit are indicated by the position of the decimal point.

T. L. S.

METRITIS, or inflammation of the womb, may be either acute or chronic. It is practically confined to the puerperal state.

ACUTE METRITIS nearly always originates in *endometritis* (*q.v.*), the inflammatory action passing by simple continuity of surface to the parenchyma of the uterus. It may, however, begin *de novo*, as from a laceration of the cervix—the absorption of septic matter from the lochia occurring at the torn surface and passing directly into the uterine tissue.

In either case its *symptoms* are those of acute hyperæmia, with increased redness, swelling, softening, or *ramollissement* of the parenchyma; suppression of the lochial discharge; hypogastric pain and tenderness; frequently vomiting, and sometimes a chill, followed by elevation of the temperature, with a small and rapid pulse.

The process of involution is arrested; and, if the inflammation advances, pus-formations occur in the connective tissue of the uterine wall, while the muscular fibre softens, sloughs, or, according to Virchow, undergoes fatty degeneration. These small abscesses are sometimes single, sometimes multiple; Hervieux has seen them studding the entire uterus.

The *causes* of acute puerperal metritis are traumatic lesions, such as lacerations of the cervix, or manual or instrumental injuries within the cavity; septic absorption, which is by far the most frequent; or any such imprudence during convalescence as tends to increase pelvic congestion.

The prognosis is usually favorable, but less so when the disease is complicated by any of the indications of puerperal phlebitis or peritonitis, or during epidemics of puerperal fever.

The indications, as regards *treatment*, are to allay pain and nervous irritation, to check the fever, and promote diaphoresis; and, subsequently, to procure free but gentle action of the bowels.

This, according to Fordyce Barker ("Puerperal Diseases," p. 318), can best be effected by the administration of Tully's powder with calomel, and the application of turpentine stupes to the hypogastrium; or, in severer and more sthenic cases, by wet cupping or a blister over the uterus instead of the turpentine stupes. Prolonged rest in bed is essential, and antiseptic vaginal injections should be used.

In the *non-puerperal* state acute metritis is one of the rarest of maladies. Most systematic works on Gynæcology ignore its existence; but Schroeder, in 1874, stated that he had observed four well-marked cases in his practice, and I have seen no correction of this statement. As the result of traumatism in surgical operations, it is certainly met with occasionally. The symptoms are the same as in the puerperal form, but more severe; for it may be said to be always complicated with endometritis and, more or less, with perimetritis also. It rarely terminates in abscess, like the puerperal variety, but either quickly ends in resolution or passes insensibly into the chronic form of the disease.

The *diagnosis* is made by conjoined manipulation when the increased volume of the uterus, its undiminished mobility, and its exquisite tenderness indicate to the practised touch the true nature of the disease, in distinction from all forms of peri- or para-metritis.

The *treatment* will be the same as in the puerperal forms of the disease, except that morphia will generally be needed hypodermatically; and a vaginal douche of hot flaxseed tea, or a copious irrigation with simple hot water, should be used, night and morning.

But in spite of our best efforts in its treatment, acute metritis will, in the great majority of cases, pass insensibly into the chronic form of the disease.

CHRONIC METRITIS.—A brief and practical article, like the present, is not the place to discuss the interminable variety of names—each indicative of some pathological difference—with which modern authors have sought to designate most accurately this condition.

Whether we call it "congestive hypertrophy" with Emmet, "areolar hyperplasia" (Thomas), "irritable uterus" (Hodge), "interstitial metritis" (Sinéty), "chronic uterine infarction" (Scanzoni and Kiwisch), "diffuse connective-tissue hyperplasia" (Klob), or "chronic metritis" (Schroeder), matters little so long as we realize clearly the leading pathological change which the uterus undergoes, and treat it accordingly.

That this change is first a congestive or inflammatory "infiltration" of the uterine parenchyma, and, secondly, a process of induration or "sclerosis" of the same tissues, is confirmed by all modern investigators since Scanzoni first announced this doctrine, nearly twenty-five years ago. In the quarter of a century that has since elapsed, minor distinctions and elaborations of his views, but no essential modification of them, have been effected.

Schroeder, Martin, Breisky, Hegar, in Germany; Courty, Becquerel, de Sinéty, in France; Playfair, Edis, Barbour and Hart, in Great Britain; Thomas, Emmet, Goodell, and other teachers, in America—all concur practically in the above view.

The advocates of the opposite doctrine—of chronic inflammation of the womb, pure and simple—are daily becoming less numerous, and their antiphlogistic practice a thing of the past.

The *causes* of chronic metritis are to be found in the causes of persistent or recurrent hyperæmia of the womb.

Imperfect or arrested involution, repeated parturition or abortions, laceration of the cervix, acute or chronic endometritis, suppression of the menstrual flow, displacements of the uterus, neoplasms within its cavity or walls, peri-uterine inflammations—all act as factors in its production. It is notably frequent in multiparous women, and equally rare in the sterile.

It is sometimes, but comparatively seldom, the result of acute metritis of traumatic origin; but, in all cases of puerperal origin, an acute inflammation of the parenchyma may be assumed to have preceded it.

The *symptoms* are often masked by the complications that attend it. They are, usually, dragging pain in the loins, backache, dysuria, or constipation; when the womb is anteverted or retroverted, pain in defecation; disorders of menstruation, usually menorrhagic in character; headache, intercostal neuralgia, and mastodynia; and gradually increasing spanæmia or chlorosis.

The *physical signs* are those indicative of alterations in the size, shape, and position of the uterus, which is enlarged, globular, or elongated, displaced forward or backward, and usually prolapsed. The cervix is thickened, soft, and sensitive in the early stage, hard and less tender as the disease advances; the body is voluminous, doughy in consistence at first, and subsequently harder and more contracted—with diminishing sensibility to pressure as the disease becomes more chronic.

These indications are all ascertained by conjoined manipulation, with the patient in the recumbent position, the abdominal muscles relaxed, and the rectum empty.

The *prognosis* is always favorable as to life, but extremely unfavorable as to cure, even the menopause often disappointing our expectations in this respect. But with careful attention to the detail of treatment most of the distressing effects of the disease are overcome.

The *differential diagnosis*—which is chiefly from neoplasms of the uterus, pregnancy, and parametritis—has been indicated in the statement of the symptoms.

The *treatment* of chronic metritis is both local and general. The local measures indicated for its relief are support by a well-fitting pessary when the womb is displaced; the vaginal douche of hot water, which is an admirable resource when employed in accordance with the rules laid down by Dr. Emmet, to whose advocacy it chiefly owes its popularity; the tampon of well-glycerized cotton, which must often be substituted for the pessary, besides fulfilling most important indications of its own; local depletion, which in Europe is largely used in the early (infiltrating) stage of the disease, although little—perhaps too little—in this country; iodine and other local alterative counter-irritants, which find their chief utility when there is complicating endometritis; operative repair of lacerations of the cervix, when present, for which again the profession is under lasting obligation to Dr. Emmet; and, in extreme cases, amputation of the neck of the uterus, as advised by Carl Braun and A. Martin; or ablation of the uterine appendages by Battey's or Tait's method.

For the detail of these measures, and their special modes of application, the reader is referred to general works on gynæcology.

The *general treatment* is of the utmost importance, and will, naturally, vary with the indications of each case.

In the main, it may be said that the diet should be as simple and unstimulating as it can be, consistently with effective nutrition.

The functions of the bowels must be carefully watched, especially to prevent the constipation to which such patients are prone. Should this occur, it is to be combated by the milder (liquefacient) laxatives, such as the compound licorice powder, compound sulphur powder, Eno's fruit salt, etc.; and drastic purgatives, especially aloes, are to be avoided.

Should the patient be anæmic, as will often be the case, similar care must be exercised in the selection of the milder and more digestible ferruginous tonics. Thus, where concentrated or grosser preparations of iron have failed, excellent results are obtained by moderate quantities of the Rockbridge Alum Spring water of Virginia, which is rich in iron salts; and the following will be found to be admirably tolerated by many women with delicate digestions:

℞. Pulv. Ferri Phosphat................ ℨ ss.
Pulv. Sodæ Phosphat.,
Pulv. Vanillæ.......................āā gr. xv.
Pulv. Sacch. Lactis .... ℨ iij.
M. Ft. pulv. Sig.—A small saltspoonful in water after each meal, for two weeks at a time.

Like other preparations of iron, this should be given, with occasional intermissions, for a long period.

In the early stage—of congestive infiltration—ergot in small quantity is thought to effect much good; later in the disease it is useless.

The mental condition of the patient—as to cheerfulness or depression—is of the utmost importance; and whatever tends to develop healthily the former quality is to be cultivated.

Cheerful society, change of scene and climate, residence at the sea-side, with moderate sea-bathing, if possible, in summer, and in a fairly warm and equable climate in winter—all these are adjuvants of the first importance.

Finally, several of the European spas, as Kreuznach, Schwalbach, Marienbad, and Ragatz, Vichy, and Plombières, have for some years enjoyed a high reputation for their supposed beneficial influence in this disease. Whether their waters, either in bathing or by imbibition, possess any such specific power is doubtful.

But the admirable hygiene enforced at most of these resorts, the comfort and pleasant surroundings that their visitors enjoy, and the simplicity of life inculcated upon them, combine to produce excellent results which are often unattainable at home. *Charles Carroll Lee.*

METRORRHAGIA (μήτρα and ῥήγνυμι) has been defined, in the discussion of *menorrhagia* (*q.v.*), as uterine hæmorrhage occurring irregularly and without regard to the patient's menstrual period.

Like menorrhagia, it is merely a symptom of a more deeply-seated disease; and, to some extent, it is dependent upon the same causes as that malady.

But its etiology is more distinctly local than that of menorrhagia; and the factors that produce it may be stated, in their order of frequency, as fungous endometritis, submucous fibromata, uterine polypi, epithelioma of cervix, carcinoma of uterus, sarcoma of uterus, metritis.

Of these, the first named, "the endometritis fungosa" of Olshausen, is not only the most commonly met with, but, happily, the most easily and surely curable. It is, indeed, often astonishing to see how small a mass of these granulations, or fungosities, will cause a constant and apparently intractable loss of blood, and how promptly the hæmorrhage is relieved by their removal.

With uterine fibroids the case is different. Neither the interstitial nor the subperitoneal form of this tumor exercises much influence in the production of metrorrhagia. The former, to some extent, increases the tendency to profuse menstruation, or menorrhagia; the latter not at all, for it is nothing unusual to meet with patients who have enormous single or multiple fibroid tumors, and yet menstruate regularly and scantily. The contrary opinion, common to the general profession and held by a few specialists in gynæcology, is due to the fact that fibromata are generally multiple; and the subperitoneal tumor, which is obvious to all, is accompanied by other interstitial or submucous growths which escape recognition. Those of the latter variety, submucous fibroids, produce such irritation and increased vascularity of the endometrium above them as quickly to lead to a metrorrhagic flow.

Uterine polypi, whether fibrous or mucous in character, also produce such constant irritation of the womb as to cause a mucoid and bloody discharge quite distinctive in character, and often most exhausting to the patient.

When *epithelioma* or true *cancer of the uterus* exists, the discharge is more watery than that just described, foul in odor, and accompanied by occasional gushes of blood, which appear without premonition, and are often quite serious in quantity.

Sarcoma of the womb sometimes, but more rarely than cancer, produces attacks of metrorrhagia of considerable severity. The writer has seen more than one case of this kind, in which the patient's health was rapidly broken down by loss of blood alone. A curetting is usually needed to differentiate such cases from simple submucous fibroids.

And, finally, acute or subacute metritis will occasionally—although more rarely—cause repeated slight losses of blood, as well as seriously increase the amount lost at the usual menstrual periods.

In the *diagnosis* of metrorrhagia we are guided by the irregularity, or want of periodicity, of the hæmorrhagic attacks; while only a careful and thorough uterine examination will reveal its exact cause.

The latter, when discovered, will decide our *prognosis* in each case, no two of which may be alike.

Thus, in cases of fungous endometritis and in polypi of the womb, it is most hopeful; where a submucous fibroid or sarcoma is found to exist, it is far graver and more anxious; in metritis it is doubtful, as the malady is most liable to recur; in malignant disease, it is hopeless from the first.

The *treatment* of metrorrhagia is, in one sense, much simpler than that required for menorrhagia; for it is essentially local, as befits a local disease. The palliative treatment consists in vaginal douches of hot water, and the vaginal tampon to check the hæmorrhage temporarily; the curative in carefully ascertaining the cause and removing it. A glance at the etiology of the disease will show that this is sometimes impossible, but whenever practicable, it should be done.

Thus, in uterine cancer, while an ultimate cure by re-

moval of the cause is beyond our reach, the diseased tissue may often be removed temporarily by simple amputation of the cervix, by Schroeder's method of supra-vaginal amputation; or, should the disease have invaded the vaginal walls, by a thorough curetting, followed by the thermo-cautery. These means will long keep the disease in abeyance, and effectually check the metrorrhagia.

Where polypous tumors exist, they are to be treated by avulsion, or by excision of the pedicle with curved scissors. When this has been done thoroughly, and the base perhaps touched with Churchill's tincture of iodine, I have never known the hæmorrhage to return.

Fungous endometritis can only be treated successfully by the *curette*, which, in modern practice, has almost entirely supplanted intra-uterine medication; although, in a limited class of cases, the latter retains a distinct value.

The choice of curettes, the method of using them, and the cautions requisite in their employment, have already been fully described (*v.* Menorrhagia), and need not here be repeated.

Submucous fibroids, if developed at the *fundus* of the womb, are best treated by thorough curetting of their surface. When found on the walls (sides) of the uterus or about the cervix, they may be safely removed by Emmet's scissors, or Thomas' spoon-scoop, after splitting their capsule. When using these instruments near the fundus the greatest caution is requisite to prevent perforation of the uterine wall, which has occurred three times, *with fatal results*, within the writer's knowledge, in the New York Woman's Hospital alone

Uterine sarcoma, if fully made out—which can only be done by careful microscopical examination—justifies, and requires, hysterectomy.

In the case of metritis (*q. v.*) the usual treatment appropriate to that malady is required to check the accompanying metrorrhagia. *Charles Carroll Lee.*

MEZEREON. (*Mezereum*, U. S. Ph.; *Mezerei Cortex*, Br. Ph.; *Mézéréon ou Bois gentil*, Codex Med.). The barks of several species of *Daphne* are collected and sold under the above names; thus the U. S. Ph. admits "*D. Mezereum* Linn. and other species;" the Br. Ph. "*D. Mezereum* and *D. Laureola* Linn." The French Codex restricts the name properly to the first-named species, but also recognizes *D. Gnidum* Linn. as *Garou ou Sainbois.* The genus is essentially of European and Asiatic origin, and comprises about thirty-six species of trees and shrubs, with tough, irritating, and acrid bark, and generally evergreen leaves, and pretty, usually fragrant, flowers. Several species are cultivated as ornamental shrubs.

FIG. 2213.—Flowering Stem of Daphne Mezereum. (Baillon.)

D. Mezereum is a small shrub from one-half to one metre high, with smooth, slender, silvery-gray branches, and sessile, lanceolate, rather blunt, smooth, alternate, deciduous leaves. Flowers pink, clustered in the axils of the last year's leaves, tetramerous, with eight stamens in the throat of the corolla, and a free, one-celled, one-ovuled ovary. Fruit a bright-red berry. *D. Laureola* has larger, wavy, obovate, lanceolate, evergreen leaves, and small, greenish, winter-blossoming flowers.

D. Gnidum Linn. has smooth, linear, lanceolate, evergreen leaves, and white or pink flowers in the axils of the leaves, etc. All these Daphnes are natives of Central Europe and Asia.

Mezereon bark is collected in winter, and imported in rolls or bundles; is in long, very tough strips which curl inward on drying. Externally it is smooth, grayish, or reddish-brown, with transverse scars and minute blackish dots; internally whitish and silky. The corky and bast layers are easily separable; odor slight (when dry), taste very acrid. The fresh bark is actively irritant to the skin, and may be used as a vesicant. The dried bark moistened, or a decoction made from it, has the same qualities. For this quality it is made into liniments and ointments abroad.

COMPOSITION.—*Mezereum resin*, a yellowish-brown, shining, non-crystalline substance of sharp, burning taste, and very irritating action upon the nasal mucous membranes and skin, is the irritating constituent. *Daphnin* is a crystalline, bitter, neutral glucoside, not important.

ACTION AND USE.—Of the irritating character of the bark, due to the above-named resin, and its application in blistering fomentations, liniments, etc., perhaps enough has been said. It is not so desirable for use, in this country at least, as several better known and more reliable rubefacients—ginger, for instance, or cantharides. Internally it has been given in chronic rheumatism, in syphilis, "scrofula," etc., with no definite reason and no advantage. In overdoses it is a gastro-intestinal irritant poison.

ADMINISTRATION.—Pieces of the bark soaked in vinegar are sometimes used as slow blisters. For internal use the dose of the bark is, say, half a gram or a little more; it is very seldom given alone. Our officinal preparations are: Compound Decoction, and Compound Extract of Sarsaparilla (*Extractum, Decoctum Sarsaparillæ Comp.*), and the Extract and Fluid Extract of Mezereon (*Extractum Mezerei* and *Ex. Mezerei Fluidum*).

ALLIED PLANTS.—The order *Thymelaceæ* comprises several hundred plants, mostly shrubs and trees of the Eastern Hemisphere, but none of much economic value.

ALLIED DRUGS.—Mustard, Cantharis, Poison-Ivy, etc. See also Sarsaparilla. *W. P. Bolles.*

MIASM is an emanation. In the general acceptation of the term it is a disease-producing agency which reaches the human system from the atmosphere by inhalation or cutaneous absorption. The word is essentially generic, and includes the essence of all specific diseases which are known to be propagated by aërial transmission, as well as of many morbid conditions similarly propagated, but which, so far as is known, do not depend upon a specific infection. Thus we have a typhus, a typhoid, and other miasms, which induce respectively their peculiar series of morbid phenomena, although the exposure of the affected individual may have been slight; and non-specific miasms, which seem to affect the individual solely in proportion to their intensity, or the duration of his exposure to their noxious influence.

The possible existence of atmospheric poisons, as accounting for fever and certain other generally diffused diseases, has been held in view by the medical profession from the earliest to the latest times. In the ignorance of the earlier days of medical science, these morbid influences were materialized into hypothetical entities inimical to the human race. But observation of the facts connected with the spread of disease failed to support this doctrine, and, indeed, showed it to be a fanciful assumption, like that which, from the theistic point of view, peopled the heavens with Immortals for the government of sublunary affairs. The essence of epidemic disease appeared to the realistic observers to be so subtile as to elude all methods of investigation, and an expression was given to this subtlety by the assumption of a peculiar epidemic constitution of the atmosphere, a theory which has its advocates even at the present day. During our civil war, many medical officers attributed the unfortunate results of the so-called *spurious vaccination* to an epidemic atmospheric constitution, and at the same time, in England, Dr. John Davy was suggesting the unknown possibilities of the atmospheric constitution in connection with the subject of miasmata. After instancing the discovery, by processes of concentration and analysis, of iodine and bromine in the waters of the ocean, he says: "Could analogous processes be brought to the aid of atmospheric chemistry, it is impossible to say what new substances

might not be discovered in the aërial ocean. That it must contain, in however minute quantity, portions of everything gaseous and volatile, is manifest to reason; but how few of them have been detected. And that it must contain also a variety of substances in the solid form, in impalpable powder, is highly probable; the matter of blight wafted by the wind, the spray of the sea carried inland very many miles by the storm, dust falling in showers over a vast extent of surface, are facts in favor of it, without taking into account meteoric stones, the history of which is not less mysterious than that of malaria, and the existence of which, though marked by properties so manifest and striking, was so long disbelieved, merely because in opposition to current ideas and commonplace knowledge. The analogies of nature may be considered in favor of different species of malaria.[1]

Malaria, used in a generic sense, includes the whole of the aërial miasms; but the word miasm has a more comprehensive grasp of the morbific agencies, as it retains its hold upon them when accidental circumstances give them the water- or the milk-supply as a vehicle for their transmission instead of the inhaled air. Up to very recent times the prevalence of paroxysmal fevers in this country led to the general application of the term miasm and its derivatives to the cause of these and analogous fevers. Thus Dr. Wood, in his "Practice," restricted the term miasm exclusively to paludal exhalations, and even as late as 1864 Levick,[2] in writing of miasmatic typhoid fever (typho-malarial fever), says he ventured to call the disease by this name, instead of using the term malarial, for although etymologically the distinction will not hold, yet by common consent, in this country, the term miasmatic is accepted as belonging to that form of poison which is believed to be due to paludal emanations; while the term malaria applies with especial propriety to what is now regarded by some English authorities as the specific cause of typhoid, or, as they call it, pythogenic fever. At the present time, however, miasm retains the enlarged signification, while malaria is restricted, in this as in other countries, to that peculiar miasm which was thus named by the Italian physicians (see Malaria).

The noxious emanations included under the generic title miasm are so numerous and varied that efforts have, of necessity, been made to facilitate their study by appropriate classification. Dr. Miller, of New York, proposed their division into *koino-* and *idio-miasmata*, the former embracing all exhalations from the soil, and the latter those from the person of the individual; and these terms have obtained a certain degree of currency in medical literature. But they do not appear to fulfil all the requirements developed by scientific inquiry into the origin and nature of the miasms, for the soil which should yield a koino-miasm may consist in part of organic matters derived from the individual, and be capable of evolving an idio-miasm.

The more the air-borne causes of disease are studied, the less becomes the necessity for the existence of the word miasm, because, when the nature of an emanation is known, it may be specialized in appropriate terms instead of remaining enveloped in the vague generalization of an unknown emanation or miasm. When the asphyxia that seizes an individual who has ventured into the depths of a disused well was definitely referred to the influence of an inorganic gas normally present to a small extent in the atmosphere, the list of deadly telluric miasms was lessened by one; so, also, when the bronchitis, pneumonia, and pulmonary consumption that are so fatal to miners were attributed to the irritation of inhaled particles, and when the colic and palsy of the lead miners were traced to the action of that metal. If the spread of cholera be referred to the operation of a particular bacillus, the etiological atmosphere becomes cleared of one of the many miasms with which our ignorance contaminated it in order to account satisfactorily for observed phenomena. When summer catarrh was shown by Blakley to result from the irritation caused by pollen grains in the inhaled atmosphere, another miasm was dissipated. The progress of medical science is gradually undermining the applicability of the term to many of the diseases hitherto regarded as miasmatic, just as in former times the same progress substituted an actual contamination or miasm for that subtile assumption, an epidemic constitution of the atmosphere.

Miasms or deleterious emanations are evolved from organic matter living or dead—from the former during the progress of histolytic change, from the latter during the changes involved in the reversion to the inorganic condition. The living organism in a state of health gives off gaseous products of the destruction of tissue, which, like poisons, are dangerous in proportion to their concentration; but in diseased conditions the organic emanations operate in many instances independently of concentration, a small dose being apparently as efficient in propagating the disease as a large one. Dead organic matter gives off volatile transition-products, in the process of ordinary decomposition, which are dangerous in proportion to their concentration; but under certain conditions dead organic matter evolves the essence of disease which, when taken into the system even in a minute quantity, becomes capable of inducing a specific result. From both living and devitalized matter there may issue specific and non-specific miasms, the latter operating as a poison when introduced into the system, the former as something more than a poison.

The nature and constitution of the *non-specific emanations* from the living body are unknown. They taint the air by exhalation from the lungs and skin, and are usually proportioned to the amount of exhaled carbonic acid, although not so readily diluted and dissipated by ventilation as this inorganic or terminal product of the normal metamorphosis of tissue. Carbonic acid, however, is not responsible for the deleterious quality of the respired air, inasmuch as this gas may be breathed with impunity when evolved into the atmosphere from inorganic materials in proportions that would be dangerous were its source the respiratory changes of animal life. The noxious quality is an attribute of the organic exhalations. Temporary exposure to their influence produces languor, lassitude, headache, drowsiness, and a condition of febrile reaction proportioned to the concentration of the miasms. Prolonged exposure to a diluted atmosphere gives a certain amount of resistance to the acute effects of the concentrated poisonous influence; but a cachectic condition is induced with a strongly marked predisposition to internal inflammations of an adynamic type. These exhalations form a chief part of the essence of what has been called the ochletic miasm, or that developed by overcrowding and inefficient ventilation, although no doubt exhalations from dead organic matter or filth contribute to the resulting morbific manifestations. Typhus fever is by many regarded as the normal offspring of a continued exposure to such emanations, and the occurrence of the disease in innumerable local outbreaks can only be satisfactorily accounted for on this assumption.

When we go back into the records of medicine to study the etiology of a disease, we are confronted with the suggestion that the observers of those days did not have the benefit of later experiences to guide their inquiries. This has weight in lowering our estimate of opinions formerly held, when the negative testimony of the past is opposed by the positive testimony of the present, as in the instance of scabies; but when, as in the case of the typhus miasm, the experience of later days has only confirmed the views of the earlier writers on the disease, these may be accepted in evidence at the present time. Pringle, in 1752, wrote: "The hospitals of an army, when crowded with sick, or when the distempers are of a putrid nature, or at any time when the air is confined, especially in hot and dry weather, produce a fever of a malignant kind and very mortal. I have observed the same sort arise in foul and crowded barracks; and in transport-ships, when filled beyond a due number and detained long by contrary winds; or when the men were kept at sea under close hatches in stormy weather." In later times, Jacquot, from his experience of the Crimean epidemics, attributed the disease to a concentrated animal miasm originating in conditions of overcrowding.

During our civil war all acute diseases became aggravated in proportion to the overcrowding and want of ventilation in hospitals and quarters. Individual cases of these diseases were so modified by the unhygienic conditions as to resemble typhus ; and typhoid and remittent fevers, measles, pneumonia, etc., were sometimes mistaken by our medical officers for the jail or ship fever—the true typhus of the European writers. Fortunately, however, the perfected miasm was not elaborated in our camps or hospitals. But the outbreak among the Union prisoners at Wilmington, N. C., in 1865, must be accepted as a spontaneous development of the contagion. These men had been confined at Salisbury, N. C., where they were so well guarded that only those who were tired of life dared to touch the dead-line within their stockade. There was no typhus fever in the Confederacy at the time. To reach these Union prisoners the contagion had to run the blockade from Europe, or pass through the lines of opposing armies before it could face their special guards in the interior of North Carolina.

Nevertheless, some authors at the present day consider the disease as always the offspring of a previous case. Its essence, in their view, is not an ochletic miasm, but a specific emanation or contagion from an affected individual. Lebert, who at one time subscribed to the doctrine of a spontaneous origin, in consideration of certain facts observed during the Crimean war, became later opposed to this idea—not from the observation of new facts bearing directly, and in the nature of counter-evidence, on the subject, but because a *de novo* origin was inconsistent with the acceptance of the germ-theory of disease. "Whatever one may think," he says, "concerning these germs, it is much more in accordance with natural science that the fact of their increase should depend on pre-existing germs rather than upon spontaneous generation, a theory continually *further and further banished* into the realms of hypothesis." But theory should be subservient to facts, not facts to theory. Typhus is contagious ; but it has originated under conditions in which a previous case has apparently had no part. Observations of this character should not be set aside as inaccurate, even although their acceptance might imply the resuscitation of the exploded doctrine of spontaneous generation. But it does not do this. The assumption of virulent qualities by an ordinarily harmless bacterium as a result of a change in its environment, suffices to explain the generation of a typhus miasm under conditions of overcrowding ; and this assumption is authorized by the changes that are known to take place in the qualities of bacterial organisms under special cultivation.

Specific organic emanations from living bodies differ from poisonous substances in that they produce effects that are neither immediate nor proportioned to the dose of deleterious miasm taken into the system. Moreover, the newly affected body becomes a source of infection for others on account of an increase of the morbific principle that takes place within it. As the yeast which determines the alcoholic fermentation of sugar becomes augmented in the fermentative process, so the infectious miasm is reproduced manifold in the person of the infected individual ; and as the reproduced yeast induces no other fermentation than that which gave it being, the reproduced infection, in like manner, is capable of inducing no other morbid process than that which caused its reproduction. Specific miasms from living bodies are therefore equivalent to the contagia of diseases that are propagated by aërial transmission. Small-pox, measles, and scarlet fever are transmitted by miasms that are rarely spoken of as miasms, because the term contagion defines their causative agencies with greater particularity than the generic term.

Liebig, from the point of view of the chemist and the chemistry of his day, suggested, from the analogies of fermentation, a zymosis as the cause of the reproduction of the specific miasmata in affected individuals. But the discovery of the vital character of fermentative action paved the way for a germ-theory of causation in those diseases that had formerly been regarded as zymotic. Fermentation is caused by the action of microphytes, or of a nitrogenous diastase elaborated by them. The alcoholic fermentation is associated with the vital processes of a fungus. The acetic is due to a bacterium, which forms a pellicle on the surface of the dilute alcoholic liquid. The transformation of urea into carbonate of ammonia by the assimilation of the elements of water, is effected by a micrococcus or by a ferment elaborated by it. The lactic and butyric fermentations are also produced by bacteria. Lastly, the complicated processes of putrefaction, by which dead organic matter is reduced to a condition in which its carbon and nitrogen are rendered assimilable by vegetable life, are recognized as due to the life-action of a variety of microphytes. The organic nitrogen is reduced to ammonia by B. termo, and the organic acids to simpler forms by other micro-organisms, as by the M. aceti on the surface of the putrefying mass ; while in the interior the lactic, butyric, and other ferments which operate in the absence of oxygen, attack the carbonaceous side of the organic matter. Meanwhile nitrification is going on, the nitrogen of the newly formed ammonia becoming converted into nitric acid by the agency of an as yet unidentified microphyte. Analogy readily suggests the presence of micro-organisms in explanation of the zymosis that takes place in the infectious diseases ; and since Obermeier discovered the spirillum of relapsing fever, this theory has been established on a basis of fact rendered possible by the improvements which of late have taken place in the microscope, and in the methods of those who use the instrument in the search after the living principle of the miasm.

When the active principle of the miasm is reproduced in an affected individual, a living contagion or germ is assumed, and the word miasm ceases to be used as an expression of the condition of the contaminated air. But the micro-organisms constituting the germs of a contagious disease do not always exist in the form of a miasm. Syphilis and hydrophobia require inoculation for the introduction of their living contagia, which, as being non-volatile, have the term VIRUS applied to them. Although small-pox is propagated by a miasm, the essence of the correlated disease, vaccinia, is a virus. Moreover, bacilli, micrococci, or other organisms occur in the blood, tissues, or secretions, not only in diseases that are propagated by direct contact, as syphilis, or by mediate contagion, as small-pox, but in certain diseases, as tuberculosis, in which the contagious quality is by no means strongly marked.

The connection between these micro-organisms and the cause of specific disease has not been established beyond question ; and doubt attaches to the germ-theory on account of the similarity of the organisms found in essentially different diseases. These are so minute that specific differences cannot always be appreciated by the microscopist. The strongest opposition at present arises from those who acknowledge the existence of the bacillus, but grant it only a harmless existence as the accompaniment of a septic matter produced irrespective of it. It is allowed that bacteria may be the carriers, in certain instances, of this septic matter. On the other hand, bacteria formed in specific diseases have been cultivated by successive generations in bouillon and other suitable pabula in an extended series, and the latest crop has been as virulent as the original germs. Thus MM. Bouley and Vulpian, in a report to the Paris Academy of Medicine in 1883, confirmed the discovery of the microbe of glanders by Bouchard, they having cultivated it to the fifteenth generation, and thereafter, by inoculation with its latest progeny, reproduced the specific disease. Nevertheless, it was contended by M. Colin that such experiments merely showed that the virulence of the poison of glanders was capable of being carried intact through so many dilutions of bouillon.

If the organisms are innocent except as carriers of a morbific agent, the dilution effected by so many successive cultivations requires the acknowledgment of a virulence which is inconsistent with experience. Moreover, a light attack should follow an extensive dilution of a poison which is simply an organic compound and not an organism, and its effects should be immediate or immediately

consequent on absorption, as in the case of prussic acid or strychnia; but grave attacks occur from these dilutions, and there is always a period of incubation.

If the morbific agent be accredited with zymotic properties in explanation of the severity of the attacks after successive dilutions in sterilized culture-media, and an incubative period in the individual, we are met with the argument based on the known instability of the albuminoids that are capable of inducing a catalytic action, and the known stability of many of the contagious principles.

On the other hand, if it be allowed that the organisms not only carry but reproduce the poison in their growth during the successive cultivations, they must be accepted as practically disease-germs.

When a micro-organism, capable of inducing morbid manifestations of a specific character, is introduced into the system, no immediate effect is produced. The acarus of scabies may reach the skin, but it may be scrubbed off before it succeeds in burrowing. The fungus-spores of porrigo favosa or herpes tondens may in like manner be removed before they have taken root. The virus of gonorrhœa may enter the urethra, but it may be washed out by an urinary flow or destroyed by the so-called abortive measures before it has produced its specific effects. The syphilitic or hydrophobic germ may be destroyed by caustic prior to absorption. Correspondingly, there seems but little doubt that the germs constituting the active principle of the miasm of small-pox, scarlet fever, or measles may be hawked from the fauces after having impinged thereon, or may be destroyed by gargles or sponge-applied medicaments; while those of tubercular disease, pneumonic fever, etc., may be removed in the glairy mucus produced and coughed up by their own irritant qualities, as inorganic atoms are extruded after their accidental inhalation. The *vis medicatrix naturæ* is ever present, constituting, in these and other instances that will readily occur to the mind, a preventive section of the force, a *vis conservatrix naturæ*—for the tendency in the living organism is to progress in the routine of health, and to throw out all matters that would tend to clog the wheels and interfere with this progress. Hence sternutation, cough, vomiting, and diarrhœa have their sanitary value. Congestions on the free surface flush away a morbific intruder; inflammations wall up, isolate, and ultimately extrude the offending material. Even the blood which flows from a slight wound is an effort in this direction, and as the careless vaccinator is aware, it is often a successful one.

The pepsin or the acids of the gastric juice appear to exercise a destructive influence upon ingested micro-organisms. It is an old observation, that he who is fasting is more liable to be attacked by infectious miasms than he who has a full stomach. When the process of gastric digestion is in operation there is less danger, perhaps because the micro-organism which causes the disease must reach the favorable alkaline environment of the intestines before its vital activities are developed. Acids are known to be unfavorable to bacterial growth, and an alkaline condition to be favorable. Sulphuric acid has been suggested as a prophylactic of cholera, and experience indicates it as one of the most efficient of the substances that have been so suggested. A sound digestion would, therefore, seem to be a desideratum as a preventive, or—to extend the significance of the statement—the healthy system can better resist the attacks of certain miasmatic diseases than that which is enfeebled by fasting or other devitalizing influences.

In fact, much may be said in argument on behalf of the origination of certain specific contagious diseases, like that already urged for typhus fever in this article, from non-specific miasms or from micro-organisms, ordinarily of a comparatively harmless nature, which become developed by cultivation in a depraved system and, under favorable conditions, into virulent and specific pathogenic agencies. Thus may we account for the erysipelas and hospital gangrene that infest the crowded hospitals of war times. The diphtheria that seizes convalescents from acute diseases appears also to be due to a similar assumption of virulent qualities by an ordinarily harmless buccal parasite, if, indeed, in this case the bacteria be not merely a regionic association, and the disease a local inflammation, assuming unusual characters owing to the constitutional state of the individual attacked. The diphtheritic cases of our civil war were apparently local inflammations modified by an existing cachæmia.

Disease is not always due to the direct action of an external cause. Material alterations in the liquids of the body were, for ages, regarded as the efficient cause of many clinical phenomena. Even in the literature of the present day we occasionally find a reversion to old modes of thought, expressed in language consistent with modern physiological knowledge. Impressions on the nervous system generally figure as the immediate cause of the changes in the humors. It is certain, however, that altered and retained secretions are potent causes of ill health. The transitional products of the decomposition of the effete material of the tissues are comparatively unknown. In the state of health they do not accumulate within the system. But even the ultimate or terminal products are deleterious. When the blood is surcharged with carbonic acid the individual dies asphyxiated; when urea is retained coma supervenes. During the waste of tissue and absence of excretion that are combined in a prolonged febrile attack irrespective of its cause, typhoid or adynamic symptoms are developed. Pneumonia, remittent fever, or any febrile disease of some continuance, may assume the clinical features—rapid and increasing prostration, muscular twitchings, black tongue, muttering delirium, and coma—which, being more commonly seen in enteric fever, have been generally spoken of as *typhoid* symptoms. These are the consequences of a systemic poisoning by retained transitional products. The clinical reporter states in such cases that the disease assumed a typhoid character. We have already seen that a concentration of non-specific human miasms due to overcrowding, gives a typhoid tendency to disease in the individual exposed to its pathogenic influence. Concentration in the individual by a failure of the eliminative process has similar tendencies. The patient becomes affected by a self-generated miasm which has never been evolved. But in this there is no assumption of virulence by hypothetical germs. The comparatively recent discovery of the ptomaines suggests caution in the acceptance of a living germ as the causative agent of *all* the morbid phenomena that are associated with contagious diseases. The tendency to *diphtheritic* inflammation of the mucous membranes in the cachectic individual, may be as independent of an associated micro-organism as the typhoid tendency in the prolonged febrile case appears to be.

The existence of the *ptomaines* has been fully confirmed since Selmi, in 1872, presented to the Academy of Bologna a paper on the basic organic compounds or alkaloidal matters which he had separated from partially decomposed viscera by the Otto-Stas method for the isolation of the alkaloids. Panum, indeed, in 1856 had obtained a poisonous extract, which he called sepsine, from putrefied flesh, and a few years later other experimenters extracted from decomposing animal matters poisonous substances which they considered different from those obtained up to that time. The first of these cadaveric alkaloids, separated and described by Selmi, resembled curare in its action on the animal organism. Many were found to be poisonous, resembling the action of strychnine, conine, morphine, etc. Their discovery throws light, not only on the bad effects produced in some instances by certain animal matters which have passed into the putrefactive state, but also on those obscure cases in which poisonous effects have followed the ingestion of matters of simply doubtful quality. But the experiments of Armand Gautier indicate that such alkaloids are produced in some of the secretions of the living body, as in the saliva and urine. These discoveries are important, as suggested above, in connection with certain morbid conditions resulting from retained and altered secretions. It does not appear that the poisonous principles pre-exist in the *healthy* secretions; they are formed during the processes of extraction. Weight for weight, so far as our

present knowledge goes, the ptomaine is less energetic in its action than the vegetable alkaloid which it resembles. Nevertheless, it must be remembered, that in the decompositions which take place during the retrogressive metamorphosis of organic compounds, many complex substances are formed and exist but a short time before their transformation into others of a more stable and better known nature ; and some of them may be of a more deadly character than those which have already been isolated and described.

If the germ of the contagious disease lodge, notwithstanding the operation of the *vis conservatrix naturæ*, an immediate effect may be produced, or it may not. The skin is sensitive, and the burrowing of the acarus is recognized by the itching and the local inflammatory conditions which are its attendants. The skin is visible, and low grades of congestive or inflammatory action unaccompanied with pain, as in certain parasitic skin diseases, may be recognized by colorations. But the germ which, in full possession of its vitality, impinges on the fauces, enters the lungs or intestines, and meets with conditions favorable to its development, may be present for some time without giving any sign of its presence. The mucous lining of the interior canals is not so sensitive as the skin, and minute points of inflammatory action do not manifest their existence until, in the aggregate, they are of sufficient extent to interfere with healthy action, or until the germ has so multiplied that it, or some deleterious matter elaborated by it, suffices to produce a constitutional disturbance. Thus, pulmonary tubercle may not be recognized until the apex of the lung has become more or less consolidated, or until a concurrent local inflammation has attracted attention to the part ; abdominal tubercle, until the mesenteric glands have been so affected as to interfere with nutrition, or the local irritation has given rise to diarrhœa or to a chronic peritonitis. In diseases characterized by an acute specific febrile action, as the eruptive and other contagious fevers, a certain period elapses before the propagation of the germ enables it to give symptomatic evidence of its presence ; and as the conditions in one susceptible person have a general similarity to those in another, the period of incubation does not differ materially for the same disease in different persons. Small-pox has an incubative period of about two weeks ; measles, of one week ; scarlet fever, of two or three days. Instances of variation from the average period express variations in the condition of the individual presenting the soil for germination.

Non-specific miasms from dead organic matter consist, so far as known, of the emanations from sewers, cesspools, etc., and the bacteria-laden gases of ordinary putrefaction. Hydrosulphuric vapors are exceedingly malodorous, but the evidence of their unwholesomeness is not so positively defined. According to Dr. Parkes, the inhalation of sulphuretted hydrogen has in some instances appeared to be harmless, in others hurtful. The men employed in making the Thames tunnel were exposed to this gas from the decomposition of iron pyrites, and apparently, in consequence, became, after a time, very feeble and anæmic. Headache, vertigo, perspirations, asthenia, spasms, tremblings, and even tetanic convulsions have been attributed to its inhalation, and the development of boils to its ingestion in the drinking-water. According to Barker, sulphuretted hydrogen produces intestinal disorders and prostration, while sulphide of ammonium sets up a class of symptoms resembling closely those of typhoid fever.

But the organic emanations associated with these sulphuretted compounds, if not the latter alone, induce febrile and diarrhœal attacks of a severity proportioned to the concentration and the duration of the exposure. Diarrhœa among the wounded prisoners exposed to the effluvia from an uncared-for battle-ground has often seemed due to the organic emanations and putrefactive gases from the carcasses of unburied horses in their neighborhood. Cholera infantum is a disease of hot weather, when the stagnant atmosphere in the streets of our cities is laden with the bacterial organisms connected with the putrefactive process. Under such conditions the *vis conservatrix naturæ* requires a sound and vigorous system in the individual to repulse the continued attacks of the pernicious microphytes ; or, in the language of another theory, to resist the epidemic tendency to diarrhœal disease. Children appear particularly susceptible to the influence of sewer or cesspool air. Sometimes distinct febrile attacks are associated with the diarrhœa, and in many instances it seems doubtful whether, indeed, a specific miasm be not present.

Specific miasms from dead organic matter embrace chiefly the causes of the various morbid conditions that have been referred to malaria, the distinctly paroxysmal fevers, sub-continued remittents, adynamic, malarial, and congestive fevers, and the cachexia known under the name of chronic malarial poisoning. But this subject is not infrequently complicated by the persistence of the contagia developed by the living body. The contagion of typhoid fever, for instance, has been known to be so frequently exhaled from an organic soil as to suggest its elaboration and evolution from the dead organic matter, instead of its preservation and reproduction in that matter from its origin in a living body. An uncertainty exists as to whether typhoid fever is to be regarded as a contagious or a miasmatic disease—viewing contagion as derived from the morbid processes of the living body, and miasm as emanating from natural changes in devitalized matter. Some deny the contagious qualities of the fever, allowing it only an indirect infection through the medium of the enteric discharges. Others deny it a miasmatic character, holding that it is always derived from the contagion of a pre-existing case. All are agreed, however, that the excreta of the typhoid fever patient contain a material which, although not specifically hurtful when recent, becomes, after a time, capable of transmitting the disease to those who are susceptible. Murchison contends that a soil contaminated with human filth will, under proper conditions of temperature and moisture, evolve a specific typhoid miasm irrespective of the presence of the discharges from an antecedent case. His views are not generally accepted by medical men in this country, as so many illustrations have been noted of excremental filth without typhoid developments, until after the known introduction of the disease by an infected individual. The foul soil then becomes a breeding place for the exotic disease which prevails as an endemic.

The association of enteric fever with excremental filth was accepted as explaining the prevalence of the disease in cities which had been freed from the paroxysmal fevers by subsoil drainage and surface improvements. The sewers were regarded as an abiding source of infection ; a contagious centre from which, by means of the sewer-gas or air, the disease might penetrate into every house having the sanitary convenience of water-carriage for the removal of the solid and liquid wastes of human life. So many instances of the propagation of typhoid by the exhalations from an infected organic mass have been recorded, that the emanations from the sewers must be regarded as dangerous in this connection. But it seems unlikely that the typhoid fever of cities is chiefly propagated by the air of the sewers, as was believed a few years ago. Great care has been given to the seals and traps that protect the atmosphere of the house from an invasion of sewer-air by way of the plumbing fixtures, but it is not evident that the prevalence of typhoid fever has been materially lessened thereby. Indeed, leakage from a contaminated soil into the well-water supply has been accepted as the main agency of propagation, not only in urban, but in rural districts. Typhoid fever has been so frequently traced along the circuit of an infected drinking-water that a well, suspected of sewer or cesspool contamination, is unhesitatingly condemned by our officers of health. In some cities, as Brooklyn, Long Island, all the wells have been disused as possible propagators of typhoid fever. Indeed, public water-supplies from lakes and rivers are not free from the suspicion of disseminating the disease if they become tainted with an inflow of sewage. Recently the town of Plymouth, Pa., was severely visited by a typhoid epidemic due to the infection of its water-supply.

But, although a contaminated water has been established by repeated observations as the chief factor in the propagation of typhoid fever, the emanations from sewers, cesspools, vaults, or other receptacles, or accumulations of decomposing filth of animal origin, have not been relieved of responsibility in the spread of the disease. Perhaps all medical men admit that it may be propagated by miasmatic influences from such accumulations, after their infection by the dejecta of a previous case. But, besides these specifically infected sources of exhalation, many medical men, particularly those practising in country districts, regard enteric fever as originating in the decomposition of organic matters in the soil, independently of the existence of any previous case of the disease, and independently even of the presence of animal excreta. They refer it to an emanation from the same soils that, under other conditions of heat and moisture, give issue to a malarial miasm. The annual wave of prevalence of typhoid fever is, in this country, spread over the months of August, September, and October, and it is greatest in those hot and dry seasons which seem unprolific of malarial diseases from their very dryness. They recognize that when the fever has made its appearance it may be propagated from the first case by direct or indirect contagion, constituting a secondary epidemic from a local focus; but hold that the origination of the disease is, in many thoroughly investigated instances, wholly independent of the contagion or germ from a previous case of the disease. Dr. Cabell, of the University of Virginia, was the first writer who consolidated the views of a number of American practitioners on this subject. He gave them expression in 1877, in a pamphlet reprint of a paper on the etiology of typhoid fever, read before the American Medical Association, which showed, by the concurrent testimony of many observers, that fevers having the clinical characteristics of enteric fever prevailed over large areas of country, generally succeeding a like prevalence of the periodic fevers, which, in a very great degree, subsided on the appearance of the typhoid affection.

Country practitioners have much better facilities for studying a question of this kind than their city brothers. The environment of their cases is less complicated, and in many instances they have been familiar for years with the affected individual, his family, home, journeyings, visitors, neighbors, and all matters bearing on the origin of the disease. When the previous case is denied by an unbiassed investigator who has his work of investigation simplified by favorable conditions, his conclusions should have too much weight to be set aside because inconsistent with preconceived ideas.

The enthusiasm with which the germ-theory of disease has been adopted, of late years, has proved an obstacle to the calm investigation of all the facts connected with the etiology of typhoid fever. Because the contagion of small-pox is known to be a morbid product of the human organism, and propagated only from one system, directly or indirectly, to another, it was assumed that the contagion of typhoid is also derived solely from the human system, and that its presence in one person presupposes its derivation from another who had been similarly affected. The mode of propagation of small-pox sometimes eludes detection; yet we do not on this account believe in its spontaneous generation. It is argued from this that the so-called *de novo* cases of typhoid are merely those in which our knowledge and methods of observation are at fault; that the antecedent case had an existence, although we are unable to trace the connection. Hence, when an outbreak of typhoid occurs, the efforts at investigation become too often valueless by overlooking the facts in a search for the hypothetical previous case. The fact that the germ of typhoid is not directly contagious like that of small-pox, destroys the influence of an argument based on analogy. Small-pox is communicated directly from the affected to the healthy system. Typhoid is not thus directly contagious. Small-pox never originates outside of an infected system; but manifestly, it does not follow that a like statement holds good in the instance of typhoid fever.

Indeed, there is so little analogy between the contagion of typhoid and that of a truly contagious disease propagated only from man to man by a specific organism, that Leibermeister threw enteric fever from the list of contagious diseases, and placed it, with cholera and dysentery, in a class by themselves. This class he named *miasmatic-contagious;* miasmatic because the essence of the disease is evolved from decomposing organic matter, and contagious because the organic material from which this miasm is elaborated has a derivation from the affected body.

The records of country practice, in asserting the *de novo* origin of the fever, deny this derivation, yet permit the term miasmatic-contagious to be applied to the disease; miasmatic because emanating from the decomposition of organic matter, and contagious because, after having thus originated as a miasm, it is susceptible of transmission indirectly from person to person, without a reversion to the conditions of the *de novo* origination. Nature does not operate *per saltem.* Species touch; the limits of genera are undefined; families affiliate in their generic characters; the fauna and flora éxtend in a continuous series. This is so well known that when a gap occurs we search for the missing link. In studying the etiology of specific diseases, malaria is found to be evolved as a miasm from organic matter, and it has no contagious qualities. Small-pox is due to a contagion which never reverts to a miasmatic origin. Typhoid fever and its congeners, among which, as we have seen, typhus fever must be included, are the connecting links, miasmatic on the one hand, contagious on the other.

The conditions that determine the evolution of the typhoid miasm are unknown. Progress will be made in this study when the specific progenitor of the causative germ ceases to obscure the view. Meanwhile it is recognized that a continuance of hot weather will evolve a typhoid miasm from a soil which may not be filthy in the ordinary acceptation of that term. Dr. George Derby, of the Massachusetts Board of Health, furnished, in 1871, evidence that in the country districts of his State the most frequent single cause to which the prevalence of typhoid fever might be attributed, was the exposure of the bottoms of ponds and reservoirs in seasons of unusual heat. Dr. Cabell, in summing up his evidence, said: "There are yet many unsolved mysteries with regard to the conditions of the development and spread of this fever, and it is to be regretted that the exclusive ascription of its generation to the influence of putrescent sewage contaminating the air we breathe or the water we drink, should be permitted to divert the attention of competent observers from other less easily assigned, but possibly equally influential, agencies." Dr. Pinckney Thompson, of Kentucky, in 1883, held similar views, and gave numerous instances of the spontaneous origination of the disease in sparsely settled districts, where previous cases could not have escaped detection. Dr. Farquharson, of Iowa, in the same year, formally announced his belief in the origination of typhoid from unknown, but not necessarily filthy, conditions of the soil.

But other health officers, sincerely interested in the protection of the public health, objected to giving publicity to this doctrine, lest it might interfere with their efforts to improve the sanitary condition of the people. A pythogenic origin or a filth factor in the propagation of the disease is readily accepted by the public, and constitutes a powerful argument in favor of general cleanliness. The negligent are ever ready to argue in defence of their negligence; and it was conceived that if a *de novo* origin, from unknown telluric conditions, were allowed for typhoid, our boards of health would be constantly met with the argument—*cui bono?*—the cleanliness you desire is a work involving much trouble, yet, when achieved by unremitting efforts, it gives no adequate protection from typhoid fever.

There is, however, so intimate an association between disease and filth, that typhoid fever might be wholly removed from the list of maladies that owe their origin and spread to the latter, without materially weakening the argument on behalf of sanitary cleanliness. But an acknowledgment of the spontaneous or miasmatic origin

of the disease does not sever its connection with filth. Granting that it may originate from conditions which our present ignorance is impotent to remove, it is well known that general unsanitary conditions are the most efficient agents in the subsequent propagation of the disease.

But at the present day anomalous cases of fever are of common occurrence, cases which do not present the special symptoms nor run the usual course of remittent, typhoid, or typhus fever, and which must be set down as belonging to the category of simple continued fever. There is the ephemeral fever, violent and short in its duration, lasting only a few hours, and terminating abruptly in perspiration, diarrhœa, or epistaxis, or in a gradual defervescence. Again, the fever may be prolonged for several days, constituting the synocha of Cullen; but it is unaccompanied by the special symptoms which would class it with any of the specific fevers. It resembles the constitutional disturbance which arises in connection with inflammatory action in the system, but no local inflammation can be discovered of which it is symptomatic. Murchison also gives us the ardent continued fever of the tropics, in which a fatal issue is oftentimes reached by the supervention of coma or delirium, and an asthenic species wherein the symptoms are those of typhoid fever without those pertaining to the abdominal lesion. This last appears to be the fever which, in this country, is sometimes specified under the title of cesspool fever. Before the observations of Louis were published, many cases of typhoid fever were classed with those of simple continued fevers. Since his observations, and more especially of late years, it seems probable that many cases of apparently non-specific fever have been diagnosticated and treated as typhoid in cities and sections where that is the prevailing fever, and as intermittent suppressed by quinine, or remittent cured by that remedy, in malarious districts. It is certain that the acknowledged action of these two poisons on the system will not account for all the cases which occur in practice. Even if a typho-malarial group be instituted for the reception of anomalous cases, there will remain many which are anomalous nevertheless. These cases have been ascribed, in the absence of any evident causative agency, to some previous exposure to the sun, to fatigue, to over-eating, but in this last instance the fever may be regarded as symptomatic of the irritation of the gastric and intestinal mucous membranes, and not as a so-called idiopathic affection. If exposure to heat or to cold be a cause of these constitutional disturbances, without the production of local inflammations of which they are symptomatic, it may be inquired why they do not invariably follow exposure. We must call in a peculiar condition of the organism to explain their occurrence under exposures in no degree greater than those which have been previously undergone without injurious consequences. If fatigue be a cause, why are similar or greater fatigues more frequently followed only by the muscular pains which are nature's indications for needful rest and recuperation? Again we must have recourse to the unknown peculiarity in the vital condition of the subject. But when we consider that so many diseases of a febrile character have been referred to the presence of micro-organisms in the system, we seem to be authorized to look in this direction for the cause of our simple continued fevers. The air, as is well known, is charged with micrococci, bacilli, and fungoid spores, and especially so in the summer and in hot climates, where these fevers are of more frequent occurrence and of greater intensity.

Although the records of the practice of medicine, and even the daily experience of physicians, show the existence of fevers that may be attributed with propriety neither to the malarial nor typhoid germ, nor to a concurrence of these, the enthusiasm with which, of late, the investigation of these etiological factors has been prosecuted appears to have caused a forgetfulness of the fact that fever may be due to causes neither malarial nor typhoid, but to miasms which, like them, have probably a particulate and living essence. To the organic analysis of air and microscopy, in connection with clinical observations, must we look for further information in this matter.

The scope of this article does not admit of a study of the active principle of the various miasms or contagia. This belongs to the etiology of particular diseases. There are two diseases, however, which prevail epidemically, that may be briefly mentioned as presenting peculiar and extreme variations from the ordinary characters of either the specific contagion or the more generic miasm; these are influenza and cerebro-spinal meningitis.

The miasms that arise from dead organic matter, as well as those emanating from diseased subjects, are so immediately diluted, and, perhaps, dissipated by their diffusion in the atmosphere, that a certain degree of proximity to their source is needful to the production of their deleterious influence on the system. The causative agency of typhus fever is readily deprived of its virulence by free ventilation. But there is a disease which must be made exceptional in this regard, because its source is unknown. The vagueness of its Italian name—the influenza—gives a fit expression to our ignorance of the etiology of the disease. Miasm is too positive and definite to be applied to its subtile cause. Indeed, in the face of this obscure malady we may recognize the conditions which led to the adoption, in former times, of the hypothetical epidemic constitution of the atmosphere as explanatory of certain morbid phenomena. A telluric origin is inconsistent with the facts recorded regarding its epidemic evolution. Its sudden appearance after the long intervals which elapse between its successive manifestations, and the rapidity with which it spreads over a vast section of the earth's surface, irrespective of lines of travel or of prevailing winds, cannot be accounted for on the supposition of a telluric exhalation. Nevertheless, an atmospheric cause must be supposed. Its symptoms, similar to those well known to be produced by exposure to cold, have led to the assumption that it is dependent on meteorological changes, especially those attended with low temperatures; and as ozone is generally and notably present under such conditions, while its inhalation, when artificially produced, has occasioned similar catarrhal symptoms, it has been supposed that a causative connection existed between the ozonized condition of the atmosphere and the prevalence of this epidemic disease. But a more extended tabulation of the recorded epidemics shows that it has prevailed where the temperature was not low, and where the ozone was not notably increased. Moreover, it is attended with a prostration of the vital powers which is foreign to the catarrh, known to be the result of climatic conditions, and which, by being always present, suggests a specific cause for the epidemic disease. And again, although it is difficult to prove contagion in the case of a disease which is so sudden and wide-spread in its epidemic attack, there are not wanting in medical literature cases which are suggestive of a contagious quality. A specific miasm must, therefore, be looked for rather than a peculiarity of the meteorological condition. But no observations have as yet been made in this direction.

The cause of cerebro-spinal meningitis is also so thoroughly beyond our ken that the epidemic constitution is frequently conjured up in connection with it, as a wordy etiological tangibility. Yet in its manifestations it differs widely from "the influenza." The one is wide-spread and general in its epidemic evolution, sparing none from attack, yet destroying few. The other is wide-spread in its distribution, but it affects few, and fortunately so, for these it generally destroys. Chauffard, in 1840, said that: "L'étiologie de cette affection est restée enveloppée d'ombres impénétrables," and Wilson, summarizing in 1881, gave a similar but more extended expression: "The cause of cerebro-spinal fever is as yet unknown. Much less is known of the laws which control its origin, its distribution, its action in communities and upon individuals, than is known of the active causes of most of the other infectious diseases. The unaccountable appearance of the disease at the same time in widely separated localities, its diffusion by isolated attacks rather than by direct advance, its variable and often long-continued prevalence in epidemics, its sporadic occurrence between the epidemics, the extraordinary diversity of the

symptoms in different epidemics and in different cases, baffle the comprehension, and render futile every effort to formulate even a satisfactory hypothesis of its cause and origin." Pathologically, the disease appears to be a deterioration of the blood, with transudation into the cutaneous and subserous tissues, and a special tendency to congestive and inflammatory conditions of the membranes of the brain and spinal cord. Usually the continued study of an epidemic or endemic disease develops what may be called its natural history. This, when adapted to an assumed cause, constitutes the theory of the causation of the disease. But in cerebro-spinal meningitis, or rather cerebro-spinal fever, no theory has been offered for acceptance, because its continued study develops contradictions rather than an augmentation of the number of similarities. Thus one epidemic has been characterized by distinctly contagious qualities; in another the evidence is positive that there was no manifestation of contagion. Sometimes children are its special victims, and occasionally, as in the case of French epidemics, soldiers in the bloom of their manhood appear to be specially prone to the disease; but no age is free from the liability to its attack. Occasionally it shows a predilection for those who are broken-down by previous hardships, privations, or prostrating maladies, and again it selects its victims from the most robust specimens of a community. Sometimes it visits malarious localities, sometimes those that are prolific of typhoid cases; but, again, it may be present where the hygienic surroundings are in an apparently satisfactory condition. It cannot be considered due to meteorological causes, for observation has shown it to be present or absent in localities having similar or identical climatic conditions; nor has any special character of locality or soil been invariably, or even generally, connected with its presence. Cold weather has usually been regarded as a predisposing cause, since a majority of the epidemics have occurred during the colder months of the year; but it has occurred in the summer on the coasts of the Gulf of Mexico and the Mediterranean, and in winter in Canada and Sweden. Local unhygienic conditions, irrespective of the nature of the soil, have also been regarded, presumably on general principles, as predisposing factors in the propagation of the disease; but the scattered distribution of the cases in an epidemic is so singular a phenomenon that a poisonous something in the food has even been suggested as the only probable method of accounting for all the facts. If we adhere to the doctrine of a miasm, the irregular distribution of the cases negatives the idea that a miasm of such energy can be produced from local unsanitary conditions in many scattered localities of a general section, in one year, and be absent from them in another presenting precisely similar conditions. The miasm must, therefore, be generally diffused, and its isolated manifestation attributed to a rarity in the human system of the conditions favorable to its reception and deleterious operation. This view gives an important prominence to the conditions usually spoken of as the predisposing causes. The subtile essential may continue to escape detection, but those factors that increase the liability to attack come more readily under observation; and, based upon their exclusion, a preventive system may be formulated which will be of much use in the absence of a precise knowledge of the miasm.

The writer began the study of the cases that occurred during the War of the Rebellion, with the intention of isolating and identifying, as far as possible, these various predisposing agencies; but it was speedily observed that perhaps the only constantly concurring phenomenon in the affected locality was the presence of a specific disease, which was sometimes malarial fever, sometimes typhoid, sometimes one of the eruptive fevers, sometimes pneumonia. Medical officers stationed in malarious districts generally mistook their first cases of cerebro-spinal meningitis for congestive fevers. Pathologically, there appeared no difference between them; there was a blood disorder in both, with a tendency to cerebral hyperæmia. Anatomically, the line between congestion and inflammation was so fine as to be indistinct during life. Even after death, in some cases, it could only be distinguished by the microscope; and yet the passage of this line was of vital importance to the patient, as its consequence was the establishment of a pneumonia, a nephritis, a dysentery, or a cerebro-spinal meningitis, according to the locality of the hyperæmic tissues. Etiologically, the diseases appeared to be identical; for, while one man, who recovered under the influence of quinine, was regarded as a temporary victim of malarial congestion, his comrade, who died with inflammatory products spread over the base of his brain, had been exposed to precisely similar morbific conditions. Undoubtedly, the clinical differences between congestion of the brain from malarial poisoning and cerebro-spinal meningitis are very great. Recovery is effected, under proper treatment, as if by magic in the one instance, while in the other the result, notwithstanding all treatment, is death or a protracted illness differing wholly from the usual course of malarial congestion. Quinine, an effective remedy in the one case, is powerless in the other. But the impotence of quinine in the latter does not antagonize the theory of its malarial causation. When malarial congestion of the intestinal mucous membrane has been followed by the ulcerations of dysentery, or when pulmonary congestion of a similar origin has developed into pneumonia, the secondary inflammatory result is uninfluenced by the quinine given for the primary disease. So, when congestion of the cerebro-spinal membranes is followed by the extrusion of the products of a secondary inflammation, relief may not be expected from quinine.

Medical men in other countries, where typhus prevails, have insisted on the affiliation of cerebro-spinal meningitis with that disease. In typhus fever, although all the organs are more or less affected, the diseased action is sometimes greater in one organ than in another, and some epidemics are characterized by the special implication of a particular organ. But the brain and its membranes are seldom affected, because, since the identification of cerebro-spinal meningitis as a disease *sui generis*, in 1805, all the cases of typhus with cerebro-spinal complications have been set aside as illustrations of cerebro-spinal meningitis. Epidemics of typhus that occurred prior to that date are now quoted, by the light of present theories, as epidemics of cerebro-spinal meningitis. But many writers do not concur in the propriety of separating these cerebro-spinal cases from typhus. Murchison, after reviewing their points of similarity and difference, concluded that, before attempting to establish a new specific disease, it was necessary to keep in view the many modifications that those already known to us may undergo, and more particularly to study their etiological relations and the circumstances under which they arise and are propagated. In this country several observers have held similar views. Upham considered the disease to partake of the nature of typhus in a severe and malignant form. Webber and Baltzell concluded that it is only epidemic typhus in which, from some cause, the cerebro-spinal system is the principal seat of the attack.

Similarly, the supervention of cerebro-spinal symptoms due to inflammatory changes in the pia mater is regarded as an uncommon result of the typhoid-fever poison. At the beginning of this century typhus, typhoid fever, and cerebro-spinal meningitis were confounded. The cerebro-spinal cases were first separated from the others; afterward typhoid was distinguished from typhus fever, and since their separation, cerebro-spinal cases occurring during epidemics of typhoid have been considered only in other connections. Nevertheless, as shown by the history of these diseases in our camps during the civil war, the association between typhoid and cerebro-spinal fever was as intimate as that between the latter and malarial congestion.

Similarly, also, the association of cerebro-spinal meningitis and the eruptive fevers and pneumonia may be shown, indicating the disease to be not one *sui generis*, but merely the localization of one of many internal congestive processes, that occur in fevers, in an organ of vital importance. Congestions of the spleen, having no notable clinical features nor specially dangerous conse-

quences, are regarded as symptomatic of the operation of the various febrile agencies; but congestions of the membranes of the brain, with their striking clinical history and deadly consequences, have been dignified into the position of a specific disease, the etiological relations of which have, of necessity, been thereby enveloped in obscurity.

Judging from the intensity of the disease in the individual case, the cause is one of great virulence; but in its operation on the community this virulence is not correspondingly evidenced. The cases in an epidemic are comparatively few and scattered, and there is no explanation of the protection of the many analogous to that which holds good in other febrile diseases, as typhoid fever, measles, small-pox, or scarlet fever. But if the cases be regarded as the cerebro-spinal or spotted manifestations of a prevailing febrile cause, the virulent scattered cases become bound together by others of less malignancy.

From a study of the records of the civil war the conclusion was reached that the so-called cerebro-spinal meningitis, or spotted fever, was the result of any febrile miasm or contagion which destroys the integrity of the blood. When death is not a quickly following consequence of this alteration, perversions of nutrition are in order, more actively manifested in some organs than in others, and depending generally, perhaps always, on local or accidental conditions involving, among others, climate, exposure, overwork, and the physiological status of the organs as determined by hereditary tendencies, growth, age, and previous disease. The lungs, the pleural, pericardial, or synovial membranes, the liver, spleen, or kidneys, the alimentary mucous membrane, or the vascular membrane of the cerebro-spinal system, may become the parts chiefly involved, and death is imminent in proportion to the deterioration of the blood, the activity of the localized hyperæmia, and the vital importance of the part affected. When the brain, lungs, or pericardium become involved, death may result before those special signs are manifested which permit of a discrimination between one febrile miasm and another. Hence the spotted fever ending fatally prior to local developments, or with congestive or inflammatory conditions of these important organs, may be attributed to malarial, typhus, typhoid, eruptive, or other miasms, according as the locality and other circumstances bearing on the etiology appear to determine. When death is not so immediate, the peculiar phenomena attending the cerebro-spinal lesion are so profound as to veil the true nature, etiologically speaking, of the disease, giving it characters apparently *sui generis*, but in no way inconsistent with its original development from the identical cause that produced a typhoid, typhus, or remittent fever in another sufferer. *Charles Smart.*

[1] Army Diseases, p. 53. London, 1862.
[2] Am. Jour. Med. Sciences, April, 1864.

MICHIGAN CONGRESS SPRINGS. *Location* and *Post-office*, Lansing, Ingham County, Mich.

ACCESS.—By the various lines of railroads centring at Lansing. The well is about a mile from the city.

ANALYSIS.—One pint contains:

	Grains.
Carbonate of soda	8.094
Carbonate of magnesia	1.421
Carbonate of iron	0.143
Carbonate of lime	7.782
Chloride of sodium	33.349
Sulphate of potassa	1.554
Sulphate of soda	3.131
Silica	0.413
Total	55.887
Gas, carbonic acid	24.5 cu. in.

THERAPEUTIC PROPERTIES.—This is an alkaline-saline water, very similar in composition to those of Saratoga, and has proved of equal efficacy as a cathartic and alterative agent.

The water flows from a well fourteen hundred feet deep in the rock. It is shipped through the country in tanks and bottles. The hotel and other accommodations and conveniences are ample, Lansing being a city of eight or nine thousand people, and the capital of the State. *G. B. F.*

MICRO-ORGANISMS, STAINING AND CULTIVATION OF. I. BACTERIA.—*Staining Reagents.*—While many forms of bacteria can be recognized in an unstained condition, it is only by the application of staining reagents that they can be demonstrated easily and satisfactorily. For staining purposes, any of the nuclei stains may be used; but the best results are obtained with the basic anilin dyes, and those most frequently employed are fuchsin, methyl violet, gentian violet, methyl blue, and vesuvin or Bismarck brown.

The rapidity with which the bacteria take up these dyes varies with the species. Some stain quickly and yield the color readily to decolorizing reagents, while others stain more slowly and hold on to the color with more tenacity when treated with these reagents. Thus we are sometimes enabled to differentiate between species. Some of them also hold the color longer than nuclei and tissue-elements, which allows of their being distinguished from the latter by differences of color.

Staining Solutions.—Fuchsin, methyl violet, gentian violet, and methyl blue are kept in stock in the form of saturated alcoholic solutions. As a rule, 20 to 25 Gm. of the dye to 100 c.c. of alcohol will form a saturated solution. Vesuvin or Bismarck brown is kept in the form of a saturated aqueous solution made by boiling an excess of the dye in water, then allowing the supersaturated solution to cool and filtering. For use, these saturated solutions are diluted with from ten to twenty times their bulk of distilled water.

Löffler's Alkaline Solution: Saturated alcoholic solution of methyl blue, 30 c.c.; aqueous solution of potassic hydrate (1 to 10,000), 100 c.c.

Ehrlich's Anilin Water Solution: About 5 c.c. of pure anilin oil are added to 100 c.c. of distilled water and well shaken for one minute, then allowed to stand for five minutes, and filtered through a paper filter previously moistened with distilled water. The filtrate should be perfectly clear. A saturated alcoholic solution of fuchsin or methyl violet is added to it until a slight precipitate appears, when the solution is to be filtered again, and will then be ready for use. As this staining fluid soon decomposes, it should be made fresh each time. In place of anilin oil, toludin, prepared in the same manner, can be used as a menstruum. Prior recommends turpentine; Ziehl, a five per cent. aqueous solution of carbolic acid.

Weigert-Ehrlich's Anilin Water Solution: This is a modification of the above, and can be kept for about ten days, when it becomes turbid. Its composition is as follows: saturated solution of anilin oil, prepared as above, 100 c.c.; saturated alcoholic solution of fuchsin or methyl violet, 11 c.c.; absolute alcohol, 10 c.c.

Weigert's Ammonia Solution: Liquor ammoniæ, 0.5 c.c.; absolute alcohol, 10 c.c.; five per cent. solution of carbolic acid, 100 c.c.; gentian violet, 2 Gm.

Neelsen's Carbolic Acid Solution: Fuchsin, 1 Gm.; absolute alcohol, 10 c.c.; five per cent. solution of carbolic acid, 100 c.c.

Wedl's Solution of Orseille (Orchella): A coloring matter obtained from the lichen *Roccella tinctoria*. The free ammonia is driven off, by gentle heat, from the French extract, and this powder is added to the following mixture until a deep-red fluid is obtained: absolute alcohol, 20 c.c.; hydric acetate, 5 c.c.; distilled water, 40 c.c.

Cover-Glass Preparations.—This method is employed for the examination of fluid exudations—sputa, blood, pus, etc. The cover-glasses must be absolutely clean, or difficulty will be experienced in making the material adhere. A drop of the fluid, or a small bit of the material to be examined, is placed in the centre of a cover-glass with a sterilized platinum loop (Fig. 2214). This, as well as the needles, is sterilized by heating to a white heat in the flame of a Bunsen burner. The material is then covered with a second cover-glass and the two squeezed between the thumb and finger, thus spreading the material out in a thin layer. The covers are now

slid apart, when a thin film will be found adhering to the surface of each. They are allowed to dry in the air, with the prepared side up, and are then passed, held in a pair of sterilized forceps, slowly through the flame of a Bunsen's burner or alcohol lamp three times, care being taken that they are not burned in the process. A convenient form of forceps for this purpose is shown in Fig. 2215. These forceps are platinum-tipped, and so constructed that a cover-glass is held between the points when no pressure is exerted by the fingers. The heating of the cover-glass, by passing it through the flame, fixes the film so that it is not soaked off by the subsequent manipulations. It also coagulates any albuminous matters contained in the specimen, thus preventing the formation of granular precipitates.

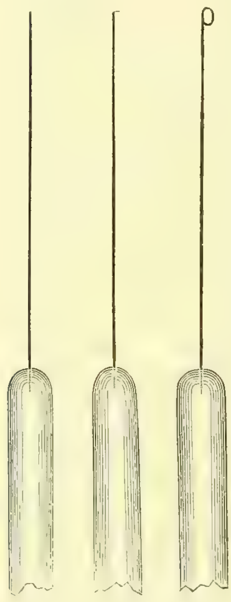


FIG. 2214.—Platinum Needles and Loop.

Pure cultures are diffused in a small drop of sterilized water as follows: A small drop of sterilized water is placed in the centre of a cover-glass, then with a sterilized platinum needle a small bit of the culture is removed and diffused through the drop of water, which is then spread out on the cover-glass and allowed to dry in the air. The cover-glass is then passed three times through the flame.

Cover-glasses prepared as above are stained as follows with the simple dyes: The cover is placed on a piece of filter-paper, prepared side up, and a few drops of the dilute stain are dropped on it with a pipette. The staining fluid is allowed to act from two to five minutes; or a small quantity of the stain is poured into a watch-glass, and the cover is held between the thumb and index-finger, prepared side down, and allowed to fall flat on the surface of the staining fluid, so that it swims. The watch-glass is then covered with a bell-jar, to protect it from dust and prevent evaporation.

When the cover-glasses have become sufficiently stained the surplus stain is washed off. This may be done in one of two ways. The cover-glass being held with a pair of forceps in a perpendicular position, the surplus stain is washed off by directing a stream of water from a wash-bottle against the cover; or the cover is moved to and fro in a beaker of distilled water. The preparation is then examined in a drop of distilled water, care being taken that the upper surface of the cover is thoroughly dry.

Preparations that are to be mounted permanently are allowed to dry in the air, and then mounted directly in a solution of hard Canada balsam in oil of cedar or xylol.

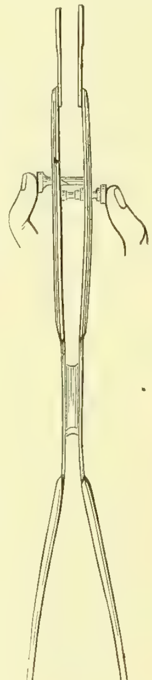


FIG. 2215. — Spring Forceps with Platinum Points.

Cover-Glass Impressions.—A perfectly clean cover-glass is placed on a plate-culture (see below) and gently pressed down. One edge is then raised with a needle, and the cover lifted off with a pair of forceps; this is allowed to dry in the air, and is then treated in the same way as ordinary cover-glass preparations.

Staining of Sections.—Tissues that have been hardened in alcohol are imbedded and sections cut with a microtome. (For these methods see article Histological Technique.) The sections are then stained by one of the following methods.

Löffler's Method: Stain the sections in Löffler's methyl blue solution for from five to ten minutes; then dip in a one-half to one per cent. solution of hydric acetate for a second, and wash in alcohol for ten minutes; the alcohol will require renewing once or twice; clear in oil of cloves and mount in balsam.

Gram's Method: Stain the sections for from three to five minutes in Ehrlich's anilin water gentian violet solution; then put directly into the following solution: Metallic iodine, 1 Gm.; potassium iodide, 2 Gm.; distilled water, 50 c.c., and allow them to remain five minutes. The sections that were at first of a violet color now become dark purple, and are placed in alcohol until they become almost decolorized. It is well to renew the alcohol once or twice. After decolorizing, place in oil of cloves, which abstracts more of the color, and finally mount in Canada balsam. Nuclei and other tissue-elements appear of a light-yellow color, while the various micro-organisms are stained an intense bluish-violet. As a contrast-stain use Bismarck brown, which stains the nuclei brown and other tissue-elements yellowish; or add a few drops of an alcoholic solution of eosin to the oil of cloves, used for clearing, which will stain the tissue-elements red.

For staining the nuclei of the tissue-elements, dilute solutions of carmine or hæmatoxylin are used after the bacteria have been stained. The sections, after being decolorized in alcohol, are placed in water for a minute to remove the alcohol, and then in a solution of carmine or hæmatoxylin for five minutes, carmine being used for sections in which the micro-organisms have been stained blue or violet, and hæmatoxylin for those stained red. They are then washed in water, dehydrated in alcohol, cleared in oil of cedar, and mounted in balsam.

Staining the Bacillus of Tuberculosis.—*a.* In Sputa. Cover-glass preparations are made in the usual manner, and stained by one of the following methods.

Ehrlich's: The cover-glass preparations are stained for twenty-four hours by floating them on Ehrlich's anilin-water solution of fuchsin or methyl violet. The covers are then placed in a twenty-five per cent. solution of nitric acid for two to three seconds; then washed in sixty per cent. alcohol until the color ceases to come away; dried thoroughly, and mounted directly in Canada balsam. It sometimes happens that other bacilli retain a little of the color after the action of the acid. If, after washing in the alcohol, we stain the preparation in a dilute solution of methyl blue for specimens stained with fuchsin, or in Bismarck brown for those stained with methyl violet, these contrast-stains will replace the primary stain in all the bacteria, except the bacilli of tuberculosis, which remain unchanged. The contrast-stain also stains the nuclei. The above process may be hastened by swimming the cover-glasses, prepared side down, on the staining solution contained in a watch-glass, and boiling gently for from three to five minutes. The cover-glasses are then treated as above. Preparations stained by this method show the bacilli stained red or violet on a blue or brown ground. This is the most useful method.

Rindfleisch's: The staining fluid is prepared by adding ten drops of a saturated alcoholic solution of fuchsin to 70 c.c. of freshly prepared anilin water. This is poured into a watch-glass, and the cover-glass, prepared side down, is floated on the staining fluid, which is heated over a flame until steam arises from the surface of the staining fluid. The cover-glass is then removed with a pair of forceps, washed in distilled water to remove the surplus stain, and placed in a watch-glass of alcohol, to which a few drops of nitric acid have been added, and allowed to remain for a quarter of a minute; it is then removed and washed well in water, dried in the air, and mounted in Canada balsam.

Kaatzer's: The cover-glass preparations are stained in anilin water, 10 c.c.; saturated alcoholic solution of gen-

Micro-Organisms.

tian violet, 15 drops. The preparations are floated on this fluid, which is warmed to 80° C., and the stain allowed to act for a few minutes. The cover-glass is then removed, the superfluous stain removed with filter-paper, and the cover-glass immersed in the following fluid for half a minute: alcohol, ninety per cent., 150 c.c.; distilled water, 30 c.c.; hydrochloric acid, 1 c.c. It is then washed thoroughly in ninety per cent. alcohol, until all the color disappears from the specimen, is dried, and stained with a dilute solution of Bismarck brown; washed again in distilled water, dried, and mounted in Canada balsam.

b. In Tissues. Sections of tissues hardened in alcohol are stained for twenty-four hours in either of the above solutions; decolorized in the acid for a few seconds; washed in sixty per cent. alcohol; dehydrated in absolute alcohol; cleared in oil of cedar, and mounted in balsam thinned with oil of cedar or xylol. Oil of cloves withdraws considerable of the color from the bacilli, so that they may remain but slightly stained; if balsam thinned with chloroform is used for mounting, the color in the bacilli soon fades.

Staining the Bacillus of Leprosy.—Sections are stained in the same manner as those containing the bacillus of tuberculosis.

Staining the Pneumococcus of Friedländer.—Friedländer's method: Cover-glass preparations of the lung-exudate are dipped, for a second, in hydric acetate, the acid blown off with a pointed glass tube, and the cover-glass dried quickly in the air. The preparations are then placed, for a second, in a saturated solution of gentian violet in anilin water, washed in water, and examined in the same. By this method the tissue-elements remain entirely uncolored, or nearly so, while the capsule of the cocci, when they are present, stands out sharply. For staining the capsule in sections, proceed as follows: Stain the sections for twenty-four hours in an acid gentian violet solution (saturated alcoholic solution of gentian-violet, 50 c.c.; distilled water, 100 c.c.; hydric acetate, 10 c.c.); then decolorize in a 0.1 per cent. solution of hydric acetate for one or two minutes; then wash in water, dehydrate in alcohol; clear in oil of cloves, and mount in balsam. If the decolorizing has been carried just far enough, the capsule appears stained a lighter blue than the central part.

Staining the Bacillus of Typhoid Fever.—This bacillus is difficult to stain in tissues, while pure cultures stain readily with the usual dyes. Gaffky stains sections for twenty-four hours in a deep-blue, opaque solution of methyl blue, which is made fresh each time by adding the saturated alcoholic solution to distilled water. The sections are then washed in distilled water, which must be free from acid, dehydrated in absolute alcohol, cleared in turpentine, and mounted in balsam.

Better results are obtained by the use of carbolic-water-fuchsin solution (water, 100 c.c.; carbolic acid, 5 c.c.; filter, and add saturated alcoholic solution of fuchsin, 3 c.c., and again filter). Sections are stained in this fluid for twenty-four hours; then carefully washed in dilute alcohol until the color is nearly discharged; and finally dehydrated and mounted in balsam. The too vigorous application of alcohol in this manipulation is likely to withdraw the color from the bacilli as well as from the tissue. These bacilli are decolorized by Gram's method.

Staining Lustgarten's Syphilis Bacillus.—He stains sections in Weigert-Ehrlich's solution of gentian violet for from twelve to twenty-four hours at the temperature of the room, then for two hours in the warm oven at a temperature of 40° C. He now washes in absolute alcohol for a minute, then in a one per cent. solution of potassium permanganate, using a glass or platinum needle, for ten seconds. In this fluid a precipitate of manganese dioxide is formed, which also covers the sections. The sections are now placed in an aqueous solution of sulphurous acid, made by the action of sulphuric acid on metallic copper. They remain in this, according to the concentration of the acid, for from a few seconds to a minute, until all the manganese dioxide is reduced to manganous oxide; some places will now appear intensely stained, while others are entirely colorless. They are washed in water and again placed in the solution of potassium permanganate for three to four seconds, then in the sulphurous acid, and so on until they become colorless. As a rule, three or four repetitions of this are sufficient. The preparation is dehydrated in alcohol, cleared in oil of cloves, and mounted in xylol balsam.

Giacomi stains cover-glass preparations in warm fuchsin solution for a few minutes, then places them in a watch-glass of water, to which a drop of ferric chloride has been added, for a minute, then decolorizes in a strong solution of the same, and washes in water. The syphilis bacilli are stained red, but all others remain colorless. Gottstein states that the same results can be obtained with a five per cent. solution of potassium bichromate, or a two per cent. solution of silver nitrate. He stains sections for twenty-four hours in an anilin water solution of gentian violet or fuchsin, washes in water, then in a dilute solution of ferric chloride, washes in alcohol, clears in oil of cloves or xylol, and mounts in balsam.

Staining the Spirillum of Relapsing Fever.—According to Koch, these are stained best with an aqueous solution of Bismarck brown. With this dye they stain very faintly. Hueppe recommends the method of Löffler as being the best.

Staining of Spores.—Cover-glass preparations are made in the usual way, with the exception that they are passed through the flame ten times instead of three; or, after drying in the air they are exposed to a temperature of 180° to 200° C., for from fifteen to thirty minutes, in the hot-air sterilizer. The cover-glasses that have been heated as above are floated on an anilin-water solution of gentian violet or fuchsin in a watch-glass, and gently boiled for five or ten minutes, when the micro-organism and its contained spores will be deeply and uniformly stained. The next step in the proceeding will depend upon the species of the micro-organism. Some—for example, the *bacillus megatherium*—show well when the surplus stain is washed off and the preparation stained in an aqueous solution of Bismarck brown. Others require to be decolorized for a second in alcohol before applying the contrast-stain (methyl blue for those stained with fuchsin, Bismarck brown for those stained with violet). Sometimes it is necessary to carefully use dilute acetic acid in place of the alcohol, in order to obtain sharp pictures. After staining in the contrast-stain the preparations are dried in the air and mounted in balsam. By this method the spores are stained red or violet, the bacteria blue or brown.

Staining of Flagella.—These are best stained after the method of Koch. Cover-glass preparations are made in the usual manner and stained in concentrated aqueous solution of the extract of logwood, and then placed in a five per cent. solution of chromic acid. The acid unites with the logwood and forms an insoluble brownish-black pigment. The covers are then washed in water and mounted in glycerine, or, after drying in the air, in balsam.

II. Moulds.—The sporongia may be examined in an unstained condition by the following method: Pick off a bit of the mould with a pair of forceps, and place it in a watch-glass of sixty per cent. alcohol to which a few drops of ammonia have been added. After a few minutes, transfer it to a drop of glycerine on a slide, tease apart with needles, cover, and examine. For staining moulds, Löffler's methyl-blue solution, or Weigert's method with orchella (see below), may be employed.

Staining Actinomycosis.—Weigert stains sections in Wedl's solution of orseille for one hour; then in a two per cent. solution of gentian violet for five minutes; then washes in strong alcohol, clears in oil of cloves, and mounts in balsam. The nuclei stain blue-violet, the inner zone of the actinomycosis-nodule a fading bluish tint, the rays of the fungus deep red.

For microscopical examination of micro-organisms good high-power, dry lenses may be used, but for fine work the homogeneous system of objectives should be employed. For illumination the Abbé condenser is used, by means of which the color-picture is brought out sharply, structural details being obliterated.

CULTURE METHODS.—*Sterilization.*—In order to obtain pure cultures of a micro-organism, it is necessary that the cultivation media, vessels, instruments, etc., should be absolutely free from all forms of contamination. This is accomplished by sterilization.

The sterilization of cultivation media is best accomplished in the steam sterilizer of Koch (Figs. 2216 and 2217). It consists of a cylinder of copper, half a metre high and twenty-five centimetres in diameter, which is surrounded with

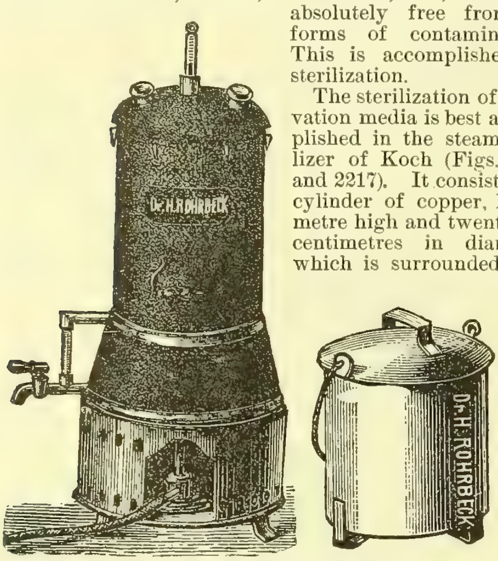


FIG. 2216.—Koch's Steam Sterilizer.

a covering of felt, *M*, to prevent loss of heat by radiation. In the interior of the cylinder, at *R*, is placed a grate for supporting the vessels; the space under this is filled two-thirds full of water, which is heated by a number of gas-burners placed underneath the bottom. The cylinder is closed with a cover, *D*, also covered with felt. In a tube in the top is placed the thermometer, *th*. The pail shown in the right of Fig. 2216 has a grating for its bottom, to allow free access of the steam, and in it are placed small vessels, test-tubes, potatoes, etc.; the pail is then covered and placed in the sterilizer.

The Pasteur school sterilizes at a temperature of 110° C. To obtain this temperature in cultivation media, H. Foll has devised the apparatus shown in Fig. 2218, which is an adaptation of Papin's digestor.

The apparatus is filled with the fluid to be sterilized so that the bulb of the thermometer, *th*, is covered. The cover is now put on and screwed down by the screw *S*. The apparatus is then heated over the flame or in a salt-, oil- or paraffin-bath for one hour; but gelatine media are heated for half an hour only, or else the gelatine will not solidify on cooling. When the fluid has been sterilized the tube, *t*, is drawn up so that the opening, *o*, shall be at *t*, then the clip, *k*, is opened and the steam allowed to escape for ten minutes, when the clip is closed and the tube pushed down again to the bottom of the apparatus. The escape of the steam at this temperature (110° C.) sterilizes the tube and cannula. The cannula, *C*, is fitted with a trocar point and has an oval opening in its side. This cannula is used for filling the culture vessels.

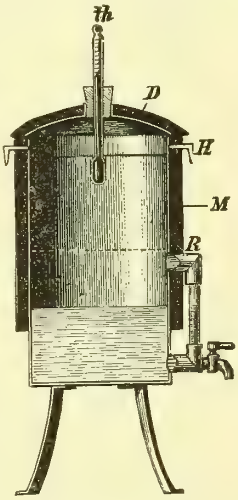


FIG. 2217.—Section of Koch's Steam Sterilizer.

All glass apparatus, flasks, etc., are sterilized at a temperature of 150° to 160° C. They are first washed with soap and water, well rinsed in clear water, and allowed to drain. Flasks and test-tubes are plugged with a closely-fitting mass of cotton.

The flasks are placed directly in the hot-air sterilizer; the test-tubes are first placed in the wire cage (Fig. 2219), and this is placed in the sterilizer.

The hot-air sterilizer (Fig. 2220) consists of a double-

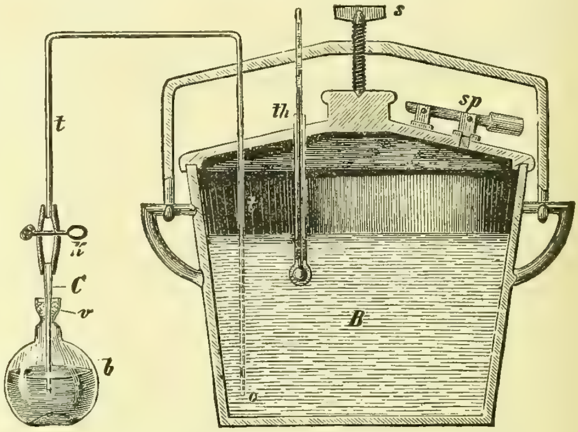


FIG. 2218.—Foll's Sterilizer.

walled box of sheet-iron, supported on four legs or hung on the wall, a sheet of asbestos being placed between it and the wall. It is heated by a large Bunsen burner placed underneath. In the top are two openings, one for a thermometer, the other for a thermostat. The latter is not absolutely necessary, as the temperature can be easily regulated by raising or lowering the flame.

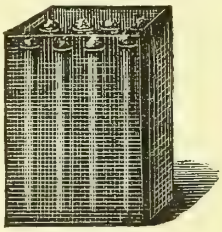


FIG. 2219.—Wire Cage.

All apparatus must be kept at a temperature of 150° to 160° C. in this sterilizer, for at least one hour. The gas is then shut off, and the contents allowed to remain until they have become cold.

Metal instruments, after being thoroughly cleaned, may be sterilized by heating in the flame, and then placing them on a piece of sterilized wire gauze, protected from the dust by a bell-jar, where they are allowed to cool; or they may be placed in a sheet-iron box, covered, and heated to 150° to 160° C. in the hot-air sterilizer for one hour.

INCUBATION.—Many forms of micro-organisms do not grow at the ordinary temperature of the room, but require an elevated temperature. In order to obtain this degree of heat, and at the same time keep it uniform, it is necessary to employ a special piece of apparatus. Such an apparatus is known as an incubator, or culture-oven. It consists of a double-walled box (Fig. 2221) of copper the sides and top being covered with felt. The interspace between the walls is filled with water. In the top is an opening communicating with the interior air-space, in which a thermometer is placed for indicating the temperature; the openings in

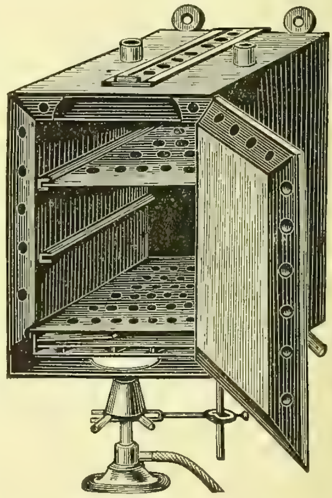


FIG. 2220.—Hot-air Sterilizer.

the corners communicate with the water-space ; in one is placed a thermometer, and in the other the thermostat for

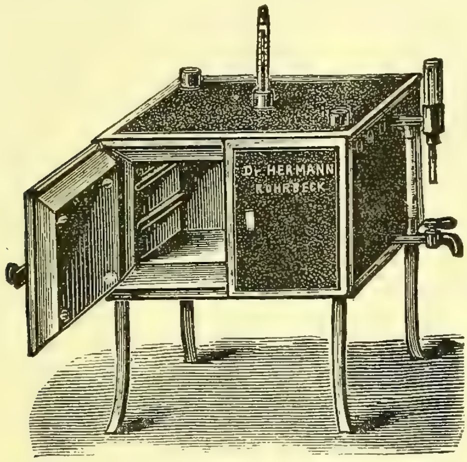


FIG. 2221.—Koch's Incubator.

regulating the temperature. The water-space is filled through one of these openings.

The apparatus is heated by one or more of Koch's safety burners, placed under the bottom. These burners are shown in Fig. 2222. The stop-cock has a long, lever-like handle. On each side of the burner is a spiral, and the two are constructed of different metals, so that they have a different rate of expansion. These spirals act on the catch seen

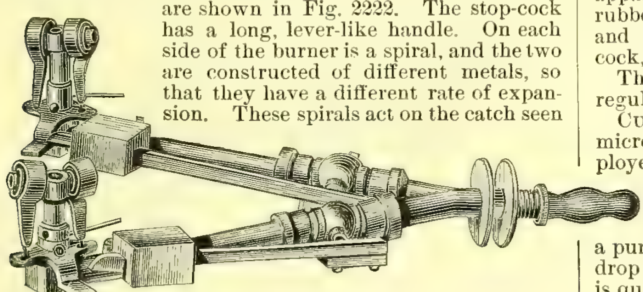


FIG. 2222.—Koch's Safety Burners.

at the foot of the burner, and in expanding turn it so that it catches the end of the lever attached to the stop-cock, holding it in a horizontal position and allowing the gas to flow. If by any accident the flame should become extinguished, the spirals cool, contract, and release the point of the lever, which falls and shuts off the supply of gas to the burner.

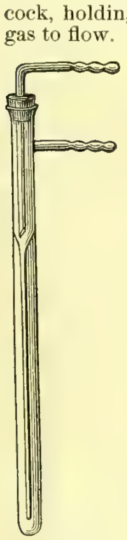


FIG. 2223.—The Thermostat.

For regulating the temperature the thermostat (Fig. 2223) is recommended, on account of its extreme delicacy. The reservoir (the lower part of the large tube) is nearly filled with a mixture of equal parts of alcohol and ether. This is accomplished by pouring the mixture into the upper part of the instrument, and then alternately heating and cooling the reservoir, by which the air is driven out and its place taken by the vapor of the alcohol and ether. A sufficient quantity of mercury, to act as a valve, is now poured in, and the cork, through which the gas-tu e passes, is placed in the opening in the top. This tube is first drawn up and, when the proper temperature has been reached, it is pushed down into the mercury, thus cutting off the flow of gas through its end. A small opening in the side of this tube allows enough gas to pass to the burner, so as to prevent extinguishment. By cautious adjustment, it is easy to find the position at which the tension of the vapor is sufficient to raise the mercury, so that it will close the end of the tube when the proper temperature is reached.

In order to have this instrument work properly, the pressure of gas should be uniform. This is accomplished by placing the gas-pressure apparatus (Fig. 2224) between the source of supply and the thermostat. This apparatus consists of a cylinder, *A*, which is filled to the level of *g* with a mixture of equal parts of glycerine and water. On this is floated the metal shell, *B*. The gas is admitted to the interior of *B*, through the tube, *k*, the pressure being indicated by the manometer, *p*. The gas flows into *B* until it is filled, when it raises it up and shuts off the supply of gas by closing the valve, *d*. The pressure on the burner is regulated by the weights placed in the pan, *h*, which is connected with *B* by the rod, *g*. The amount of pressure on the burner is indicated by the manometer on the left of the apparatus. The burner is connected with the apparatus by means of a rubber tube attached to *i*, and the height of the flame is regulated by the stop-cock, *m*.

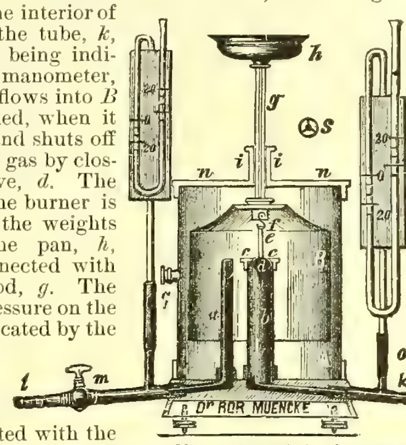


FIG. 2224.—Moitessier's Gas-pressure Regulator.

The incubator may also be heated by any of the self-regulating oil-lamps used for the incubation of chickens.

CULTURE MEDIA.—For the artificial cultivation of micro-organisms, either solid or fluid media may be employed. The latter were used exclusively by the earlier investigators, but they have largely given place to the more advantageous solid media introduced by Koch. With a fluid medium it is difficult to obtain a pure culture from a mixture of micro-organisms. If a drop of such is introduced into a sterile fluid medium, it is quickly disseminated, each germ reproduces its own species, its progeny are soon floating through the fluid, and the result is a mixed culture. If, on the other hand, a drop of the same mixture is introduced into a tube of melted gelatine, and this allowed to cool, each germ will become separated from the others by a wall of solid gelatine, and under proper conditions will develop into a colony of its own distinct species, which by proper manipulation can be removed and resown (see below). Again, the solid media possess advantages for studying the morphological characters of a micro-organism. Each species, when sown on a solid medium, presents some special characteristic, such as the formation of pigment, liquefaction of the gelatine, peculiar modes of growth on different media, etc. Air contaminations are easily recognized, as they grow on the surface only. Finally, the convenience of manipulation is a great advantage.

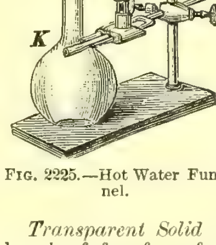


FIG. 2225.—Hot Water Funnel.

The solid media are divided into two groups, solid transparent media and solid opaque media. To the first group belong the gelatinized nutrient solutions and coagulated blood-serum. To the second potatoes, bread-paste, fruits, etc.

Transparent Solid Media.—Gelatine. One pound of lean beef, free from fat and tendon, is chopped fine ; to this is added 1,000 c.c. of distilled water, and it is allowed to stand in a cool place for from twelve to fifteen hours. At

the end of this time it is strained through a linen cloth and the beef is squeezed. The solution is to be made up to 1,000 c.c., if necessary, by the addition of distilled water. This fluid is then placed in a large flask (2 litres) and 10 Gm. of peptonum siccum, 5 Gm. of sodium chloride, and 100 Gm. of French gelatine added. The flask is then heated on a water-bath until the gelatine is melted and the peptone and salt dissolved. The reaction of this mixture will be acid, and as most micro-organisms require a neutral or slightly alkaline medium for their successful growth, this acidity must be neutralized. This is accomplished by adding a saturated solution of sodium bicarbonate. A few cubic centimetres of the soda solution are added to the contents of the flask, which is then well shaken and a drop removed with a glass rod and tested, first with blue, and then with red litmus paper. This operation is repeated until the red paper shows a very slight blue tinge. The gelatine solution is now heated in the steam sterilizer for thirty minutes, when the matter coagulable by heat and the products of neutralization will be precipitated. Care must be taken not to prolong the heating, or the gelatine will be converted into metagelatine, and will not solidify upon cooling.

The solution is now strained through flannel and filtered through paper or absorbent cotton. A glass funnel is fitted, water-tight, in a copper funnel, *T* (Fig. 2225), and the space between the two filled with water, which is warmed by a flame placed under *a*, the filtrate being received in the sterilized flask, *K*. If the gelatine is filtered through paper, a round filter is plaited and placed in the funnel, the point being reinforced by a small round filter folded in a quadrant, or by a bit of folded gauze first placed in the apex of the funnel. During the filtration the funnel should be covered with a glass plate or filter to protect its contents from dust. In using absorbent cotton the neck of the funnel is packed rather loosely with the cotton, and then put in the hot-water funnel. The filtering through paper is a long, tedious process, while the filtering through cotton is much quicker. The experience in the laboratory of the Alumni Association of the College of Physicians and Surgeons, is that an equally clear gelatine can be obtained by the latter method as by the former.

The filtrate must, when cold, be solid and perfectly transparent. In some cases the gelatine, even after repeated filtration, will remain cloudy ; but this can, as a rule, be corrected by the following procedure : The gelatine is allowed to cool as much as possible without solidifying, the white of an egg is added, and the flask is well shaken. It is then heated in the steam sterilizer until the albumen is coagulated, the coagulum carrying down with it all the suspended matter, leaving the gelatine perfectly transparent. The coagulated albumen is removed by straining the gelatine through flannel.

The clear gelatine is now poured into sterilized test-tubes. The cotton plug is removed from the mouth of the test-tube with the third and little fingers of the right hand, a small sterilized glass funnel is placed in the test-tube, and the gelatine poured through this into the tube until it is about one-third full. The funnel is removed with the thumb and index-finger of the right hand, and the cotton plug replaced in the mouth of the test-tube. After all the tubes have been filled they are placed in the pail (Fig. 2216), and this is placed in the steam sterilizer for twenty minutes. The water in the sterilizer must be boiling when the pail is put in. This process is repeated on the next day, and when the tubes have become cold they are ready for sowing. Any gelatine remaining after filling the tubes can be preserved in flasks plugged with sterilized cotton, the flasks being sterilized with the test-tubes.

Agar-Agar. Agar-agar, or Japan isinglass, is a gelatinous material obtained from *Gracilaria lichenoides* and *Gigartina speciosa.* It is used in place of gelatine, as it will stand a higher temperature without liquefying. A ten per cent. solution of gelatine becomes liquid at about 30° C., while a one per cent. solution of agar-agar will remain solid up to 45° C. This is a decided advantage when we wish to cultivate the micro-organisms at an elevated temperature (37° C.).

The beef-juice is prepared as in the gelatine solution. To it are added the same amount of peptone and sodium chloride as in the gelatine solution, and one per cent. of agar-agar. It is then heated on a water-bath until the agar-agar is dissolved ; then neutralized or rendered very slightly alkaline with sodium bicarbonate, and heated in the steam sterilizer for one hour. It is then strained through flannel and filtered through absorbent cotton in the hot-water funnel, or the glass funnel and flask are placed in the steam sterilizer. Agar-agar filters very slowly, and the filtrate will never be as clear as the gelatine, being slightly opalescent when cold.

The test-tubes are filled in the same manner as with gelatine. After the final sterilization they are placed in an inclined position and allowed to cool. By this means a larger surface for cultivation is obtained. After the tubes have cooled a quantity of condensation water will be found at the bottom of the inclined surface. This condensation water serves to keep the air in the test-tube moist ; but in sowing the tubes, care must be taken not to allow it to flow over the surface of the agar-agar, or the culture will spread over the entire surface.

Slide Cultures (Plate XIX., Fig. 17). The ordinary microscopical slides are thoroughly cleaned and placed in a small beaker, which is covered with a larger one, and then placed in the hot-air sterilizer for one hour, at a temperature of 150° to 160° C. After cooling, a number of these slides are placed on the levelling apparatus (Fig.

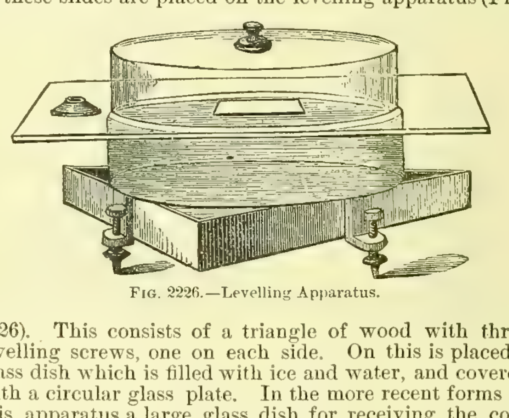


Fig. 2226.—Levelling Apparatus.

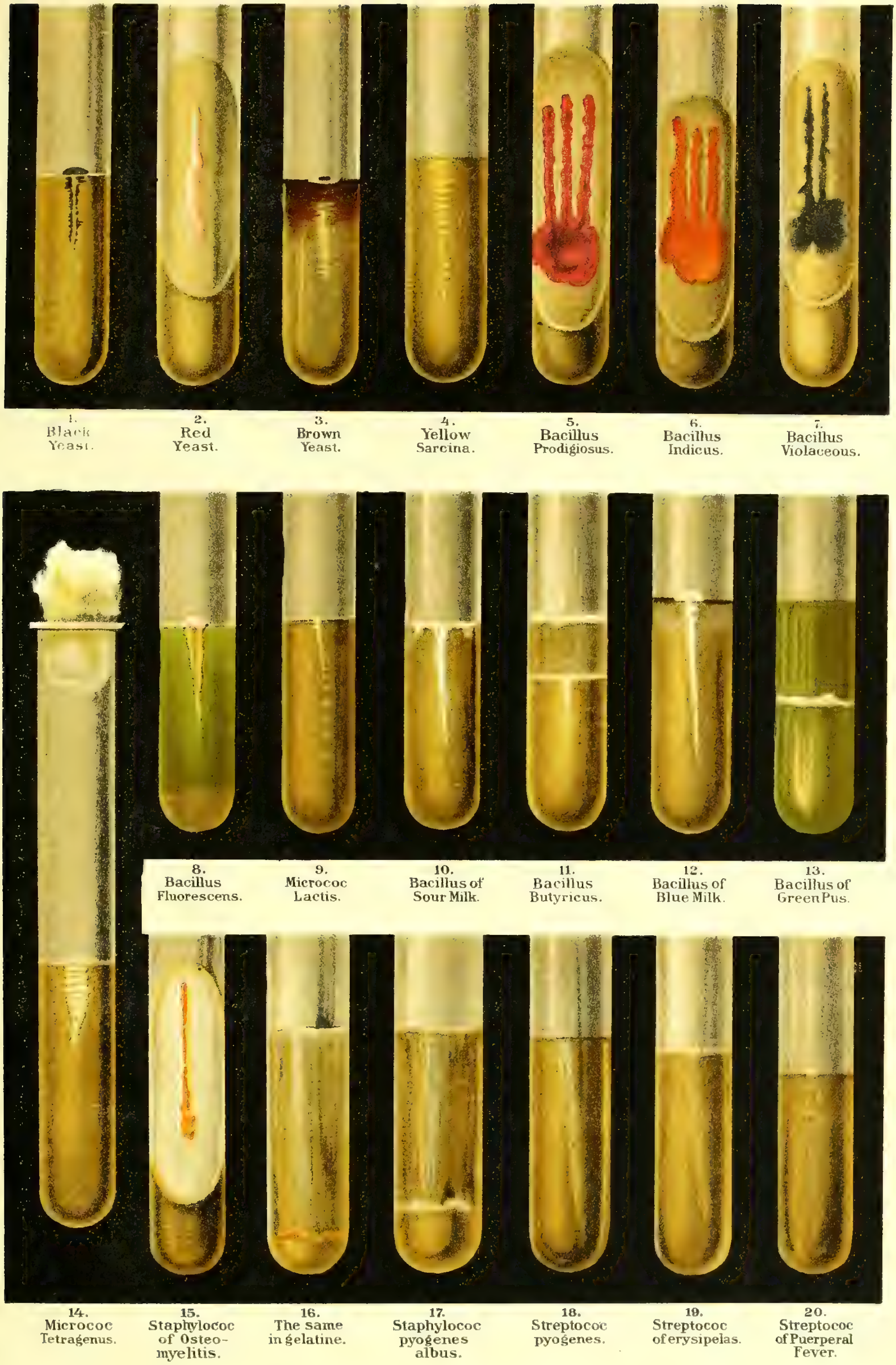
2226). This consists of a triangle of wood with three levelling screws, one on each side. On this is placed a glass dish which is filled with ice and water, and covered with a circular glass plate. In the more recent forms of this apparatus a large glass dish for receiving the condensed moisture is placed on the triangle, and the dish containing the ice-water fitted in this by means of pieces of cork.

A small, round level is placed on the glass plate and the apparatus brought to an absolute level by manipulation of the levelling screws. The slides are placed on the glass plate, being handled with sterilized forceps, and covered with the bell-jar to protect them from dust.

The test-tubes of nutrient gelatine are placed in water at 30° C., and when melted, the gelatine is removed with a sterilized pipette and spread in a long, thin layer on the slides, care being taken that it does not extend to the edge of the slide at any point. The slides are covered with the bell-jar and the gelatine is allowed to become nearly solid. The slides are now sown by drawing a sterilized platinum needle (Fig. 2214), charged with the seed material, lightly across the gelatine, forming from three to five lines, care being observed not to go through the layer of gelatine. By this procedure the germs, if they are not too numerous, become separated so far from each other that each germ may develop into a colony.

The slides are now labelled and placed in a moist chamber formed of a pair of double glass dishes (Fig. 2227). Another form of these, without the handle, is used. In this form the larger dish is used as the cover. These are thoroughly washed with a one to one thousand solution of mercuric chloride ; a round filter, two-thirds the diameter of the dish, is placed in the bottom of the lower dish and a second one in the cover. All surplus mercury solution is drained off. The slides are arranged on a glass or zinc bench, preferably the former, placed

PLATE XVIII.



TEST-TUBE CULTURES.

Reproduced from Huber & Becker's "Pathologischen - Histologischen - Bacteriologischen Untersuchungs - Methoden."

Micro-Organisms.

in the bottom of the dish, with two to four slides to a bench. Over this is placed a second bench, and on it the same number of slides (Fig. 2228). In this way several tiers can be placed in one dish. These benches can be made from a strip of zinc fourteen centimetres long and four centimetres wide, each end being bent

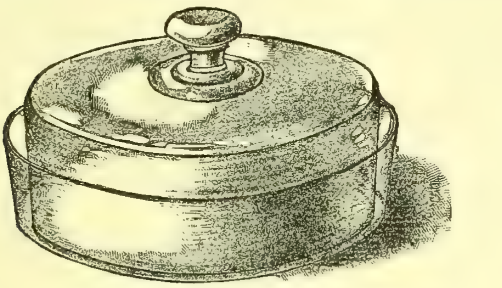


FIG. 2227.—Double Glass Dishes.

over. The glass ones are made from plates of glass fourteen centimetres long by four centimetres wide, to the ends of which are cemented strips of glass one centimetre square. As a cement, hard Canada balsam, sealing-wax, or shellac may be used, heat being employed in its application.

The growth along the line of sowing is examined with a magnifying power of about thirty diameters, and if different forms of colonies have developed, a second sowing is made from each colony on a fresh slide. After a few transfers, only a single form will remain on the slide. These transfers are made with a sterilized platinum needle, the seed being taken from the edge of a growing colony in which the characteristic differences

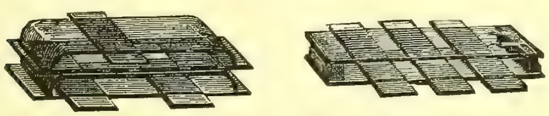


FIG. 2228.—Benches for Slides and Plates.

are as pronounced as possible. For control, it is necessary to make cover-glass preparations of each colony transferred, for microscopical examination. When a pure culture has been obtained, sowings are made in gelatine tubes (see below).

Plate Cultures (Plate XIX., Fig. 18).—For this purpose we use glass plates eight centimetres wide, fourteen centimetres long, and of the thickness of an ordinary slide. These plates are thoroughly cleansed and placed in the plate-box (Fig. 2229), made of sheet-iron and heated in the hot-air sterilizer for one hour, at a temperature of 160° C. When cool, the box is placed in a horizontal position on the edge of a table; the cover is removed and a plate withdrawn by grasping the corners between the thumb and index-finger of the right hand; the cover is then replaced; the plate is put on the ground-glass plate of the levelling apparatus (Fig. 2226), and covered with the bell-jar. While the plate is cooling, a number of gelatine tubes are to be melted by being placed in water at a temperature of 30° C. A tube is then taken between the thumb and index-finger of the left hand, being held in as near a horizontal position as possible, and

FIG. 2229.—Plate-box.

the cotton plug removed with the last two fingers of the right hand. A sterilized platinum needle or loop, charged with a small quantity of the seed material, is introduced into the gelatine, moved to and fro in it; it is then removed, and the cotton plug is replaced. The test-tube is gently shaken so as to diffuse the germs through the melted gelatine. This is called the original tube, and from it the first dilution is made. This tube and a tube of melted gelatine are held between the thumb and index-finger of the left hand in as nearly a horizontal position as possible (Fig. 2230). The cotton plug is removed from the original tube with the backs of the third and fourth fingers of the right hand, and the plug from the new tube with second and third fingers of the same hand. Then, with a sterilized platinum loop, held like a pen between the thumb and index-finger of the right hand, a drop is withdrawn from the original tube and thoroughly mixed with the gelatine in the second tube.

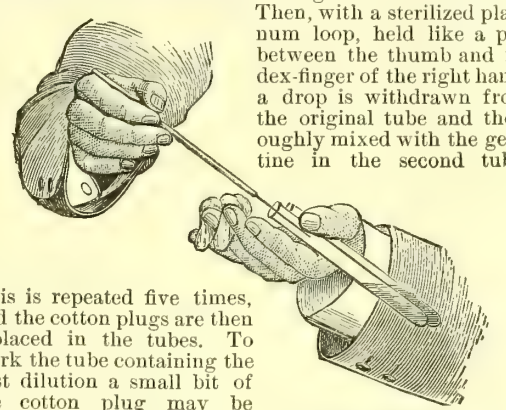


FIG. 2230.—Method of Holding Tubes in Making Dilutions.

This is repeated five times, and the cotton plugs are then replaced in the tubes. To mark the tube containing the first dilution a small bit of the cotton plug may be twisted up; the second dilution may be marked by two twists, and so on. A second dilution is made in the same manner from the first; a third from the second, and so on. As a rule, three dilutions are all that are necessary, though with some forms that liquefy gelatine quickly it is advisable to make even a fifth dilution.

After the dilutions are made we proceed to plate them. The cotton plug is removed from the original tube and the contents poured out upon the glass plate on the levelling apparatus, and spread out in an even layer, with a sterilized glass rod, to within half an inch of the edges of the plate. The plate is then covered with a bell-jar, and the gelatine allowed to set. A moist chamber is prepared in the same manner as for slide cultures. On the bottom of the dish is placed a glass bench; upon this a piece of sterilized filter-paper, cut to the size of the bench, upon which is written the description of the plate, the number of the dilution, and the date. Upon this is placed the plate, and over this a glass bench (Fig. 2231). This process is repeated with all the dilutions,

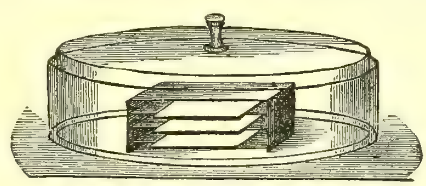


FIG 2231.—Moist Chamber, with Plates.

and the moist chamber set aside for twenty-four hours or longer to allow the colonies to develop.

The agar-agar culture medium can also be employed for plate cultures, but, on account of its higher melting-point, the manipulation is more difficult. The test-tubes containing the agar-agar are placed in water at a temperature of 40° to 42° C., and the water kept at this temperature until the agar-agar has become fluid. The sowing and dilutions are made while the tubes are in the water. They are then rapidly poured out upon the plates and spread, as in the gelatine method.

After the colonies have developed, the plates are examined by placing one on the stage of a microscope, and using a low power ($\frac{3}{8}$ or $\frac{1}{4}$ inch objective). Having selected a characteristic colony, test-tubes of gelatine and agar-agar are sown from it. This is done by removing, with a sterilized platinum needle, a small portion from the edge of the colony and placing it in a test-tube (see test-tube cultures). A cover-glass preparation is made from the same colony, stained, and examined.

E. Esmarch has introduced a modification of the above

method by spreading the gelatine out on the sides of the test-tube. He uses rather wide tubes and about 10 c.c. of gelatine to a tube. A tube of gelatine is melted in warm water, the cotton plug removed, and a drop of the material to be plated introduced into the tube with a sterilized platinum loop. This is thoroughly distributed through the gelatine by gentle shaking. The cotton plug is replaced and a rubber cap placed over it. The tube is now floated on ice-water, and slowly rotated with the right hand until the gelatine has become solid, which requires about fifteen to twenty seconds. During the rotation the neck of the tube is clasped with the left hand, so that the tube shall lie level and the gelatine be evenly distributed.

FIG. 2232.—E. Esmarch's Modified Plate Culture in a Test-tube.

After the colonies have developed they will appear as shown in Fig. 2232.

For microscopical examination the tube is placed on the stage of the microscope and held by two sheet-zinc clamps, screwed in the place of the ordinary slide-clamps, and bent so as to grasp the tube and hold it securely.

In order to obtain material from a colony for sowing or cover-glass preparations, the cotton plug should be gently removed, when, in most cases, the lumen of the tube will be found closed with a thin layer of cotton and gelatine melted together; a large opening is melted in this with a hot platinum needle, and through the opening so formed the colony is fished out with a sterilized platinum needle. This manipulation must be made under the control of the microscope.

Drop-Cultures. For this purpose a hollow slide (Figs. 2233 and 2234) is used. This is thoroughly cleaned and sterilized in the flame of a Bunsen burner. When cold, a ring of vaseline is painted around the edge of the hollow in the slide, or around the edge of the cell. A cover-glass is sterilized by heating in the flame; when cold a small drop of the culture medium is placed in its centre with a sterilized platinum loop, and sown by touching it with a sterilized platinum needle charged with a very small quantity of the seed material. The cover-glass is then taken up with sterilized forceps, inverted, and placed on the slide so that the drop will come in the centre of the hollow or cell. A ring of vaseline is then painted around the edge of the cover-glass, and the preparation is labelled and set

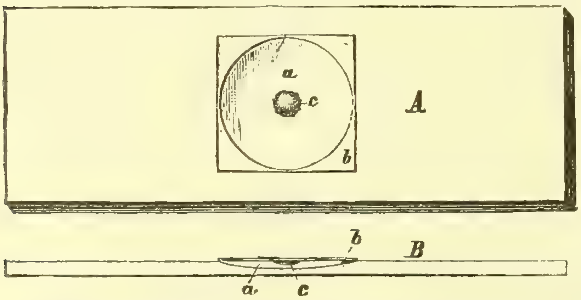


FIG. 2233.—Drop Culture in a Hollow Slide. *A*, surface view; *B*, side view; *a*, hollow; *b*, cover-glass; *c*, drop of culture medium.

aside to allow the bacteria to develop. The preparation is examined from time to time, under the microscope, and the various phases of development are thus studied.

Test-tube Cultures (Plates XVIII. and XIX.). The test-tube to be sown is held in a perpendicular position, mouth down, to prevent contamination by the settling of air-germs. The cotton plug is removed with the third and fourth fingers of the right hand, and a platinum needle, charged with the seed material, is thrust once

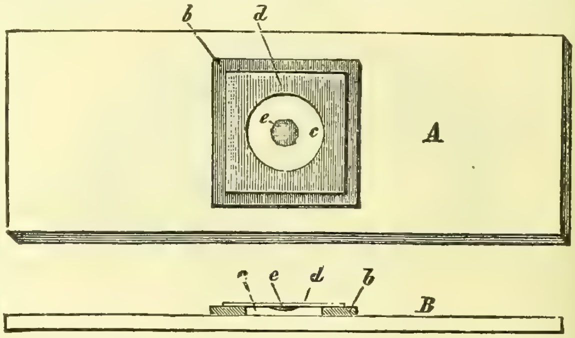


FIG. 2234.—Drop Culture in a Cell Slide. *A*, surface view; *B*, side view; *b*, edge of cell; *c*, hollow of cell; *d*, cover-glass; *e*, drop of culture medium.

into the gelatine, after which the cotton plug is replaced. With agar-agar tubes it is well to draw a line on the surface after making the thrust.

In cases where a tube is to be sown from one in which the gelatine has become liquefied, the tube cannot be inverted, but it must be held in a position as nearly horizontal as possible. The manner of holding the tubes is shown in Fig. 2235, the tube containing the fluid gelatine being held next the thumb.

The test-tubes are labelled and set aside for development. For holding the test-tubes, tumblers, with a bit of cotton in the bottom, and test-tube racks, may be used.

Blood Serum. The blood of the ox or sheep is used. For collecting the blood, tall glass-stoppered jars, eight to ten centimetres in diameter, are used. These, after being thoroughly washed with soap and water, and well rinsed in pure water, are sterilized by washing with a 1 to 1,000 solution of mercuric chloride. This is poured out and the jar washed with alcohol; the alcohol is poured out and ether added; the surplus ether is poured out and what remains evaporated by gently

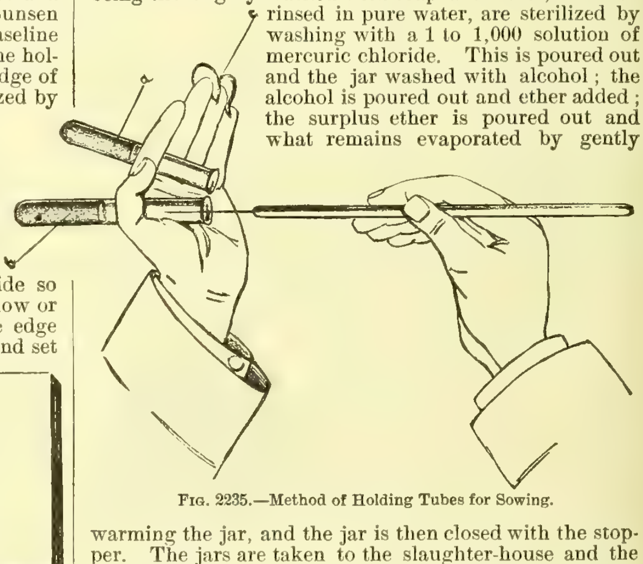
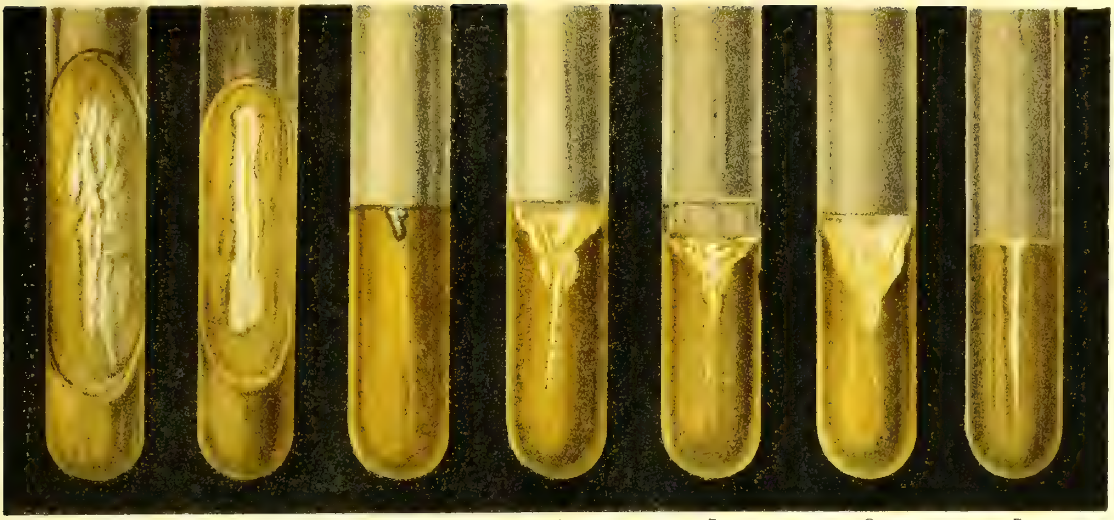


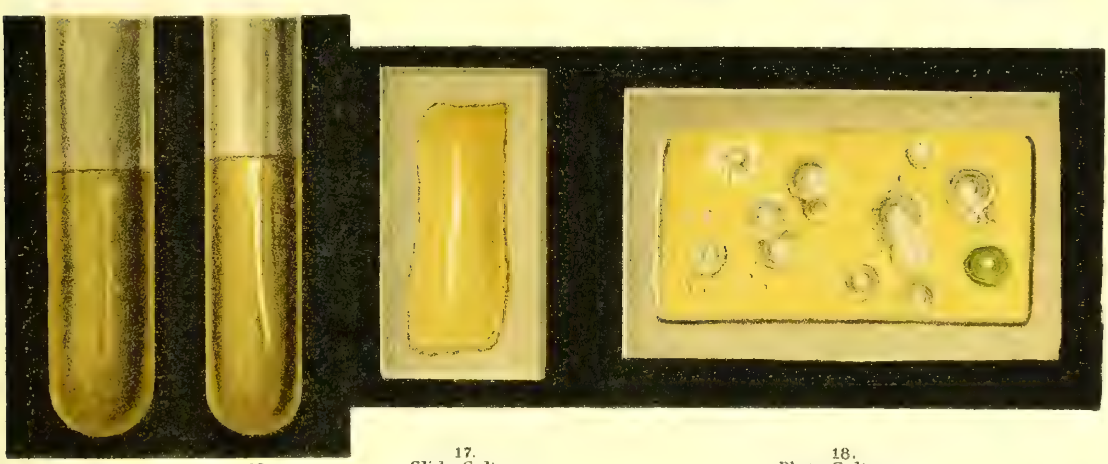
FIG. 2235.—Method of Holding Tubes for Sowing.

warming the jar, and the jar is then closed with the stopper. The jars are taken to the slaughter-house and the blood is received in them directly from the cut artery, the first spurt being rejected. The jars are filled nearly full, closed with the stopper, and carefully removed to the laboratory. After standing two hours the stopper is removed, and the edge of the clot separated from the sides of the jar with a sterilized glass rod. The stopper is replaced and the jar allowed to stand in a refrigerator for twenty-four hours. At the end of this time the clot will be found suspended in the clear serum. This is carefully drawn off with a sterilized pipette, taking care not to



1. Bacillus of Tuberculosis.
2. Bacillus of Cholera Asiatica.
3. The same in gelatine.
4. Finkler-Prior, Comma Bacillus.
5. Denecke's Bacillus.
6. Miller's Bacillus.
7. Bacillus of Typhoid Fever.

8. Pneumococcus.
9. Bacillus of Glanders.
10. Bacillus of Anthrax.
11. The same in gelatine.
12 Bacillus of Malignant Oedema.
13. Bacillus of Septicaemia of Mice.
14. Bacillus of Septicaemia of Rabbits.



15. Bacillus of Chicken Cholera.
16. Bacillus of Pigeon Diphtheria.
17. Slide Culture (reduced.)
18. Plate Culture. (reduced.)

TEST-TUBE CULTURES.

Reproduced from Huber & Becker's "Pathologischen - Histologischen - Bacteriologischen Untersuchungs - Methoden."

Micro-Organisms.

disturb the clot, or the serum will become colored with the blood-cells. The serum is then transferred to sterilized test-tubes, which are filled one-third and immediately replugged with the cotton.

The test-tubes containing the serum are now sterilized. As the serum would be coagulated and rendered opaque by the high temperature of the steam sterilizer, 100° C., we make use of Tyndall's process of sterilization. This method, "sterilization by discontinuous heating," is based on the fact that living bacteria are killed by a temperature lower than is required for the coagulation of the albumen, while the spores that are not destroyed are easily killed after germination. Now, if a fluid is kept at a temperature of 58° C. for an hour, the living bacteria only will be killed, and possibly not all of these, by the first heating. The fluid is allowed to stand for twenty-four hours, at the ordinary temperature of the room, when the spores, or at least a portion of them, will develop. The fluid is again heated as above, when the bacteria that have developed from the spores will be killed. If this operation is repeated on five or six consecutive days, we finally kill all the contained spores and render the fluid absolutely sterile.

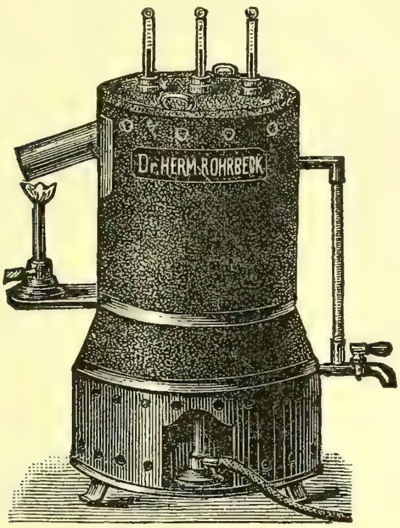


FIG. 2236.—Koch's Blood-serum Sterilizer.

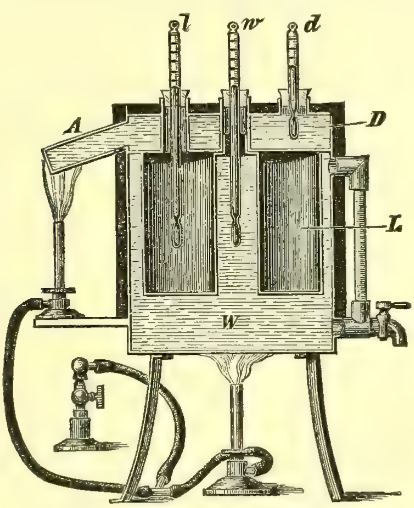


FIG. 2237.—Section of Blood-serum Sterilizer.

The above method of sterilization is carried on in the blood-serum sterilizer (Fig. 2236; also shown in section in Fig. 2237). This apparatus consists of a double-walled cylinder of copper, filled with water, *W*, and closed with a double-walled cover, filled with water, *D*. On one side of the cover is the tube, *A*, by which the water is warmed; the contents of the cylinder being warmed by a flame placed underneath it. In the cover are three tubes, one, *d*, through which the cover is filled with water and into which a thermometer is afterward fitted; *l*, fitted with a thermometer which passes into the air-chamber, *L*; *w*, also containing a thermometer, which passes into the water-chamber, *W*. The whole apparatus is covered with felt to prevent the radiation of heat.

The test-tubes are placed in racks, which are then placed in the air-chamber, *L*. The temperature of the air-chamber is then raised to 58° C., and kept at this point for one hour. This is repeated for six successive days, when the sterilization of the serum will be complete. This sterilization may be omitted if one cares to take the risk of losing a certain percentage of the tubes by contamination. The serum contained in the test-tubes is solidified by coagulating the albumen of the serum. This is accomplished by placing the test-tubes in the coagulator (Fig. 2238), which is inclined at such an angle that the serum shall reach to the upper third of the tubes, thus securing a larger extent of surface for cultivation. The coagulator consists of a double-walled box of copper, the space between the walls being filled with water. The front legs are movable, so as to allow the inclination to be adjusted, and are fastened by thumb-screws. The water in the coagulator is heated by a flame placed under the bottom. The temperature of the air-chamber is regulated by a thermometer placed on the floor among the test-tubes. It is kept at 65° C., as at this point the serum solidifies without becoming very opaque. The nearer we approach the coagulating temperature, 75° C., the more rapidly the solidification takes place, but at the same time the opacity of the serum is increased. At 65° C. about one hour is required for the solidification of the serum, though the time varies with the blood of different animals. The serum of sheep's blood solidifies most rapidly, that of calves' blood most slowly.

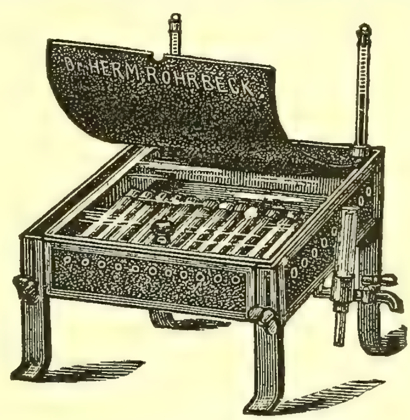


FIG. 2238.—Blood-serum Coagulator.

Serum that has been properly solidified should be of an amber color, transparent or opalescent, except in the lower third, where it may be slightly milky. During the solidification the moisture condenses in the upper part of the tube, which is the coolest, and collects at the bottom of the incline when the tube is placed in a perpendicular position. By the subsequent evaporation of this fluid the air in the test-tube is kept moist.

Blood serum may also be solidified in sterilized watch-glasses and small glass salt-cellars covered with glass plates; this permits of the growing cultures being examined with the microscope.

Potato Cultures. For this purpose smooth, sound, and old potatoes are selected. They are well scrubbed with a stiff brush and water, all bad spots and eyes scraped

out, and the potatoes soaked in a solution of mercuric chloride (one per cent.) for an hour. They are then placed in the pail of the steam sterilizer and steamed for one hour. At the end of this time the gas is shut off and the potatoes are allowed to cool in the sterilizer. While they are cooling the double glass dishes that are to serve as moist chambers are prepared as for plate cultures. The knives for cutting the potatoes (shoemakers' knives in wooden handles) are sterilized by heating, nearly to redness, in the flame of a Bunsen burner, and placed on a piece of wire gauze, edge up, covered with a bell-jar, and allowed to cool. The hands are first washed in a solution of mercuric chloride (1 to 1,000), and then a potato is removed from the pail, being held in its shortest diameter between the thumb and index-finger of the left hand, and is cut nearly through horizontally. The cover of the glass dish is removed with the right hand and the potato placed on the bottom, the upper half being turned over with the knife-blade so that the cut surfaces of both shall be up; the cover of the dish is then replaced. A second potato is to be manipulated in the same manner. These two potatoes, making four halves, will fill one dish. The potatoes are now to be sown. With one hand the cover of the glass dish (Fig. 2239) is raised and a sterilized platinum needle, charged with the seed material, is introduced and drawn gently upon the centre of the potato, not coming within half an inch of the edge; one or two punctures should also be made with the needle a short distance from this line; or a small quantity of the seed material is taken up on the point of a sterilized scalpel, placed in the centre of the potato, and with the flat of the blade spread over the surface to within half an inch of the edge. With a second sterilized scalpel a small portion is taken from the first potato and spread on the surface of a second potato; a bit is taken from the second potato and spread on the surface of a third. By this procedure we obtain a fractional cultivation analogous to the dilution in plate cultures.

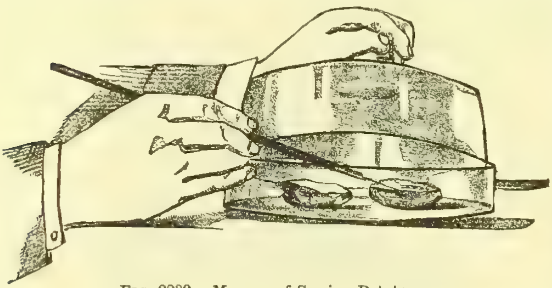


FIG. 2239.—Manner of Sowing Potatoes.

Potato-paste. Potatoes which have been well washed are steamed in the steam sterilizer for one hour. After cooling, the potatoes are peeled and mixed with sufficient water to make a thick paste. Enough of this paste to form a layer half an inch thick is placed in sterilized Ehrlenmeyer's flasks, the cotton plugs replaced, and the flasks sterilized in the steam sterilizer for half an hour on two successive days. These are to be sown in the same manner as test-tubes.

Bread-paste. A stale loaf of bread is broken into bits and heated in the hot-air sterilizer at a temperature of 100° C. When thoroughly dry it is pulverized in a mortar and preserved in a glass-stoppered bottle for use. Ten grammes of this powder are placed in a sterilized Ehrlenmeyer's flask and 2.5 c.c. of water added. The cotton plugs are then replaced and the flasks sterilized in the steam sterilizer for half an hour on two successive days. These are also to be sown in the same manner as test-tubes.

Fluid Media.—Bouillon. This is prepared in the same manner as are the gelatine media (see above), except that the gelatine is left out. After being neutralized, the bouillon is heated in the steam sterilizer for thirty minutes, and then filtered through paper. The filtrate is received in sterilized flasks, which are plugged with sterilized cotton, and heated in the steam sterilizer for thirty minutes on two consecutive days; or test-tubes are filled and sterilized.

Blood Serum. This is prepared, as has been already described, except that the final process of coagulation is omitted.

Milk. This is placed in sterilized test-tubes, and then sterilized in the steam sterilizer for half an hour on five successive days.

Vegetable Infusions. Aqueous infusions of hay and vegetables are made and filtered, and then treated in the same manner as bouillon.

Pasteur's Fluid. Distilled water, 1,000 c.c.; pure cane-sugar, 100 Gm.; ammonium tartrate, 10 Gm.; ash of yeast, 0.75 Gm.

Cohn's Fluid. Potassium phosphate, 0.1 Gm.; magnesium sulphate, 0.1 Gm.; tricalcic phosphate, 0.01 Gm.; distilled water, 20 Gm.; ammonium tartrate, 0.2 Gm.

Nägeli's Fluids. 1. Water, 100 c.c.; ammonium tartrate, 1 Gm.; potassium biphosphate, 0.1 Gm.; magnesium sulphate, 0.02 Gm.; calcium chloride, 0.01 Gm. 2. Water, 100 c.c.; albumen-peptone, 1 Gm.; potassium biphosphate, 0.2 Gm.; magnesium sulphate, 0.04 Gm.; calcium chloride, 0.02 Gm. 3. Water, 100 c.c.; cane-sugar, 3 Gm.; ammonium tartrate, 1 Gm.; potassium bitartrate, 0.21 Gm.; magnesium sulphate, 0.04 Gm.; calcium chloride, 0.02 Gm. The above chemical solutions, after being filtered, are placed in the various culture vessels and sterilized in the usual manner in the steam sterilizer. Besides test-tubes, various forms of tubes and flasks have been contrived by different investigators for carrying on cultures in fluid media.

FIG. 2240.

Sternberg uses small bulbs (Fig. 2240) made from glass tubing of three- to four-tenths of an inch in diameter. After blowing a bulb at the end of a glass tube, it is provided with a slender neck, drawn out in the flame, and the end sealed by melting. To fill these bulbs proceed as follows: Heat gently over the flame first the bulb, and then the extremity of the neck; break off the point with sterilized forceps, and plunge the bulb beneath the surface of the fluid. The bulb is to be one-third filled and the point of the neck immediately resealed in the flame. After filling, the bulbs are sterilized in the steam sterilizer as usual. To sow the fluid contained in these bulbs, the end of the neck is broken off with sterilized forceps, the bulb gently heated so as to force out a small quantity of air, and the end plunged into the fluid containing the bacteria to be cultivated, a small quantity of which enters the bulb. The end of the neck is resealed by melting in the flame.

Cultures may also be made in the hanging-drop (see Drop-cultures).

INOCULATION OF ANIMALS.—For this purpose various animals are employed, mice, rats, guinea-pigs, and rabbits being most convenient.

Inhalation.—The animals are placed in a large box, the air of which is impregnated with the germs by means of a steam- or hand-spray.

Administration with Food.—A thin layer is cut from a small rectangular piece of potato, so that it can be lifted up like a cover, and then the interior is hollowed out and filled with a pure culture of the bacteria. The cover is replaced, and the piece of potato placed on the back part of the tongue, so that the animal will swallow it without mastication. Small pieces of hard-boiled white of egg may be prepared in the same manner.

Sometimes, when the acid gastric juice has an injurious effect on the bacteria, an artificial gastro-intestinal catarrh is produced, before feeding, by the administration of drastic cathartics, or the acid neutralized by introducing alkaline solutions into the stomach.

The bacteria may also be administered suspended in water or milk.

Cutaneous Inoculation.—This is performed by producing a slight abrasion of the skin with a sterilized scalpel,

after removing the hair and disinfecting the part. Upon this is placed, with a sterilized platinum loop, a particle of the pure culture or a drop of material containing the bacteria, and gently rubbed in. Or a slight incision is made with a sterilized knife charged with the material to be inoculated. The situation chosen for inoculation should be one that cannot be licked by the animal, as, for example, the root of the ear.

Subcutaneous Inoculation.—A spot that cannot be licked by the animal is chosen. The hair is cut close, and after the skin has been washed with soap and water, it is disinfected with a 1 to 1,000 solution of mercuric chloride. An incision is made with a pair of sterilized scissors or knife. Then, with the point of a sterilized knife or probe, a pocket is made under the skin; into this is introduced, with a sterilized platinum loop, a bit of the material, and the skin is pressed down. A mouse is inoculated as follows: A mouse is placed in a glass cylinder, and the cylinder is covered with a glass plate. The tail of the mouse is then seized with a pair of long forceps, and drawn out through a small space between the cover and rim of the cylinder, and the end of the tail is grasped with the left hand. An incision is then made in the loose skin at the root of the tail with a pair of sterilized scissors, and a bit of the material is introduced in the manner above described.

Subcutaneous Injections.—For subcutaneous injections the syringe of Koch or that of Sternberg is used.

Koch's syringe consists of a glass barrel graduated into fractions of cubic centimetres. At the end it is fitted into a metal cap provided with a nipple, fitted to the various-sized cannulæ. The upper end is fitted into a metal cap provided with a stop cock. On the end of this cap a rubber ball, with a small hole to act as a valve, is attached by means of a short, threaded, metal tube, which screws into the end of the cap. The rubber ball being removed, the instrument is sterilized in the hot-air sterilizer.

Sternberg has constructed a very simple syringe from a glass tube. A piece of glass tubing 10 to 12 cm. long, and with a lumen of 3 to 4 mm., is taken. One end is drawn out conically and ground, so as to fit the various cannulæ. To the upper end a piece of rubber tubing is attached, and through this a piece of brass wire is fitted, air-tight. This brass wire acts as a piston.

Pure cultures are mixed with sterilized distilled water, or one-half per cent. solution of sodium chloride, just before being used, and injected with the above syringe.

For injecting directly into the circulation, pure cultures are mixed with sterilized distilled water or salt solution. In the rabbit, one of the large veins at the base of the ear is selected. The hair is cut off with curved scissors, and the vein exposed by snipping out a bit of skin. The point of the needle attached to the syringe is introduced into the vein and the fluid slowly injected.

All animals that die after inoculation experiments should be examined as soon after death as possible. The animal, *e.g.*, a mouse, is pinned out by the feet on a piece of wood and thoroughly washed with mercuric chloride solution (1 to 1,000). A number of scalpels, forceps, scissors, etc., are sterilized by heating nearly to redness in the flame, placed under a bell-jar to protect them from dust, and allowed to cool. The skin of the abdomen is cut through over the median line with a hot pair of scissors and laid back on each side. The abdominal cavity is then laid open with sterilized scissors and pinned back on each side. The appearance of the abdominal organs is to be noted, especially the spleen. This organ is removed with sterilized forceps and scissors, and placed upon a sterilized glass plate. It is then washed with the mercuric chloride solution, by means of a camel's-hair brush, incised with sterilized scissors, and a bit of the pulp removed with a sterilized instrument, and test-tubes of gelatine sown with it. Other organs from which cultures are wanted are treated in the same manner. The thoracic cavity is now opened by cutting the ribs on each side of the sternum with sterilized scissors. The pericardium is then opened; the apex of the heart is fixed with sterilized forceps, and one of the cavities opened with sterilized scalpel or scissors, and test-tubes of gelatine are then sown from the blood.

Bits of the organs are removed and hardened in alcohol, for subsequent microscopical examination.

The test-tubes, sown as above, should be immediately plated.

Specimens from the post-mortem room are thoroughly washed with mercuric chloride solution, to destroy any adhering bacteria of putrefaction. Then with hot knives, changed with each cut, a cut is made through the organ, almost dividing it; then a second cut is made at right angles to the first, and from this surface a third, from the bottom of which the material to be sown is removed with sterilized instruments.

FIG. 2241.—Koch's Apparatus for Air Analysis.

EXAMINATION OF AIR.—*Koch's Apparatus.*—This consists of a glass cylinder about fifteen centimetres high, containing a glass capsule (Fig. 2241) which can be removed with the brass lifter. The mouth of the cylinder is plugged with cotton, and the whole apparatus sterilized in the hot-air sterilizer, at a temperature of 150° to 160° C. for one hour. A test-tube of gelatine is melted and poured into the glass capsule. The cylinder is then exposed to the air for a definite time, the cotton plug replaced, and the apparatus set aside until the colonies have developed. The colonies are counted, after which the capsule is removed from the cylinder, placed on the stage of the microscope, and the character of the colonies examined into with a low power. With this apparatus only an approximate estimation of the germs can be made.

Hesse's Apparatus (Fig. 2242).—This apparatus consists of a glass cylinder 70 cm. long and 3.5 cm. in diameter,

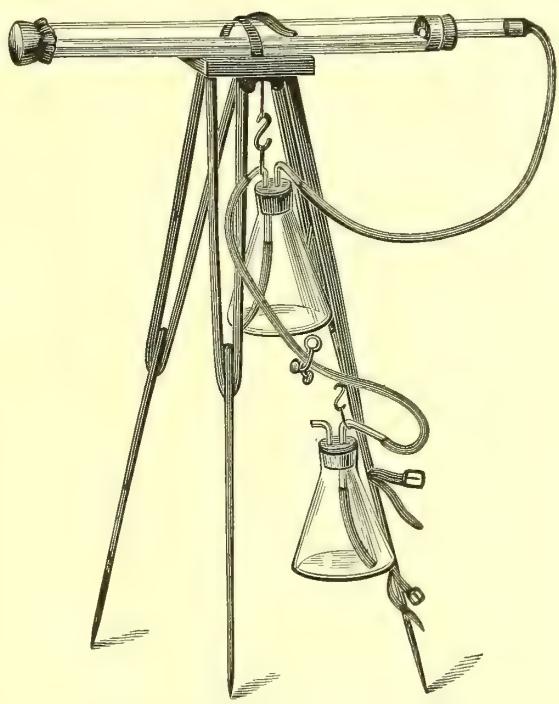


FIG. 2242.—Hesse's Apparatus for Air Analysis.

fastened to a tripod. One end is closed with a closely fitting rubber cap, provided with a central perforation 1 cm. in diameter, and over this a second cap, without a perforation, is placed, thus completely closing the end of the cylinder. In the other end is fitted, tightly, a rubber cork, in the centre of which is a hole 1 cm. in diameter. Through this a glass tube 10 cm. long is introduced, the

free end of which is connected with aspiration flasks. This tube is plugged with sterilized cotton, and the apparatus is steamed for one hour.

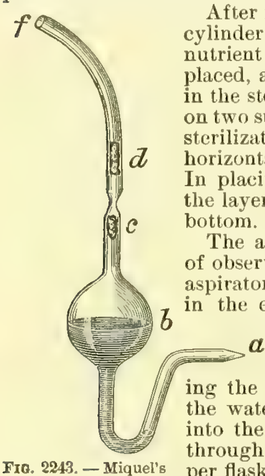


FIG. 2243. — Miquel's Bulb.

After removing the rubber cork the cylinder is filled with about 50 c.c. of nutrient gelatine, the rubber cork is replaced, and the apparatus is sterilized in the steam sterilizer for half an hour on two successive days. After the final sterilization the cylinder is placed in a horizontal position and allowed to cool. In placing the cylinder on the tripod the layer of gelatine should be at the bottom.

The apparatus is set up at the place of observation, the rubber tube of the aspirator connected with the glass tube in the end of the cylinder, and the outer cap removed from the other end. The spring-clip, on the rubber tube connecting the two flasks, is opened, so that the water in the upper flask can flow into the lower, thus drawing the air through the cylinder. When the upper flask is empty the lower one is put in its place, and the flow of water again started. After several litres of air have been drawn through the cylinder, the rubber tube of the aspirator is disconnected, and the outer cap replaced on the end of the cylinder. The cylinder is then set aside, at a suitable temperature, until the colonies have developed. The colonies may be counted through the wall of the tube. Specimens may be fished out with a long-handled platinum needle for examination and sowing.

Miquel's Bulb (Fig. 2243).—This consists of a glass tube, *a*, *f*, in the course of which a globe, *b*, of about 50 c.c. capacity, is blown; at one end the tube is bent in an **S**-form, while the other end remains straight, or is slightly curved. In this part of the tube are placed two plugs of asbestos or glass-wool, *c* and *d*, and the tube is constricted between the two by heating in a flame. The apparatus is sterilized in the hot-air sterilizer, and then filled with about 20 c.c. of sterilized bouillon, by placing the end *a* in the fluid and sucking on the end *f;* the apparatus is then inclined so that the point *a* shall be free from bouillon, when it is sealed by melting in the flame. The apparatus is then sterilized in the steam-sterilizer for half an hour on two successive days. For use the apparatus is fastened so that the shank *c*, *d* shall form an angle with the horizon of about twenty-five degrees. The end *f* is connected with an aspirator by means of a rubber tube, then the sealed end *a* is heated in the flame to destroy any adhering germs, and broken off with hot forceps. The aspirator is then started. After sufficient air has been drawn through the apparatus the point *a* is again sealed by melting in the flame. By blowing strongly into the end *f*, any germs that may have been caught by the plug *c* will be forced back into the bouillon; then the apparatus is raised until the bouillon flows into the point *a*, so that all the germs between *c* and *a* shall be brought into the bouillon. Three litres of air are drawn through each of

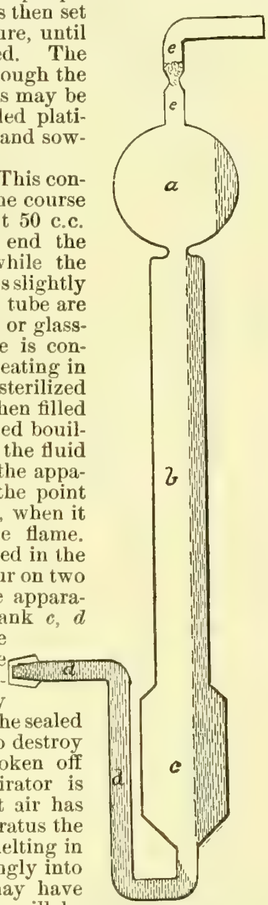


FIG. 2244.—Apparatus of Kammerer and Giacomi.

fifty of these bulbs, so that one hundred and fifty litres of air shall be examined. The bulbs are placed in the incubator, and after a few days examined. The number of bulbs that have become turbid is counted, the presumption being that each turbid bulb originally contained but one germ. If none of the bulbs becomes turbid the experiment is repeated, a larger volume of air being aspirated. If all the bulbs become turbid, too large a

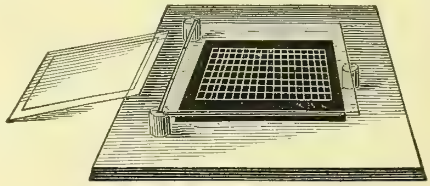


FIG. 2245.

quantity of air has been used, and the experiment is repeated, using a smaller volume of air.

Kammerer and Giacomi's Apparatus (Fig. 2244).—This apparatus is constructed of glass. The upper part consists of the globe *a*, 7 cm. in diameter, from the upper part of which passes the constricted tube, *e*, *e*, plugged with cotton. To the under part of the globe is attached a tube, *b*, 20 cm. long and 1.5 cm. in diameter, separated from the globe *a* by a constriction. The lower end of the tube *b* is widened out into a chamber *c*, 7 cm. long and 2 cm. in diameter. The cubic capacity of the apparatus is from 40 to 50 c.c. The tube *d*, for filling the apparatus, is attached to the exact centre of the under part of the chamber *c*, and its mouth must be at least 1 cm. above the point of union between *b* and *c*. The mouth of this tube (*d*) is closed with a conical cap, ground on air-tight. After the apparatus has been sterilized in the hot-air sterilizer, melted nutrient gelatine is introduced until the chamber *c* is filled, when the cap is placed on the mouth of the tube *d*. The apparatus is sterilized in the steam sterilizer for half an hour on two successive days.

At the time of the aspiration of the air, the apparatus is heated up to a temperature of 30° to 40° C. The au-

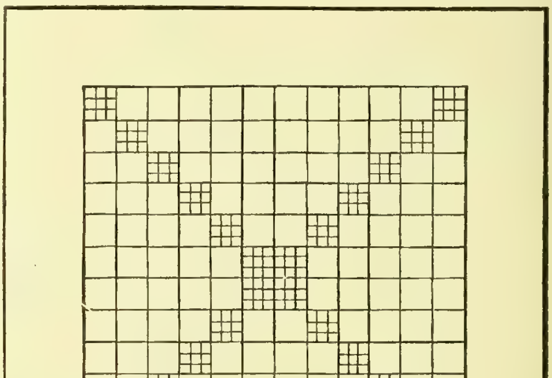


FIG. 2246.

thors found that the air bubbled through the gelatine easily at this temperature. The rapidity of the aspiration is so regulated that the tube *b* shall be filled with foaming gelatine and the bubbles shall burst in the globe *a*. The foaming gelatine forms a good filter for the air. After aspirating from three to five litres of air the aspira-

tor is cut off, and the cap placed over the mouth of the tube *d*. The apparatus is then inclined so that the whole interior is washed with the fluid gelatine, in order that all germs may be brought into it. The gelatine is then allowed to fill the tube *d*, and the apparatus is placed in a horizontal position to cool. After cooling, the gelatine should have the position shown by the shading in Fig. 2244. The apparatus is then set aside to allow the colonies to develop. The colonies may be counted through the walls of the apparatus.

FIG. 2247.—Esmarch's Modified Plate Culture for Examining Water.

EXAMINATION OF WATER.—For the collection and transportation of samples, small cylindrical bottles, holding about 100 c.c., and fitted with ground-glass stoppers, are used. These are sterilized in the hot-air sterilizer at a temperature of 150° to 160° C. When cool, a rubber cap, previously sterilized in the steam sterilizer, is drawn over the stoppers. These bottles are filled from the reservoir or stream as follows: The rubber cap is removed and the glass stopper taken out after the bottle has been immersed in the water; when the bottle has become filled the stopper is replaced, the rubber cap drawn over the stopper, and the bottle dried and labelled. If they are filled from a faucet, the water is allowed to run for a few minutes, and then the bottles filled by allowing the water to run directly into them. The stopper is then replaced and the rubber cap drawn on.

Plate cultures are made from these samples as soon as possible. One cubic centimetre of the water is measured with a sterilized pipette and mixed with a test-tube of nutrient gelatine, and a plate culture made in the usual manner (see above). At the end of the second, third, or fourth day the colonies on the plate are counted.

The plate is placed on the black surface of the apparatus shown in Fig. 2245, and the ruled glass plate, Fig. 2246, placed over it. This plate is divided into centimetre squares, some of these being subdivided into ninths. If the colonies are numerous the number in some of the smaller squares is counted; if scant, that in some of the larger ones. From these counts an average of the entire number of colonies on the surface of the plate is calculated.

Esmarch uses his modification of plate cultures. One cubic centimetre of water is mixed with a test-tube of melted gelatine and the tube manipulated as described above (see plate cultures). To aid in counting the colonies, a longitudinal line is drawn on the outside of the test-tube and the length of the test-tube divided equally by from three to six circular lines. (Fig. 2247.) These lines may be made with ink, or with Faber's pencils for writing on glass. For magnifying the smaller colonies the apparatus shown in Fig. 2248 is used.

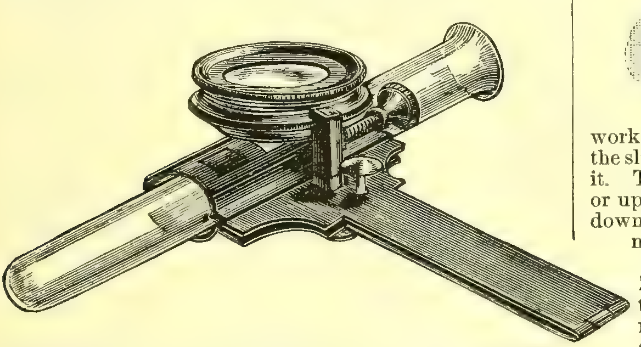


FIG. 2248.—Apparatus for Magnifying Smaller Colonies in Esmarch's Culture Tubes.

EXAMINATION OF EARTH.—The earth to be examined is ground fine in a sterilized mortar, and a small portion of this powder taken up on the point of a sterilized scalpel and scattered on partially fluid gelatine spread upon a plate. Or a few particles of the earth are shaken in a test-tube of liquid nutrient gelatine, and a plate culture made from this in the usual manner.

George Cornell Freeborn.

MICROSCOPY, CLINICAL. Perhaps in no branch of microscopical science is it of greater importance to have a first-class instrument, and to be able to use it to advantage, than in the subject of clinical microscopy. This remark applies, not only to the use of the stand and lenses, but also to the means of illumination of the specimen, and the judicious application of light. This latter point is of the utmost importance. Minute organisms, blood-cells, hyaline casts, etc., may be present in the field, and yet be brought into view only by the proper application of light. For that purpose no optical arrangement equals the Abbé condenser, which is so important, and consequently so much used now in bacteriological work.

The stand of the microscope must be perfectly steady. To insure that object, it is necessary that it should be heavy and solid. The stage also should be firm, and not too large. The micrometer screw must be easy and delicate in its movement. It is not absolutely necessary, even for a "first-class" instrument, that the coarse adjustment should consist of rack-and-pinion movement. A sliding tube works sufficiently well for every purpose. In the use of the sliding tube considerable care is required in adjusting it. The movement should never be directly downward or upward, as the case may be, but always rotatory with downward or upward tendency. The rack-and-pinion movement, however, is preferable.

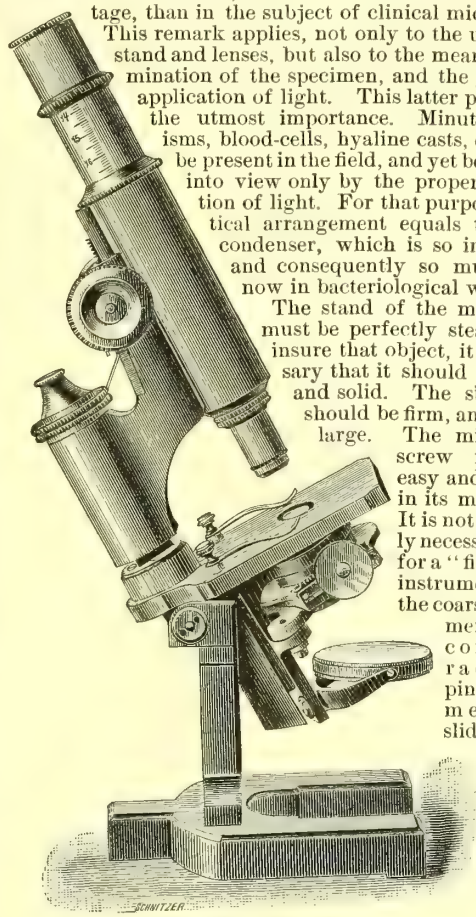


FIG. 2249.—Zeiss' Stand, No. IV.

Fig. 2249 represents a medium-sized instrument, Zeiss' "stand IV.," with Abbé's illuminator attached. It is about as perfect an instrument as is made, and fulfils all the requirements of the most advanced microscopist. A recent and very useful improvement is the adaptation of rack-and-pinion to the vertical movement of the Abbé illuminator. This is a great advantage, as it obviates the necessity, when using very low powers, of removing the condenser from the stand.

Simply lowering it, so that the focal point will be some distance from the stage, will be quite sufficient to moderate the light to such an extent as to suit the lowest powers. This illuminating apparatus in its simplest form, and that most generally useful, consists of (Fig. 2251, *A*) two lenses, one biconvex, and the other, the uppermost one, plano-convex. These are so arranged and constructed that, when brought close up to the stage, the rays of light, reflected from a plane mirror* and transmitted through this system of lenses, meet at a focal point on the glass slide placed on the stage, so that, in fact, the object rests on the apex of a cone of light. Where more oblique illumination may be required, as in working with objectives of very large aperture, an illuminating apparatus of 1.40 numerical aperture can be substituted for that just described. As is shown in a sectional view in Fig. 2251, *B*, this consists of a system of three lenses. Beneath these lenses is a sort of substage, upon which can be placed a diaphragm, with an aperture to limit the amount of light to be transmitted through the condenser. A number of diaphragms are provided, each with different-sized aperture, varying from one millimetre up to ten millimetres in diameter. By the judicious selection of these, images of transparent objects can be obtained which it would be impossible to procure otherwise. By the use of the "open condenser," that is, the condenser without diaphragm obstructing any of the rays, much more distinct images of stained objects are obtained than can be in any other way. The light being directed toward the object from all directions, renders impossible the formation of its own image, which otherwise frequently conceals the structure of minute bodies, such as micro-organisms. This subject of light, and the proper illumination of objects, is a very important one, and is too frequently overlooked. With the ordinary revolving diaphragm, such as is generally used in the smaller stands, especially with those placed under the stage, it is impossible to obtain a good image of the smaller organisms under a high power. The rays of light passing up from the mirror through the aperture in the diaphragm are more or less dispersed in the space between the bottom of the slide and the upper surface of the diaphragm ; hence results loss of definition. Some of the continental instrument-makers have remedied this to a great extent by the use of curved or arched diaphragms ; better still is the use of the cylinder diaphragm. Bausch & Lomb, of Rochester, N. Y., have improved on the revolving diaphragm by the adoption of their "iris diaphragm," by means of which, by working a screw, the aperture for illumination can be easily changed in size. One of the instruments to which they have adapted this is a very steady and useful stand, quite equal to the same style of foreign make. Fig. 2252 illustrates the instrument referred to. The manufacturers make the instrument also with rack-and-pinion for coarse adjustment. To this instrument can be adapted a condenser, which may be used for the same purpose as the Abbé condenser (Fig. 2253). Bullock, of Chicago, Ill., makes a very good instrument with a condenser. The stand is a steady one, and serves every purpose for the advanced microscopist. Like Zeiss, he has also improved on the working of the condenser by adding to it a vertical rack-and-pinion movement. Several other American opticians make microscopes quite equal to those just named.

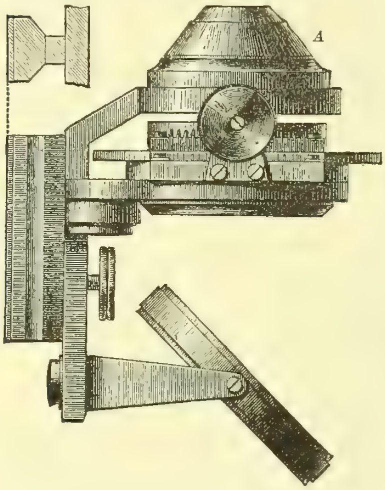


FIG. 2250.—Zeiss' Abbé Condenser.

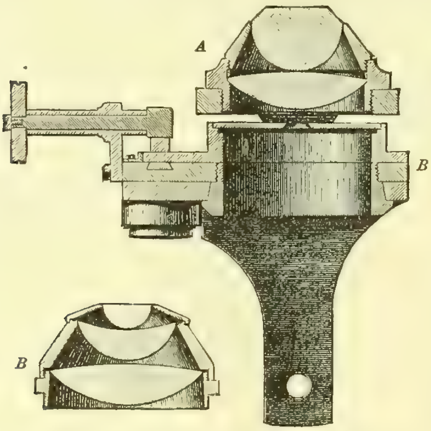


FIG. 2251.—Zeiss' Abbé Condenser ; Sectional View.

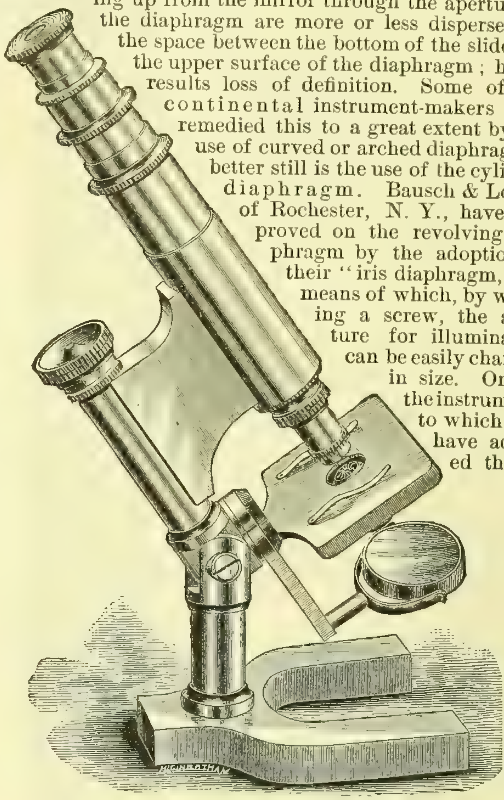


FIG. 2252.—Bausch & Lomb's Harvard Microscope.

Objectives.—Two objectives and two eye-pieces will do for most clinical work, but it is advisable to have at least three objectives. A lens which with low eye-piece will magnify 50 diameters, and another about 250 diameters, and with higher eye-piece nearly double that power, will be the most useful where two lenses

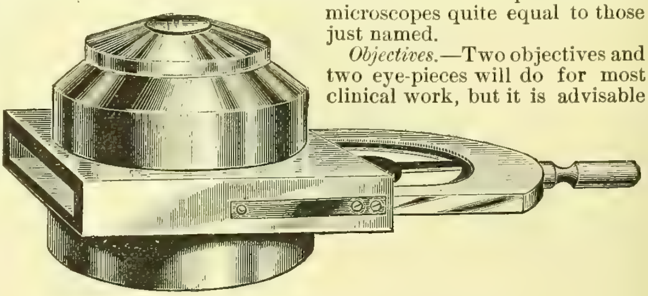


FIG. 2253.—Bausch & Lomb's Substage Condenser.

* When using low-power lenses not only should the condenser be removed a short distance from the stage, but the concave mirror should be used for reflecting the light.

only are procured. A most desirable and most useful acquisition would be a $\frac{1}{12}$ homogeneous immersion-lens. This would magnify, with a high eye-piece, very nearly 1,000 diameters. Without this lens it is quite possible, in some cases of phthisis where tubercle-bacilli are numerous and well stained, to recognize them; but in other cases it would be impossible to give a decidedly negative reply unless the immersion-lens and the Abbé condenser were used. These micro-organisms might be present and yet not be visible even with the best "dry" lens.

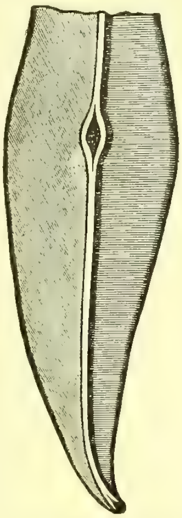


Fig. 2254.—Pleurosigma Angulatum.

The selection of lenses is a somewhat difficult matter. Many makers very properly send out with their microscope and lenses a test-object, generally one of the diatoms. The *pleurosigma angulatum* (Fig. 2254) is probably the best. It presents three systems of very fine lines crossing one another. With central illumination by transmitted light, these are readily made out by a first-class high-power lens, while an inferior one would fail in showing all, possibly would show none whatever.

"Oblique illumination" is sometimes advisable, or even necessary, to demonstrate the separate set of lines distinctly. This is obtained by placing the mirror as much to one side as is possible, while still permitting the rays to pass through the large aperture of the diaphragm. In stands provided with the Abbé condenser it can be obtained very readily. A diaphragm with medium-sized aperture is used, and then, by means of the rack-and-pinion attached to the substage carrying the diaphragm, the latter is removed sufficiently from the centre to permit rays from one direction only to pass through the condenser, and in this way any degree of obliquity may be obtained. With very high powers, such as the $\frac{1}{12}$ immersion, what appear to be fine straight lines are found not to be such, but are in reality zigzag (Fig. 2256). In the absence of diatoms, saliva is a fairly good test-object. High powers show beautifully the Brownian * movement in it.

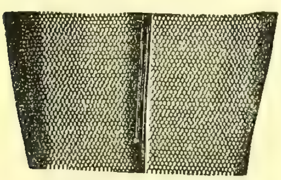


Fig. 2255.—Pleurosigma Angulatum, showing Hexagonal Areolations. Central illumination.

No set of accessories to a microscope can be considered complete for clinical work without a dissecting lens. By far the most useful is a Brücke lens, consisting of a double objective with achromatic lenses. It has a long focal distance of about two inches. This is at times a great advantage. It can either be used as a hand lens or be fitted into a stand similar to the one shown in Fig. 2257, that is supplied with it, and then used as a dissecting lens; hence it is well adapted to teasing out specimens.

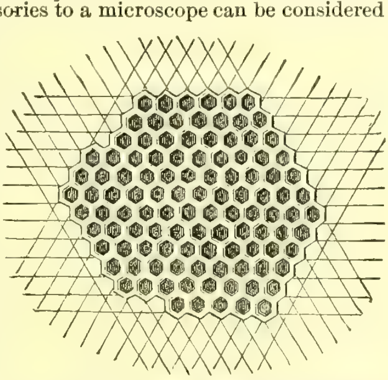


Fig. 2256.—Pleurosigma Angulatum, deeper portion slightly out of focus. Central illumination. (Highly magnified.)

* Brownian, or, as it is sometimes called, Brunonian, movement is the peculiar vibratory movement observed when very minute solid bodies are in a state of constant oscillation. It is supposed to be due to the influence of thermal currents in the fluid under observation.

In the absence of a Brücke lens the simple loup, as seen in Fig. 2257, may be used. A useful adjunct to either lens, for dissecting purposes, or for teasing out a specimen, is the very convenient arrangement devised by Ranvier, and called by him a *photophore* (Fig. 2258). It consists simply of a box about four inches square, made of hardwood, having the top and one side open. On the top is placed a piece of plate-glass, and into the box is fitted a mirror at an angle of about 35°. The mirror is placed opposite the light, which is reflected up through the plate-glass and through the specimen placed on a glass slide lying on the plate-glass. I consider it advisable to have this photophore longer than the measurement given by Ranvier. Eight inches will be found a more convenient length, as it forms also a support for the hands.

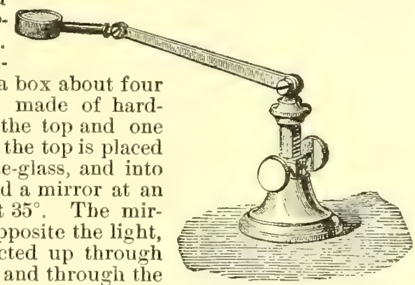


Fig. 2257.—Stand, with Simple Dissecting Loup.

A *revolver* or *nose-piece* for two or three lenses will be found very useful, especially when the microscope stand is provided with rack-and-pinion coarse adjustment. One made for three lenses is the most serviceable.

A *micrometer eye-piece*, and also a stage micrometer,

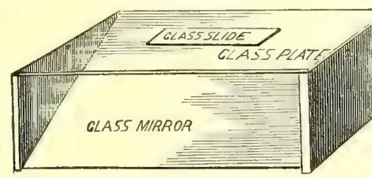


Fig. 2258.—Ranvier's Photophore.

graduated into hundredths of a millimetre, are very desirable additions; so also would be a camera lucida.

Among other accessory apparatus necessary for use may be mentioned the following: *Glass slides;* these are better with ground edges; sufficiently good ones for class purposes can be obtained from a glazier, by having him cut to the desired measurements ordinary window-glass, which, however, must be perfectly clear and moderately

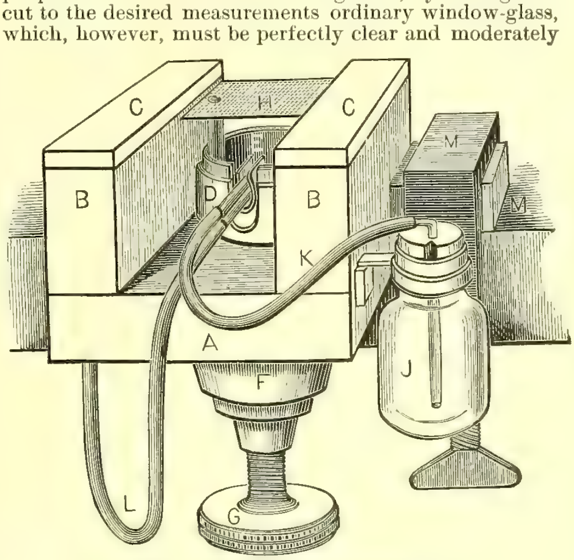


Fig. 2259.—Cathcart's Ether-freezing Microtome.

thin. *Cover-glasses;* these should be thin for the higher powers, though for the homogeneous immersion this is not so important. *Watch-glasses* of different sizes. *Needles* for teasing specimens. Very fine *forceps;* it is de-

sirable to have several pairs, one with somewhat broader blades for the purpose of grasping the cover-glass, and thus avoiding greasing it with fingers, and also platinum-pointed ones for bacteriological work. *Scissors*, curved and straight. Several conical *test-glasses*, large and small. These are very useful for allowing the deposit of sediment in fluids to be examined. Glass *pipettes* of various lengths; the most useful are about four, eight, and twelve inches. *Microtome and knife.** Although in this article but little reference will be made to anything bearing on pathological histology, the necessity of the clinical microscopist having a microtome, and being able readily and quickly to prepare a section of any diseased growth, or of any suspected pathological specimen, cannot be overlooked. For this purpose no instrument equals the freezing microtome. The simplest, and, what is by no means unimportant, the cheapest, I have seen is a little instrument known as Cathcart's ether microtome (made by Fraser, 7 Lothian Street, Edinburgh, price fifteen shillings; planing-iron, one shilling). It consists of a hollow brass cylinder, D, on the top of which is a roughened zinc plate, H. At the bottom of this cylinder is a screw, with fine thread, worked from below. The cylinder is attached to a wooden frame, the sides of which are covered by a strip of thick glass, C, along which the planing-iron is shoved with the hand, according as the cylinder is raised by the fine screw. Through one side of the cylinder a double tube is pushed up to its centre. One of these tubes is closed at its end, and perforated at the side facing the bottom of the zinc plate. The other tube, which is in connection with the ether bottle, J, terminates in a fine point opposite the perforation in the first tube referred to. By means of the ordinary double india-rubber ball used with spray apparatus, air is forced through, carrying the ether with it as a fine spray against the under surface of the zinc plate. This by its rapid evaporation causes congelation of any substance that will freeze. A tiny fragment of any suspicious growth may be cut, imbedded in gum on this zinc plate, be frozen, cut, and subsequently stained with logwood, and mounted temporarily in glycerine, easily, within fifteen minutes.

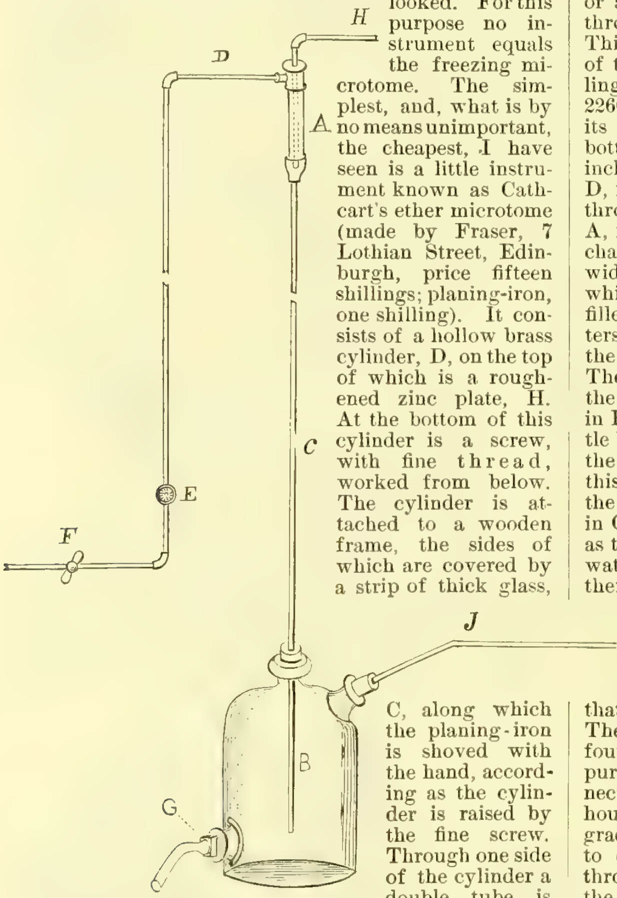


FIG. 2260.—Air-pump for Compressed Air as adapted to Ether Microtome.

In my private laboratory, as well as in that at McGill University, I have adopted a modification of Sprengel's pump, connected with the water-supply of the house, by which all that is necessary to freeze a specimen is to connect the tube L, by means of a glass nozzle, with another long rubber tube attached to J, in Fig. 2260, and then to turn on the water-cock, F, and within a couple of minutes the specimen will be frozen. The essential parts of my arrangement are the chamber A, and the bottle B, in which the air is compressed, and the height through which the water falls. The entire apparatus, except the glass bottle, is made up with steam-fitters' "fittings." To make the chamber A (Fig. 2261) take a piece of one-inch (one inch internal diameter) iron pipe, nine or ten inches long; screw on its upper end a **T**-fitting, 1 × ¼, and on its lower end a "reducing, coupling," 1 × ⅜. The upper end of the **T** can be plugged with a piece of brass or a rubber cork perforated with a hole in the centre, through which is passed a piece of ¼-inch brass tubing, H. This tubing should reach to within about one-fourth inch of the narrowest part, internally, of the reducing coupling. A long piece of three-eighths inch iron pipe, C (Fig. 2260), is screwed on to the lower end of this coupling, its other end passes through a rubber stopper in the bottle and reaches to within about an inch or so of the bottom. The tube D, is one-fourth inch iron piping, and through it the water enters the chamber A, falling down the long tube C. The chamber A being so much wider than the pipe D, by which the water enters, can be filled only by air, which enters by the tube H, shown in the chamber A by dotted lines. The body of water falling down C carries the air along with it, and compresses it in B. The water escapes from the bottle by the tube in the opening G, while the compressed air escapes by J. It is this latter tube that is connected with the spray apparatus. The tube inserted in G should be about the same diameter as the supply-pipe. In this way, as the water escapes as rapidly as it enters, there will be a constant supply of compressed air so long as the water-supply is turned on. It is advisable to have a second cock, so that, when once regulated, it will not be necessary to watch the apparatus to see that the bottle does not become filled. The cock E, which is an ordinary one-fourth inch iron steam valve, serves this purpose. The cock F, which is connected with the water-supply of the house, is turned on full; then the flow is gradually checked by E, until it is found to escape by G, as fast as it passes through E. When it is desired to stop the flow of compressed air the water is turned off at F, and E is left untouched. The chamber A should be about fifteen feet above the bottle B, although it will work fairly well with a fall of only nine or ten feet.

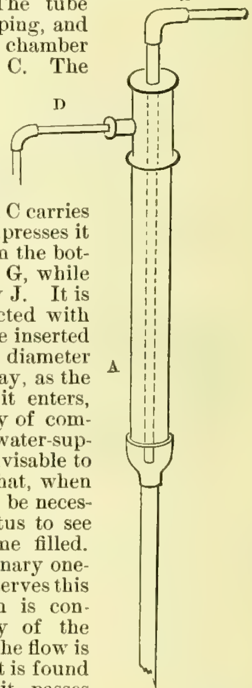


FIG. 2261.

This apparatus can be made to serve many other purposes.* If the tube H be prolonged downward, and connected with a two-necked Woulff's bottle by one neck, the other neck having a perforated rubber cork in it, the apparatus will serve admirably for cleaning the "mixer," figured on page 687, vol. iii., of this HANDBOOK, and used in connection with the enumeration of blood-corpuscles The mixer should be inserted into the opening in the cork, and have water passed through it by at first inserting the ivory mouth-piece in a tumbler of water and then turning on the water at F. Water from the tumbler will be aspirated through the mixer. After a few minutes the tumbler can be withdrawn and air allowed to pass

* See this HANDBOOK, vol. iii., pp. 666 *et seq.* for full description of microtome.

* This apparatus will work a gas blow-pipe admirably, or, connecting it with the benzine-bottle of the thermo-cautery apparatus, it will work it also; when I use the cautery in office-practice I always employ this apparatus.

through for about half an hour, when the mixer will be perfectly dry.

The *reagents* that are employed in connection with clinical microscopy are comparatively few. Distilled water is useful for many purposes besides its employment in preparing the various solutions. In bacteriological investigations it will be required for diluting the stronger acids and alcohol, and in the preparation of the dyes; also for washing the cover-glass preparations. Before being used for these purposes it should be examined to see that it is free from micro-organisms, and if not it will require fresh distillation.

It must be remembered that distilled water alters the appearance of cellular structures. It causes the red corpuscles to swell, and dissolves their coloring matter. In this way they may become invisible.

A solution of common salt is absolutely necessary. The most useful strength is 0.75 per cent. It should be prepared from pure salt obtained by recrystallization and then dissolved in distilled water. Prepared in this way, and of this strength, it is of great service in the examination of blood, and also of fresh pathological specimens. For some purposes it will be improved if a couple of drops of a two per cent. solution of methylene blue or gentian violet be added to a watch-glassful of the solution. As micro-organisms quickly form in salt solution of this strength, it should be frequently made anew. Artificial serum, prepared by adding one part of egg-albumen to nine of the salt solution, is useful when it is desired to preserve, for a longer period, the vital properties of cells. A solution of salt, 0.5 per cent., to which some aniline dye has been added, may be employed with advantage for counting both red and white blood-corpuscles. Four drops of a 1.5 per cent. watery solution of gentian violet is added to 50 c.c. of the salt solution. This colors the white corpuscles a dark blue, and has no effect on the red cells.

A three per cent. solution of salt may also be used with advantage in counting corpuscles. The red corpuscles are all more or less corrugated, while the white are prominently brought out, presenting their characteristic white and globular appearance, and are readily recognized.

Hayem's solution,* which contains other ingredients than the salt, is a most useful fluid for examining blood-corpuscles. Besides retaining their shape, they also keep their color in this fluid.

Glycerine is extensively employed in microscopical investigations. It finds more extensive use in histological work, especially as a medium in which to examine specimens hardened in alcohol. For fresh preparations it is not so useful, as it clarifies them to such an extent as to render them almost invisible. It may, however, be used to preserve fresh preparations for subsequent treatment. Some alcohol may be added with advantage.

A mixture of glycerine one part, and water seven parts, is a good medium in which to examine blood-stains for red corpuscles. If in the examination of any fresh specimen in water it is desired to keep it for further investigation, it may be prepared permanently by allowing a drop of glycerine to run in under the cover-glass by applying it to its side. If the glycerine does not run in readily, it may be made to do so by applying a piece of filter-paper or white blotting-paper to the opposite side of the cover-glass. It is then to be sealed.

Farrant's solution possesses many advantages over glycerine alone. It is more useful in examining fresh tissues, as they do not become quite so transparent in it. This fluid is made by, first of all, preparing a saturated solution of arsenious acid, and then mixing together equal parts of this solution, of water, and of glycerine, adding to the mixture about half its bulk of gum arabic, and then allowing it to stand for two or three weeks, until the gum is entirely dissolved. It should then be filtered through coarse filtering-paper and allowed to stand for a few days, to allow air-bubbles to rise to the surface. It may then be decanted into a bottle, with a prolonged glass stopper, for use. The specimen is well preserved in this fluid, and is more easily mounted on account of the solution drying at the edge of the cover-glass. This may subsequently be cemented by the use of Le Page's glue or Hollis' glue, or a solution of india-rubber, run along the edge of the cover-glass.

Alcohol, so useful in histological work, has not many applications in clinical microscopy. The "⅓ alcohol" (one part alcohol and two parts water) introduced by Ranvier may be employed for facilitating the teasing-out of fresh specimens, which should be previously treated with this alcohol for twenty-four hours. Alcohol is also used, in various degrees of strength, for washing cover-glass preparations. Concentrated alcoholic solutions of aniline dyes are also frequently required in the preparation of standard color solutions.

Acetic acid, in different degrees of strength, is a most important reagent for clinical as well as for histological work. This is due to the fact that elastic fibres, the nuclei of cells, the medulla of nerves, etc., are not acted upon by the acid, while albuminates are dissolved by it. Granular cells containing obscured nuclei or fat granules are cleared up by the acid, and the nuclei and fat, if present, are readily observed.

The glacial acetic acid is of great value in the preparation of hæmin-crystals from dried blood or old blood-stains (see HANDBOOK, vol. i., p. 576). It should be used in full strength for this purpose. A ten per cent. solution is used by Bizzozero in making preparations of microphytes of the normal skin. A dilute solution only is required for "clearing-up" purposes; one per cent. is a very useful strength. Even in much weaker solutions it exerts the same action, but requires a longer time.

The diluted acid is especially useful in searching for elastic fibres in the sputum, in which it dissolves the mucus and pus cells that may be present. In very weak solutions it simply clears up these cells, rendering their nuclei more distinct. Micro-organisms, when mixed with the tissues, are more readily brought into view by its use. In a one-third per cent. solution it is used for mixing with blood and counting white corpuscles. In adding acetic acid to a specimen, it should always be applied after the cover-glass is in its place on the slide.

The strong mineral acids are used in clinical work mostly for decolorizing purposes in bacteriological investigation. Nitric acid and hydrochloric acid are the two most frequently employed.

Chromic acid and its salts are indispensable in making permanent preparations of the tissues, but are of very little use in clinical work.

Alkalies have an extensive application in microscopical technique. Various degrees of strength are employed; the most useful are, one of thirty-three per cent., and another, which may be of any degree between one and three per cent. The stronger solution dissolves the cement-substance of the tissues, while the elements themselves are preserved intact. Hence a portion of a tumor, such as myoma, if placed in this fluid for a few minutes, is readily separated or teased out into its individual fibres. It must be examined in the same fluid, for, if the latter were at all diluted, the fibre-cells themselves would be dissolved. Red blood-corpuscles may be examined in this solution, but not in the weaker one.

In examining for some of the parasites of the skin, this fluid serves a useful purpose. It dissolves the cement-substance of the epithelial elements, and exerts no injurious action on the spores of vegetable parasites. It may also be used in examining sputum for elastic fibres. It more completely "clears up" the specimen than does acetic acid, and is quite inert as far as elastic fibres are concerned. Fats, amyloid tissue, the threads of fungi, as well as their spores, and bacteria, are also unaffected by the alkalies.

Iodine is a most important reagent in microscopical work. A watery solution is the best, but the iodine requires a menstruum for its solution. That used is a watery solution of iodide of potassium. One part of iodine is added to a solution of two parts of iodide of potassium

* This solution, which is a modification of Pacini's, is made as follows: Hydrarg. bichlorid. corrosiv., 0.5; sodii sulphid., 5; sodii chlorid., 2; aq. destil., 200.00.

in fifty parts of distilled water. Kept in this form it can be diluted as required. In the diluted state it may be used for staining red blood-corpuscles, hyaline casts, etc. In a very dilute state it may be used for staining amyloid substances, with or without the subsequent addition of sulphuric acid.

Xylol serves very useful purposes, especially as a solvent of Canada balsam, for bacteriological work.

Osmic acid, which is of such great use to the histologist, can also be applied with advantage clinically, for the purpose of "fixing" certain elementary bodies. A one per cent. solution is the most useful. When the vapor can be used, it penetrates better than the fluid itself, as the latter affects the superficial parts only. Blood-corpuscles and other cellular elements are at once fixed in shape by this most useful reagent. It blackens

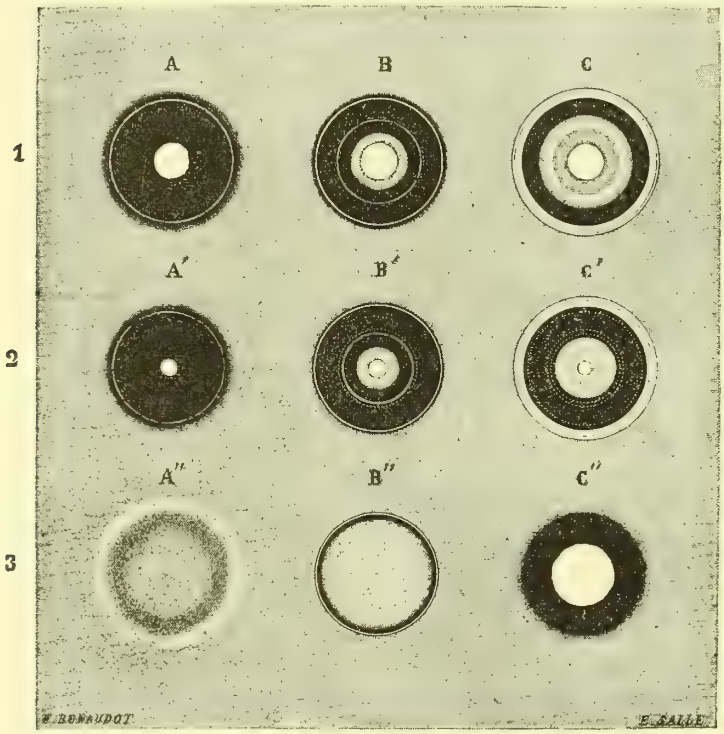


Fig. 2262.—Air-bubbles (Fol.). 1. As seen in water: A, with upper portion in focus; B, with middle portion in focus; C, with deepest portion in focus. 2. As seen in Canada balsam: A′, with upper portion in focus; B′, with middle portion in focus; C′, with deepest portion in focus. 3. Fat drops, as seen in water: A″, with deepest portion in focus; B″, with middle portion in focus; C″, with upper portion in focus.

fatty matter very rapidly. Tissues hardened by this acid will stain by picro-carmine, but not by carmine.

In using it, care is required in avoiding the inhalation of its fumes, which are very injurious to the mucous membranes.

Aniline water is frequently required for preparation of stains for micro-organisms. It may be prepared by adding five parts of aniline oil to one hundred parts distilled water, shaking well every half-hour or so for three or four hours, and then filtering for use.

The Use of the Microscope.—The table on which the instrument is used should be solid, and fixed opposite a window which gets very little sun. In daylight, the light as reflected from the clouds is the best. For artificial light, a coal-oil lamp is the most suitable for this work. A large flat one, with broad flat burner, which is not quite six inches from the level of the table, is the best. It may be used with a condenser for concentrating light on the mirror. A good condenser, possibly the best, is a globular glass flask capable of holding about five hundred cubic centimetres, and containing a weak solution of the ammonio-sulphate of copper sufficient to give it a pale blue or neutral tint. This bottle is placed between the lamp and the mirror of the microscope. If the lamp is used without the interposition of the bottle, it is better to have it so placed that the flame will be edgeways toward the mirror. It is better to accustom one's self to the constant use of the microscope with its stand in the erect position, and not to have the tube inclined. This is especially advisable in clinical work, where substances are nearly always examined in the fluid condition, and if used with stand inclined there would be the liability to movements of the fluid and of its contents through gravitation; the cover-glass also is liable to slide off. In examining fluids the drop used should be a small one, so that the cover-glass will not swim about. In the application of acid or coloring reagents to the specimen on the slide, the cover-glass must never be removed. The acid or other reagent should be applied with a clean glass rod; it should be allowed to drop on the slide close to the cover-glass, barely touching its edge. If it does not readily run under the cover-glass, as it should through capillary attraction, it can easily be made to do so by placing a small scrap of filter-paper or blotting-paper at the opposite edge of the cover, when the current will be at once established.

It is always advisable to be able to use either eye in making observations through the instrument. While doing so the microscopist should never close the unused eye; if that is done, microscopical work is certain to become tedious. A very little practice will enable one to keep both eyes open. A very good plan to commence with, for a person who finds difficulty in doing so, is to cut a hole, the size of the tube of the instrument, in a small piece of cardboard or stiff paper sufficiently large to obstruct the view of the other eye, and place it with the hole adjusted over the tube of the instrument. After a little practice in this way, it will be found that all difficulty will be overcome. Small vulcanite or brass shades are specially made for this purpose, and may be had from most opticians.

In focusing, some care is required with the higher powers. It is best to bring down the lens as close as possible to the cover-glass, without actual contact, before looking through the instrument, and then gradually removing the lens by the fine adjustment for focusing. If the microscope is not provided with rack-and-pinion coarse adjustment, the movement for coarse adjustment should always be done with the hand working the tube, up or down, in a spiral or rotatory direction — never vertically. In examining specimens with a high power, the slide should never be removed without first raising the objective, as otherwise there is danger of soiling and possibly scratching the lens. When changing lenses, if one is left on the table, it should never be left on its side, but always with the open end resting on the table, thus preventing the dust, which is continually being deposited around the room, from falling upon the inside or uppermost lenses, which are difficult to get at and clean.

For most specimens it is advisable first to examine the entire field with a low power. If a stand such as that of Zeiss (Fig. 2249), is used, this can be very conveniently done by means of a revolver capable of holding three lenses. Besides the advantage of quickly changing powers, the revolver also facilitates the removal of the objectives, if necessary, for cleaning them, as the two not directly beneath the tube are placed at an angle of about forty-five degrees, and thus are more easily got at for removal.

Accidental Foreign Bodies, etc.—Some of the substances to be submitted to microscopic examination, especially

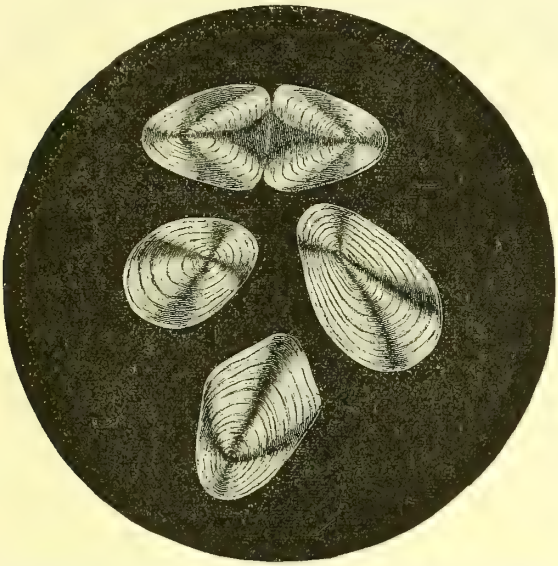


Fig. 2263.—Starch Granules highly Magnified, as seen by polarized light. (Behrens.)

fluids, such as sputum, urine, etc., are likely to contain some foreign bodies accidentally admitted, either through the atmosphere or otherwise; consequently it is of importance to be able to recognize them.

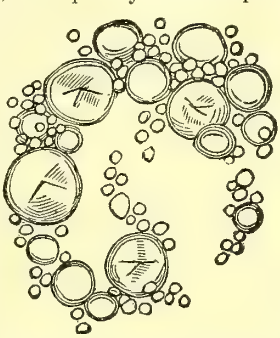


Fig. 2264.—Wheat Starch. Many of the granules are as small as red blood-corpuscles.

Bubbles of air cannot very well be called foreign bodies, nevertheless they may most conveniently be referred to here. They are at first the cause of some little amazement to beginners, but two or three observations will enable them to be recognized. This can be done by their very dark contour and brilliant centre.* Fig. 2262 is sufficiently explanatory of their various appearances. A very good medium to study them in is the saliva, which always contains them in great numbers mixed up with the mucus. Fig. 2262, B, shows a bubble properly focused. Saliva is also a useful study for many morphological elements, and, as before stated, is a good object for testing the quality of the high-power lenses, by the study of the Brownian movement in the salivary corpuscles. Grains of starch are constantly floating about in the dust of the atmosphere, and may be mixed up with the specimen for examination. They will be readily recognized by their behavior with polarized light (Fig. 2263), also by their concentric striation and their shape, which is often pyramidal; sometimes they are quite round, and they may be as small as a red blood-cell, as seen in Fig. 2264. Treating a suspected specimen with a solution of iodine at once removes any doubt, as this colors the starch granules blue.

Fig. 2265.—Cotton Fibres. (Zacharias.)

Threads and fibres of various kinds may be present, such as cotton fibres; these may be recognized by their consisting of thin, flat bands, which always have a twist in some part of their length. Linen fibres are cylindrical in shape and have frequently small nodular swellings from which a very fine thread can be seen branching off. Sometimes they consist simply of a cylinder with a crevice extending along it for some distance. They have a firm consistency and do not twist. Wool appears as cylinders of unequal thickness covered with scales or flat cells. The fibres are irregular in shape, and are soft and wavy. Silk consists of simple homogeneous fibres which refract light powerfully. No scales or lines of any kind can be seen on them. The application of iodine and sulphuric acid at once distinguishes them from the vegetable fibres, which are colored blue, while these reagents have no effect on the silk.

Fig. 2266. — Linen Fibres. (Zacharias.)

Spores of some fungi may be present, and possibly be mistaken for red blood-cells. From these latter they may be distinguished by the fact of their containing a nucleus which is rendered very apparent by the action of iodine. They also refract light to a much greater extent than the red corpuscles.

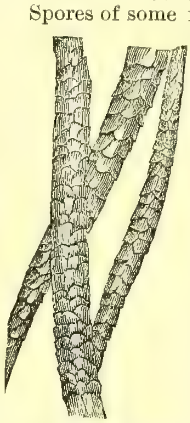


Fig. 2267.—Wool Fibres. (Zacharias.)

Yeast-cells are frequently present in fluids, but may be recognized by their oval shape, and by the presence of buds projecting from some of them; many of them also have vacuoles.

General Instructions in the Examination of Fluids and Tissues.—For many fluids all that is necessary is to place a drop on a glass slide, apply the cover-glass, and submit it to examination. Fragments of morbid growths, and the like, may be examined by teasing them out in a 0.75 per cent. solution of common salt, in which case it should be spread out in as thin a layer as possible. A better menstruum is the same solution, to which methylene violet, or gentian violet, has been added in sufficient strength to give it a decided purple color. If there should be any difficulty in separating the fibres, if the specimen is of a fibrous nature, it may be facilitated by placing the fragment previously in "one-third alcohol" (alcohol one part, water two parts), and after twenty-four hours teasing it out on the photophore.

Delicate objects, such as urinary tubules, cancer-cells, etc., are better made out when examined in a weak solution of iodine, made by diluting with water the solution previously referred to. The object can be teased out or prepared in this solution; or the latter can be added, after the cover-glass is applied, by placing a drop by the side of the cover-glass, and drawing it under by a piece of filter-paper at the opposite side.

Fig. 2268.—Silk Fibres. (Zacharias.)

If the preparation is a fluid one, and it is desirable to keep it under observation for a few hours, it will be necessary to protect it from evaporation. For this purpose one of the following methods may be employed. A very simple one is to run a drop of olive-oil, by means of a camel's-hair pencil, along the edge of the cover-glass. A better method is to have a mixture made by heating together paraffin fifteen grammes, and liquid paraffin fif-

teen cubic centimetres This melts at about 39° C (102.2° F.). This mixture, contained in a small wide-mouthed bottle, placed in hot water, melts rapidly. In this condition it can be applied readily with a fine camel's-hair brush. Another very ready method is to take three or four small pieces of the solid paraffin, very little larger than a pin's head, placing one at each side of the cover glass, and then taking some small metallic substance, such as a piece of iron wire with a fine point, or a steel pen in its holder, and heating it over the chimney of a common lamp, to apply it in the heated state to the particles of paraffin. The melted paraffin runs along the edge of the cover-glass and hermetically seals it. In this way the preparation can, with ordinary care, be carried from one place to another for examination.

Another method is to examine the preparation in Farrant's solution, which is allowed to dry along the edge, so that the cover is hermetically sealed.

Fluids supposed to contain micro-organisms are best examined as *cover-glass preparations.* These are very instructive and easily made. The same general rule applies pretty much for all purposes. The cover-glass is smeared with the substance to be examined—sputum, blood, juice from a pathological growth, etc. Another cover-glass is placed on this one, and the two drawn apart, so as to have a uniform film of the substance to be examined on both. It is now quickly dried in the air, and then passed slowly three times through the flame of a spirit-lamp or Bunsen burner, with the surface of the cover-glass having the specimen on it turned away from the flame. Now it is submitted to the staining process. Many micro-organisms require special methods to render them visible under the microscope. A very great number, however, may be stained by the one process. The most useful colors are gentian violet, fuchsin, methylene blue, and vesuvin. It is advisable to have two solutions of all these dyes on hand; the one a saturated alcoholic, and the other an aqueous, solution. The aqueous solution of gentian violet is in the proportion of 2.25 to 100 of distilled water. The aqueous solutions of the other staining fluids consist of alcohol, 15 parts; water, 85 parts, and 2 parts of the dry color. A drop of one of these staining fluids is applied to the preparation and retained there for about a minute, then washed off with distilled water, and the other side of the cover dried with filter-paper. It may now be examined in water, or made into a permanent preparation by allowing it to dry perfectly, and then mounting it in balsam dissolved either in turpentine or xylol. Some micro-organisms stain much better when treated with colors dissolved in aniline water. This is prepared by mixing about 5 c.c. of aniline oil with 100 c.c. of distilled water; allowing the mixture to stand for about an hour, but shaking it several times during that time, and then filtering. A few drops of an alcoholic solution of one of the colors just mentioned are added to that, until the fluid is rendered slightly opaque. Colors prepared in this way cannot be kept. They change in the course of a few days and become unfit for use; it is, therefore, advisable to prepare the colors freshly when required. Should the stain be too strong, part of it may be removed by washing repeatedly with alcohol.

Special forms of organisms require different methods of treatment, which will be referred to under the various headings

Up to the present time, only two forms of bacilli are known which resist the decolorizing effects of mineral acids when previously stained with the basic aniline dyes; these are tubercle-bacilli and the bacilli of lepra. Weigert's nucleus stain,* by coloring the latter, serves to distinguish it from that of tubercle.

Precautions to be Observed in Examining Fluids.—In the use of the cover-glass, when the layer of the fluid is thin, capillary attraction is very strong, and by drawing down the cover-glass is likely to distort some of the softer morphological elements. This can be avoided by placing a hair, or perhaps better, a couple of fragments of broken cover-glass beneath the cover-glass.

In making use of the hæmacytometer, if the cover-glass is too thin, the attraction of the fluid beneath it will cause a slight depression of its centre, and render incorrect the calculation of the number of corpuscles, the depth of the cell at that particular spot not being the same as at the margins. Most hæmacytometers have this one-tenth of a millimetre in depth, and require a moderately thick cover glass to overcome the attractive force of the thin layer of fluid.

Blood.—The microscopic examination of the blood is of the utmost importance in determining the relative number of the red and white corpuscles, as well as the absolute number of each in a definite quantity of this fluid; the presence or absence of nucleated red corpuscles, of abnormally large or small red corpuscles, or their altered appearances in certain diseases; the presence or absence of parasites; the examination of blood-stains,* etc.

Associated with this might also be mentioned as of great importance the determination of the relative amount of hæmoglobin in the blood-corpuscles, by means of specially devised apparatus.

Method of Examination.—This varies according to the purpose. In all cases both glass slide and cover-glass † should be scrupulously clean. The cover-glass, after having been cleaned, should be handled only with forceps. Catching hold of it with the fingers will be almost certain to make it more or less greasy, and prevent the blood forming a uniformly thin layer. The palmar surface of the tip of the finger is a good place from which to take the blood. It should be well cleaned and dried, and then pricked with a needle—preferably a Glover suture-needle which has been previously passed through the flame of a spirit-lamp or Bunsen burner, to insure freedom from septic material. The cover-glass is applied to the drop of blood that escapes, and is quickly placed on the slide and examined.

If the examination is merely for the purpose of observing the different elements of the blood in a general way, as a sort of preliminary examination it is advisable to dilute it with some so-called "neutral" or indifferent solution. The simplest of these is the 0.75 solution of common salt. A better fluid is the modification of Pacini's fluid, recommended by Hayem and known by his name. It has a great advantage over other diluting fluids, inasmuch as it permits the red corpuscles to retain their form and color. This they quickly lose in salt solution, in which they also diminish in size.

When a more accurate observation of the individual elements of the blood is the object in view, it will be necessary to use one of the so-called "fixing" fluids.

The best fixing solution is undoubtedly a one per cent. solution of osmic acid. It immediately hardens and fixes the elements in the shape in which they happen to be at the moment of contact with the solution. Laker[1] especially recommends this for the purpose of demonstrating the presence of the small blood-plates (Blutscheibchen). Schimmelbusch[2] uses this method for the same purpose, and says he never fails in demonstrating the blood-plates. The skin should be well cleaned and a drop of the solution placed on it, the puncture being made with a fine needle through this drop. Bizzozero uses for demonstrating the blood-plates a solution of common salt, 0.75 per cent., to which a concentrated solution of methylene violet has been added in the proportion of one part of the latter to five thousand of the former. For the same purpose, a concentrated solution of gentian violet may be used, in the proportion of one part to three thousand of salt solution. Either of these solutions is added to perfectly fresh blood. By this means the blood-plates, he says, as well as the white corpuscles, are stained.

Another method of "fixing" the corpuscular elements of the blood is the so-called "dry method." A small drop of blood is taken up with the cover-glass, and this

* Weigert's nucleus color has the following composition: Hæmatoxylin, alum, alcohol, āā 2 parts; distilled water, glycerine, āā 100 parts.

* See Blood-stains, vol. i. of this Handbook.

† Cover-glasses, to be thoroughly cleansed, should be treated with strong acids, either nitric or sulphuric, and then with alcohol.

Microscopy.

placed on another, and the two cover-glasses with the drop of blood between them rubbed together, so as to spread it in a thin layer. They are drawn asunder and allowed to dry. This may be hastened by blowing on them. A method which sometimes succeeds better in preserving the shape of the corpuscles in the dried state, is to heat the cover-glass before applying it to the drop of blood, so that it may dry quickly. This method requires care in order to avoid too great heat at the moment of application. There is also the liability of having too thick a film of blood.

To count the blood-corpuscles, it will be necessary to use known and accurate degrees of dilution with some special fluid. If it is the red blood-corpuscles that are to be counted, then a three per cent. solution of common salt may be used. With this fluid the white corpuscles stand out prominently among the red, and are easily avoided in the enumeration. Staining with one of the basic aniline dyes helps in this respect. A good solution for that purpose is one recommended by Toison.[3] It is prepared as follows: Chloride of sodium, 1 Gm.; sulphate of sodium, 8 Gm.; methylene violet B., 0.025 Gm.; glycerine, 30 c.c.; water, 160 c.c. Mix together the glycerine and 80 c.c. of water, and in this dissolve the methylene violet; dissolve the sulphate of soda and the chloride of sodium in the rest of the water, and then mix the two solutions and filter. The white corpuscles are colored violet and the red receive a slight greenish tinge. Hayem's fluid is also a very useful one for diluting the blood for enumeration.

A simpler fluid, and one which in my experience has proved equally effectual, is that recommended by Geigel[4]; that is a one-half per cent. solution of common salt, to which a few drops of gentian violet have been added. A one and one-half per cent. watery solution of gentian violet should be kept on hand, and four drops of this added to 50 c.c. of the salt solution. After a few minutes this colors the white corpuscles blue, by which means they are easily separated in the enumeration of the red.

The blood must be diluted to a definite extent. One part of blood to 200 is a very convenient strength to use. This can be done by means of the mixer figured and described on page 687, vol. iii., of this HANDBOOK. Thoma's blood-counter, as made by Zeiss and illustrated in Figs. 1747 and 1748 in the same volume, is the best. After being thoroughly mixed in the "mixer," three or four drops are first blown out of it, as it will be diluting fluid only that is in the tube of the mixer. A fresh drop is now placed on the ruled slide or "blood-counter," and the enumeration is made in the manner described.

To enumerate the white blood-corpuscles only, a differently graduated mixture has been devised by Thoma.[5] He uses the same form of mixer as that described for counting the red corpuscles, but with a smaller bulb. It will hold only ten times the quantity of fluid that the graduated portion below can hold. The diluting fluid is distilled water containing one-third per cent. glacial acetic acid. This dissolves the red corpuscles but simply renders more distinct the nuclei of the white corpuscles, which otherwise are unaltered. The same graduated slide can be used as for the red corpuscles, although it is unnecessary to use the graduated lines in counting, as the whole field of the microscope can be used as a standard of unity. A power of about two hundred diameters with low eye-piece is to be used. The draw-tube of the microscope is raised or lowered, as the case may be, to get one of the ruled lines in the counting-chamber exactly at the margin of the field of vision on either side, and then the spaces between these two lines are counted. Suppose the diameter of the field of vision corresponds to eleven divisions; then, as each of these is $\frac{1}{20}$ mm., the unit of length will be $\frac{11}{20}$ mm. Upon this will be based an arithmetical calculation. The radius will then be $\frac{1}{2} \times 11 \times \frac{1}{20}$; that is, $\frac{11}{40}$. Now, as the area of a circle is equal to π,* multiplied by the square of the radius, the area of the field of vision will then be $\pi\left(\frac{11}{40}\right)^2$ mm. As the depth of the counting-chamber is $\frac{1}{10}$ mm., that is, 0.1 mm., the capacity of that part of the chamber in the field of vision will be $0.1\left(\frac{11}{40}\right)^2\pi$ cmm., and may be represented by the quantity Q. In order to average the number of corpuscles, it is advisable to count a number of fields. Suppose 50 have been counted, and in that number about 950 cells have been found, then we will have $\frac{950}{50Q}$ as the contents of a cubic centimetre of that fluid. As, however, the blood was previously diluted with the acid water to the extent of ten times, then $\frac{950}{50Q} \times 10$ is equal the number of white cells in the blood, which in this case will be 7,998 to the cubic centimetre.

* The Greek letter π is that used by mathematicians to represent the ratio of the circumference of a circle to its diameter. This is constant, and has been determined to be as 3.14159 to 1.

Blood mixed with acetic acid is not reliable for enumeration purposes after the lapse of from twelve to eighteen hours.

In examining blood for micro-organisms it is necessary to make a dry preparation, either on a cover-glass or a slide (better on a cover-class), and then to color it with one of the aniline dyes. Good solutions to use are methylene blue or fuchsin, about two per cent. (2 Gm. in 15 c.c. alcohol, and 85 c.c. water), or gentian violet about the same strength without the alcohol. This may be washed off and then examined. If to be kept permanently, it may be dried and mounted in Canada balsam. Dr. V. D. Harris recommends the following method for making permanent preparations in conditions in which micro-organisms are suspected: A cover-glass preparation is made and placed in a solution of chromic acid, $\frac{1}{12}$ per cent., or of bichromate of potash, one-half per cent., in methylated spirit or absolute alcohol, for five or ten minutes, is then washed in water and again dried. The specimen is now ready for staining. Dr. Harris considers the best dye for this purpose to be a recently prepared one per cent. solution of Spiller's purple in water, to which a small quantity of alcohol has been added. A few drops of this are filtered into a watch-glass, and the cover-glass is floated on the surface with its prepared side downward, and allowed to remain for five or ten minutes. It is now washed in distilled water, dried thoroughly, and mounted in Canada balsam.

In counting blood-corpuscles, an important precaution is to have the drop of diluted blood rather small than otherwise. If a large drop of the blood mixture is placed on the slide, and, after the cover-glass is in place, is found to be too large for the cell, the result of the calculation made from what remains after the excess has been removed, by filter-paper or otherwise, will be deceptive, as the white corpuscles adhere both to the bottom of the cell and to the cover-glass. If the drop is too large, it will be necessary to clean the slide and the cover-glass, and add a fresh drop of the mixture.

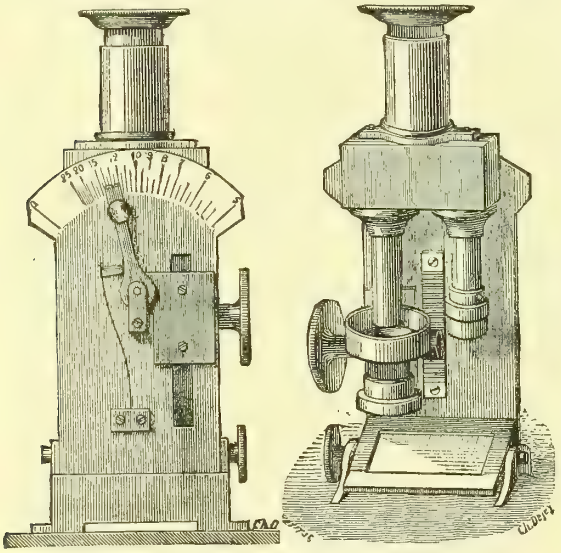
It is questionable whether the enumeration of the blood-corpuscles possesses the value in disease which is claimed for it by many physicians. We know that the important constituent of the red corpuscle is hæmoglobin, and that the corpuscles vary very much in the depth of color. This variation depends on the amount of hæmoglobin. Several methods have been suggested for the purpose of estimating the quantity of this important constituent of the blood. Two of these are described on page 548, vol. i., of this HANDBOOK. Dr. Gower's globinometer, illustrated there, is the one most used. Other methods have lately been introduced. A comparatively recent, and a very simple one, is that suggested by Von Fleischl, the apparatus being made by Reichert, of Vienna. It consists of a wedge of ruby-colored glass with a scale upon which are markings corresponding to solutions of hæmoglobin of various strength. A specimen of the blood to be examined is diluted to a definite extent, and compared with the wedge by means of transmitted light. The markings on that part of the colored wedge with which it corresponds in color indicate the percentage of hæmoglobin which has been ascertained previously by comparison with a standard solution.

A still more recent apparatus is one described by Malassez.[6] It is an improvement on a former apparatus

introduced by him a few years ago. It consists of a small circular trough with a glass bottom for containing the blood to be examined, which is diluted to a certain degree (Figs. 2269 and 2270) This trough is worked perpendicularly by a rack-and-pinion movement, which at the same time moves an indicator. Upward movement of the trough brings it against a cylindrical tube also fitted with a glass plate. By means of this rack-and-pinion the thickness of the layer of diluted blood between the glass bottom of the circular trough and the glass of the cylindrical tube is diminished or increased, until the solution is of the same color as the standard solution in the other tube of the apparatus. The light is reflected through both tubes by means of a mirror at the bottom of the stand. The indicator points to a scale upon which can be read off the percentage of hæmoglobin.

Normal human blood consists of red corpuscles, white corpuscles, granules, and small "blood-plates" floating in a clear, transparent fluid.

The red corpuscles are biconcave disks of a faintly yellow color when seen singly by transmitted light. Their red color is well seen where several corpuscles lie one over the other. The red blood-corpuscles, as seen in the



FIGS. 2269 and 2270.—Malassez's Hæmochromometer.

blood, contain no nuclei, but nucleated red corpuscles are found in the marrow of bone.

The size of the corpuscle varies slightly, even in the same individual. The measurements generally accepted by writers on the subject are 7.4 μ to 8.0 μ.* This may be taken as an average.

The number of red blood-corpuscles varies even in the normal state. At birth, in the European,† the number is about five million in the cubic millimetre. Within twenty-four hours it increases to about six million, but is soon reduced to about five million. This number is subject to variations even in health, according as the amount of fluid in the system is diminished or increased. Sudden increase in the amount of fluid withdrawn from the blood by the kidneys or by the bowels (as in cholera), or by profuse sweating, may temporarily increase proportionally the number of red elements, while the number is lessened by large draughts of water.

* The sign μ, used throughout this article, stands for micromillimetre, which is the $^1/_{1000}$ of a millimetre, and is equivalent to about $^1/_{25000}$ of an inch.

† Maurel (La Semaine Médicale, 1886, p. 358) says that the black races have the largest number of red corpuscles. Among others he gives the following figures per cubic millimetre: The blacks of Guadeloupe, 5,112,-256; the Hindoos, 5,008,222: the Chinese, 4,334,861; the Annamites, 4,238,731. The white corpuscles do not bear the same ratio in the different races. The number per cubic millimetre he gives as being in the Hindoo, 5,549; the European, 5,000; the Chinese, 4,611; the Annamite, 4,123; and the black, 3,823.

Gram,[7] who has paid some attention to this subject in the way of personal investigations, and has also studied carefully its literature, finds that, according to investigations of others, the size varies, the diameter increasing in passing from southern to northern climes. Bizzozero gives the average diameter of the Italian red blood-corpuscles as 7.0 to 7.5 μ; Malassez, whose measurements refer to France, states that 7.5 to 7.6 μ is the average diameter; in Germany 7.8 μ is taken as the average, while Laache, who writes of measurements made of the blood-corpuscle of the Norwegian, gives 8.5 μ as the average. Gram gives exact measurements, in some of which the corpuscles measured 9.3 μ. In new-born children a larger diameter and greater variations in size are frequently met with; some measurements being as high as 10.3 μ and others as low as 3.3 μ. The average thickness of the red blood-corpuscle is 1.9 μ.

The characteristic biconcave appearance of the corpuscle is well demonstrated by focusing either its centre or circumference. When the centre is properly focused under the microscope it is quite clear, with a dark circumference; on raising the fine adjustment of the microscope the circumference becomes clear, with a dark centre. This becomes quickly changed on the addition of fluid · if the latter be of higher specific gravity than the blood, such as a concentrated solution of salt, the corpuscles diminish in size and present serrated edges. The addition of water, or of a very dilute solution of any indifferent fluid, causes the corpuscles to become spherical and also lessens their diameter. The fluid in which they float also becomes colored from the escape of the hæmoglobin into it from the corpuscles.

The white blood-corpuscles, called also leucocytes, are much fewer in number than the red, being between five thousand and ten thousand per cubic millimetre; they are slightly larger, and, as their name indicates, they are colorless, or, to speak more correctly, perhaps, they are white. This white appearance is well seen in examining the blood in the three per cent. solution of salt sometimes used as a medium for the enumeration of the corpuscles; especially so if they are a little out of focus.

The protoplasm of the cell has a granular appearance, and contains several nuclei—from one to four. This granular appearance may be made to disappear by the addition of dilute acetic acid. The addition of water increases the granular appearance, and shows also very well the molecular movements of the contents of the corpuscle. Leucocytes vary considerably in size—from 4 μ to 13 μ.

They possess the property of moving about. This is well seen in the large leucocytes. Sometimes it requires the use of the hot stage, but under favorable circumstances this movement can be seen at the ordinary temperature of the atmosphere. From the similarity of the movements to those of the amœba, the term "amœboid" is given to them. Besides this movement the white corpuscles possess the property of attracting substances that may be in their immediate vicinity, and transporting them from one place to another.

The blood-plates, known also as the third element of the blood, are very small bodies, about 3 μ in diameter, and are about forty times more numerous than the white corpuscles. They are described by some as being biconcave; this is not satisfactorily proved.

There is yet a great absence of unanimity as to whether these are really distinctly preformed elements, or are the products of destruction or breaking down of the leucocytes. Some look upon them as the results of disintegration of the red corpuscles. I think there can be but little doubt that they are preformed elements existing in the blood. Outside of the blood-vessels they very rapidly undergo marked alterations in appearance; so much so as to be incapable of recognition unless examined within a few seconds, or fixed by some of the methods previously mentioned.

Besides the blood-plates, there are found a large number of "elementary granules." These are looked upon as broken pieces of white corpuscles. They are also supposed to be derived from the destruction of the blood-

plates. Many of these very small particles are simply fat-granules which have been absorbed into the blood.

Pathological and Anomalous Conditions of the Blood.—The most important of these is an *alteration in the number of the red corpuscles.* The red corpuscles may be increased in number, producing the condition known as polycythæmia. There is, as yet, no disease known which has directly associated with it an increase in the number of the red elements of the blood. Accidental conditions may occur in connection with some diseases, in which the blood may be retarded in its passage through the vessels. This will favor the escape of the fluid portion of the blood through the walls of the vessels into the lymph-paths, rendering the blood more concentrated and richer in red corpuscles. This is found to be the case in some of the more severe valvular affections of the heart, in which there may be impeded blood-flow. As many as 8.82 millions in the cubic centimetre have been met with in these cases. Similarly, artificially produced retardation of the circulation, as in the application of bandages, or the pressure of tumors on the vessels, may increase the number of red corpuscles in the delayed blood.

Decrease in the number of red blood-corpuscles is of frequent occurrence. In most fevers which have existed for any considerable length of time, and in malignant diseases, especially carcinomatous affections of the stomach, the number is considerably diminished; the coloring qualities of the red corpuscles are also appreciably lessened in some syphilitic affections, and in cachectic conditions generally; also in some forms of poisoning, as by lead or mercury, they are much fewer in number. In malarial fevers the corpuscles are not only fewer, but many of them contain micro-organisms. Infectious diseases have also a destructive effect on the red blood-cells. The red corpuscles are also diminished in number in hæmorrhages. The anæmia associated with hæmorrhages is also characterized by the presence of a number of abnormally large red corpuscles. Suppurative conditions and affections, such as albuminuric dysentery, etc., which produce the state of anæmia, diminish the number of red corpuscles. Anæmia is occasionally due to the presence of animal parasites in the intestines. The *ankylostomum duodenale* has been observed in several cases of pernicious anæmia, in which the anæmic condition has disappeared with the removal of the parasite. In pernicious anæmia, besides the diminution in number of the red corpuscles, some of them are much smaller than normal; others, on the contrary, are much larger. The small red corpuscles vary in size from 3.3 μ to 6 μ. The abnormally large cells are rare, but when present may be found as large as 12 or even 14 μ in diameter. Besides these variations in size, abnormally shaped red corpuscles are always present in chronic anæmia. They may be oval, spindle- or pear-shaped. It frequently happens, even in severe cases of anæmia, that the number remains normal, but their size and hæmoglobin-contents are considerably diminished.

In chlorosis the red corpuscles are considerably enlarged (8.3 μ), while in cancer, on the other hand, they are diminished in size (6.6 μ). Very small blood-corpuscles (microcytes) are present in great numbers in extensive burns; their size is about 2 to 4 μ. Similar corpuscles are also present in carbonic-acid poisoning, fevers with very high temperatures, septicæmia, and inanition.

In Addison's disease and the condition known as melanæmia there is a considerable decrease in the number of red corpuscles. In the latter the red cells are destroyed and changed into pigment. This is to some extent taken up by the red corpuscles, and by them deposited in the various tissues of the body.

Nucleated red corpuscles are found in all severe cases of anæmia. They can be recognized only in colored preparations. For this purpose use a 0.6 per cent. solution of common salt, colored with a few drops of watery solution of methylene violet. For more accurate observations make a dry "cover-glass" preparation and stain with the following solution: Hæmatoxylin, 2; alcohol, glycerine, distilled water, āā 100; glacial acetic acid, 10; alum in excess. This mixture is allowed to stand in the light for three weeks, and a few grains of eosine are then added. The dry preparations are allowed to remain in this for from six to twelve hours, and are then washed with water and examined. The nucleus of the nucleated red corpuscles will then be found colored dark purple. A very large proportion of nucleated red corpuscles are found in the lymphoid marrow of the spongy bones in pernicious anæmia, and also in lymphoid marrow which replaces the fatty marrow of long bones which exists in health. The white blood-corpuscles are increased relatively after hæmorrhages and diseased processes associated with the lymph-glands. In leukæmia they may be increased to such an extent as to almost equal the red in number. When such is the case there is always present a hyperplasia of the lymph-glands, spleen, and bone-marrow. In the anæmia produced by the *ankylostomum duodenale* the white corpuscles are also increased.

The *parasites of the blood* are not very numerous. They may be either of a vegetable or animal nature.

The *bacillus anthracis* * is a polymorphous organism existing under three distinct forms: the bacillus, the filamentary form, and the spore. The bacillus is the form which was first discovered, and that under which it exists in the body. When examined in blood, or without preparation, it is seen to consist of straight and immobile rods. They are cylindrical, homogeneous, and transparent as glass. Their thickness is about 1.25 μ; their length between 5 and 20 μ. Treating the preparation with concentrated acetic acid causes the blood-globules, both red and white, to disappear, and the bacilli to become more prominent. The preparation may also be treated with basic aniline colors, as recommended by Koch. This is done by placing a very thin layer of blood, or other liquid, on a cover-glass, allowing it to dry in the air; then fixing it by passing it across the flame of a spirit-lamp or Bunsen burner three or four times, the face of the cover-glass holding the preparation being turned away from the flame. The cover-glass is then floated on a concentrated aqueous solution of some basic aniline color, such as methylene blue, methylene violet, or fuchsin. In the course of a few minutes it is removed and washed with distilled water, in which it may be examined. If, however, it is desired to make a permanent preparation, it is then passed rapidly through absolute alcohol, clarified in oil of cloves, and mounted in balsam.

The filamentous state is that in which growth occurs outside the body. It is that which takes place in cultures. If preparations of filaments containing spores are treated as just mentioned, the filament takes the stain, while the spore remains uncolored. The spores may be colored by the following procedure: A portion of the culture is spread on the cover-glass and dried; it is now passed through the flame of the lamp ten times at least, and is then colored by a basic aniline color. The intense heat so alters the filaments that they will not retain any coloring matter, while the spores are unaffected by it.

The bacillus is the only form which is met with in the blood. The filaments and the spores are never met with there.

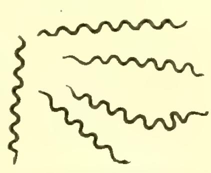


Fig. 2271.—Spirillum of Relapsing Fever.

In this diseased condition the red globules are more or less agglutinated, flowing like a jelly, slightly fluid; the white globules are more numerous than in normal blood, the rods floating in the limpid serum.

The spirillum (Fig. 2271) of relapsing fever (*spirochaeta*, Obermeier) was first described by Obermeier[8] as occurring in the blood of patients affected with this disease. It may be demonstrated by the following procedure, as recommended by Gunther:[9] A drop of blood is spread out in a thin layer on a cover-glass by the usual method, and fixed by heat. The cover-glass preparation is placed for ten seconds in a five per cent. solution of acetic acid. It

* See, also, Anthrax, vol. i.

is then taken out and permitted to dry, after which it is exposed for a few seconds to the vapor of strong ammonia, so as to neutralize the acetic acid. It is now washed and placed in Ehrlich's solution of gentian violet (11 c.c. concentrated alcoholic solution of gentian violet, 100 c.c. aniline water), again washed in water, dried, and mounted in xylol balsam.

This procedure is very useful for searching for bacteria of any kind in the blood; the red corpuscles become very pale, or are almost obliterated by the acetic acid.

The spirilla present a number of spiral turns, varying from four to eight or ten, which are frequently bent upon themselves. In the fresh state they move about actively, and unfold to some extent. They vary in length from 12 μ to 43 μ. They are very thin, and of a clear, light color, and in appearance very closely resemble the spirochaeta buccalis (see Fig. 2282). They are present in the blood only during the attacks of fever. The blood is then of a dark-red color. In the intervals between the elevated temperatures they are not found. They cannot be cultivated outside of the body.

The bacillus of malaria is a living organism, which is found in the blood.[10] It exists both inside the red corpuscle and also free in the fluid of the blood. In certain stages of development it possesses amœboid movements, and at other stages it is very active, being provided with flagella, which vary in number from one to four. By means of these it lashes the red corpuscles about in the fluid of the blood. Pigmentary granules of a black color may be found within the organism. These are supposed to have their origin in the hæmoglobin of the blood, which this organism transforms into melanine (melanæmia).

The filaria sanguinis hominis is found in the human blood only in the night-time. It exists there in the embryonic state, and causes, through its migration, the condition known as chyluria, and sometimes also the condition of hæmaturia. It has a long, slender body, with a rounded head and pointed tail (see HANDBOOK, vol. iii., page 156). It measures about 0.35 mm. in length. The parasite has also been found in elephantiasis, chylous hydrocele, varicocele, and lymph-scrotum.

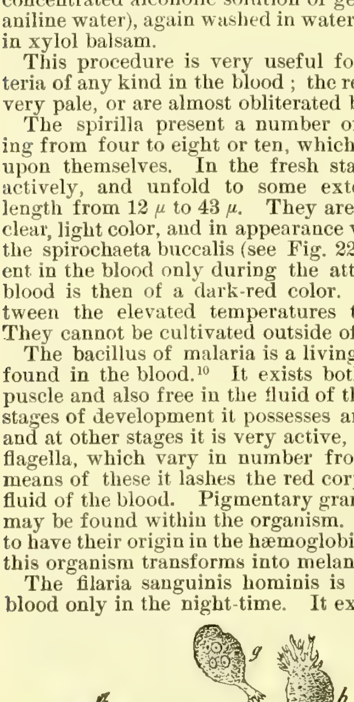


FIG. 2272.—Pus-cells. *a* to *k*, Living cells, showing changes in shape; *l*, a dead cell. (Frey.)

Pus, like blood, consists of fluid and corpuscles; but besides the corpuscles, other elements are nearly always present. The character of the corpuscles varies according as to whether the purulent fluid is of recent origin or of long duration (Fig. 2272). In the former case they present all the characters of the white corpuscle of the blood, especially the larger ones. In recently evacuated pus, more especially in abscess of not long duration, these cells are identical in appearance and behavior with the white cells of both blood and lymph. Their protoplasm has the same white, glistening appearance. They possess the same amœboid movements, which become more active on the application of heat. They are granular in appearance, and have one or more nuclei. When examined fresh, in the fluid in which they float, they are slightly opaque and of an irregular shape. The addition of a drop of water, especially if slightly acidulated, causes them to swell up somewhat and become transparent, showing then quite a number of small granules floating within. When suppuration is of long duration, besides the active, living, white corpuscles just described, others are present which are devoid of the amœboid movement, even on the application of heat. These are dead corpuscles, some of them in a state of vacuolation; others undergoing fatty degeneration, and in consequence containing a number of fatty granules. Those with vacuoles contain sometimes a clear liquid inside the vacuole. Suppurative masses sometimes present a cheesy appearance, due to the absorption of the fluid of the pus. This is especially the case when the purulent collection is of long standing. In such cases the corpuscles will be all out of shape and very small. They will have the appearance generally imparted to cells by pressure; that is, angular.

As suppuration advances very many of the cells undergo disintegration, forming the small granules that are seen in such large numbers in old pus. Instead of disintegrating and breaking up, they may simply undergo fatty degeneration. In consequence of this they increase in size, and look like a mass of fatty granules to which the name of "corpuscles of Glüge" has been given.

Occasionally in purulent masses, especially abscesses of the gum, large cells are found, having a diameter of from 30 μ to 40 μ. These cells consist of a number of pus-cells, mixed with granular protoplasm to form one large cell. Bizzozero has seen them also in the anterior chamber of the eye, and he considers them to be hypertrophied contractile cells, probably leucocytes which have devoured the cells around.

Red globules are sometimes found mixed in with the pus. They may be more or less altered in shape, or their places may have been taken by masses of pigmentary granules, generally crystals of hæmatoidine, which may be recognized by their brown color.

Foreign Substances.—Structures already existing may be mixed with the pus, and, practically speaking, become foreign bodies. Fragments of bone or of cartilage may be present, indicating a destructive process going on in the vicinity and involving these tissues. Very frequently it is only by the aid of the microscope that it is possible to decide whether an abscess is connected with bone or not. In examining for the presence of this tissue it is advisable to add to the preparation a weak solution of potash, which will have the effect of clearing up the specimen by its action on the pus-cells. If bone is present, the bone-cells will be readily recognized. Glycerine is also a good medium in which to search for fragments of bone.


FIG. 2273.—Pus from an Old Abscess. Numerous leucocytes, some rhombic crystals of cholesterine, and crystals of fatty acids in the form of rosettes. (Frey.)

Epithelial cells from the kidney or urinary passages may indicate the source of pus, or the connection of a fistulous opening with the stomach or intestines may be revealed by the character of the cells mixed with the pus or by the presence of food in it.

Crystalline substances are sometimes present in pus, especially in old purulent cavities. Fig. 2273 shows plates of cholesterine and acicular crystals of the fatty acids, some arranged in the shape of rosettes. There may also be present crystals of the ammoniaco-magnesian phosphate, of carbonate, and of phosphate of lime. These all form irregular masses, which are not affected by water, but are readily acted upon by acids.

Echinococcus cysts may sometimes be diagnosed by the presence of some portion of the parasite, or of the cyst from which it has grown, mixed up with the pus. In the former case it will be recognized by its head, provided with suckers and a large number of booklets, or by the peculiar stratified membrane forming the cyst.

Actinomycosis is a parasitic disease associated with more

or less suppuration. When affecting the jaw it may have its origin in decayed teeth. The parasitic growth is sometimes so large as to be visible to the naked eye, while at other times it will require a high power to detect its presence. Clinically, it sometimes resembles tuberculosis in its course; at other times it simulates pyæmia. Although first observed in cattle, and supposed to be confined to them, several cases have recently been

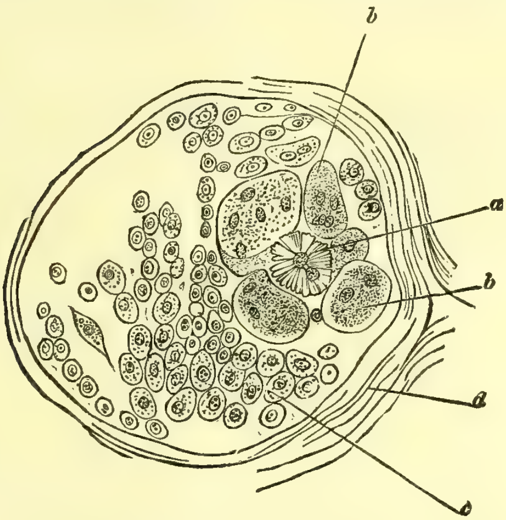


FIG. 2274.—Miliary Actinomycosis Nodules from Lung of Cattle.

recognized and described in man. Here the tendency to suppuration is greater than in cattle. This suppurative process may give rise simply to the formation of an abscess, or suppurating fistulous tracts may be associated with it. The parasite may be met with not only in the region of the mouth, but also in the thorax, or in the abdomen, either in the cellular tissue of these cavities or in the organs which they enclose.

Microscopic examination: A small portion of the scrapings obtained from the cut surface of the suspected growth, or any fluid which it is supposed contains the fungus, may be examined at once without the use of either water or glycerine. The latter, especially, causes alterations in its structure and destroys the exact image. The fungus may be recognized by the characters to be described presently. If sections of the growth are made,

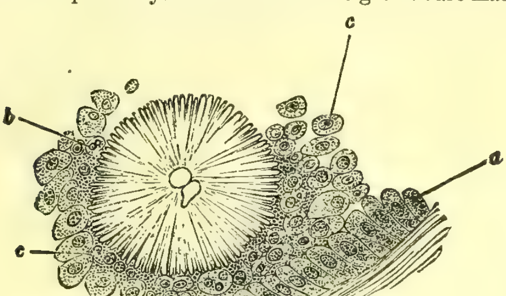


FIG. 2275.—Miliary Actinomycosis Nodules from Lung of Cattle.

they can be stained with advantage by Wedl's solution of orchella extract—20 c.c. of absolute alcohol are mixed with 5 c.c. of strong acetic acid (specific gravity 1.070) and 40 c.c. of water. French extract of orchella, which has been previously heated in a sand-bath to drive off any excess of ammonia that may be present, is added to this mixture until it produces a deep red coloration. After the solution has been filtered, sections are placed in it for about an hour, then washed in alcohol, and subsequently stained with gentian violet. By this method the radiated corpuscles of the fungus are colored ruby-red, the nuclei of the cells a bluish violet, and the connective tissue orange.

When the specimen is to be examined unstained, it should be done rapidly. By this procedure two zones are readily recognized (Fig. 2275).

The peripheral zone is generally much smaller than the central, and is composed of elongated corpuscles, one

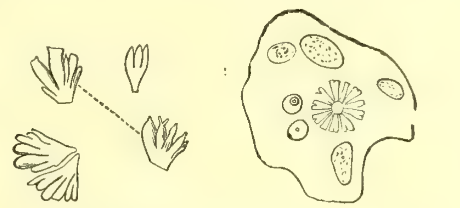


FIG. 2276.—Miliary Actinomycosis Nodules from Lung of Cattle.

extremity of which is directed in a radiated manner toward the centre of the mass. This end is somewhat pointed, whilst the external end of the corpuscle is rounded and divided dichotomously. On displacing the corpuscles by pressing on the cover-glass, they may be observed divided at one end into several branches, as seen in Fig. 2276. In the central zone the corpuscles are much flatter than in the periphery, and have more of a radiated and fibrillary appearance. Fig. 2275 gives a good idea of this as met with in a bronchiolus in cattle, the epithelial lining of the air-tube being shown at *a*. The fungus is here shown surrounded by lymph-cells, *b*, and epithelioid cells, *c*. Fig. 2274 shows a section of another and smaller bronchiolus, in which the parasite, *a*, can be seen as a very small rosette. It is here seen surrounded by some large cells, *b*, with several nuclei. A number of epithelioid cells, *c*, can also be seen, while the fibrous wall of the air-tube is shown in *d*. It is quite unnecessary to stain sections containing actinomyces in order to demonstrate them. But as calcification sometimes occurs, it may be necessary to use a weak solution of nitric acid to decalcify the structures. Actinomyces has been cultivated by Israel. The only medium which he found suitable was Koch's coagulated blood-serum, in which it grows very slowly. In the other media in which he tried to cultivate it, it was crowded out by the growth of other organisms.

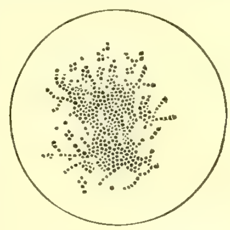


FIG. 2277. — Staphylococcus Pyogenes Aureus.

The micro-organisms present in suppuration, and in abscesses, have been variously described. Rosenbach [11] describes four varieties of micrococci. The most frequently occurring are: the *staphylococcus pyogenes aureus* and the *staphylococcus pyogenes albus*, so called on account of the color of their colonies. They occur in masses like bunches of grapes or the ova of fish. The diameter of a single coccus is about 0.87 μ. In benign abscesses the *micrococcus pyogenes tenuis* is found. The fourth variety, which is met with in the form of chains, Rosenbach calls *streptococcus pyogenes*. It is found in the pus of abscesses in chains of three, ten, thirty, and more links. Frequently they are found in chains of twos, presenting the appearance of diplococci. The diameter of a single coccus averages between 0.58 and 0.73 μ. When the inflammatory process is slow and affects the lymphatics, the streptococcus prevails; whereas, when rapid suppuration occurs, the staphylococcus predominates.

FIG. 2278.—Streptococcus Pyogenes.

In acute catarrhal suppuration of joints, Krause has found diplococci arranged in chain-like form, similar to the streptococcus and to the chain cocci described by Löffler as occasionally met with in diphtheria.

Chain-like pus cocci, exactly the same in every respect as the *streptococcus pyogenes*, and as such described by Fraenkel,[12] have been found in the meningeal exudation in a case of puerperal fever. Other fluids of the inflamed organs in the same patient contained exactly the same organisms.

Cornil[13] quotes Doyen as saying that puerperal fever is only a variety of septicæmia, characterized by one of the three microbes usually present in acute suppuration: Staphylococcus aureus, S. albus and Streptococcus pyogenes. These microbes, he says, are found everywhere in the air and in decomposing liquids.

Jaccoud[14] says that in some cases of acute pneumonia, where resolution is delayed, there may be suppurative foci, and microbes from these, entering the blood, will determine suppurative points of the same nature elsewhere.

Micro-organisms are met with in suppurative joints in consequence of *erysipelas.* There is some difference of opinion as to their nature, but the weight of evidence is in favor of the views of Rosenbach, who considers the diseased condition to be due to the presence of a micrococcus in chains—the streptococcus of erysipelas.

Contents of the Mouth.—It is of the utmost importance to know what structures and organisms are found in the mouth, and to be able to recognize them. This is necessary especially in the examination of sputum and of vomited matters.

Method of Examination.—It is advisable to make preparations in two different methods; one method is to examine the contents of the mouth in the natural fluids, or in these diluted with a drop of .75 per cent. solution of common salt, placed on a glass slide and a cover-glass applied. The other method that may be followed is to make a cover-glass preparation; that is, to place the specimen for examination, say the scrapings from the sides of a tooth, between two cover-glasses, and then rubbing slightly together and drawing them apart, to pass them over the flame of a spirit-lamp or Bunsen burner. The specimen should now be stained with one of the aniline dyes, and proceeded with as for the examination of micro-organisms. This method applies more particularly to the searching for micro-organisms. For the examination in the manner first described, all that is necessary is to scrape with the back of a clean knife, and then to proceed as above directed.

Some of the contents of the mouth can be found only in the fluids; their origin being localities not easily accessible in the manner referred to; such, for example, are débris from the posterior nares, mucus containing dust, and detached epithelium coughed up from the larynx.

The mouth is lined with mucous membrane covered with stratified pavement epithelium, detached cells from the superficial layer of which are constantly present lying on its surface or mixed up with the fluids collected there. Besides these, numerous other cells are found. It has opening into it the ducts of the salivary glands, as well as the mucous glands found in various portions of its walls. At its back part lie the tonsils, whose crypts contain cells which may be more or less degenerated and assume a cheesy appearance, and in this state be discharged into the mouth. With the mouth communicate also the nose, larynx, pharynx, œsophagus, and indirectly the air-sinuses. Cells of various kinds from all these cavities may be normally present in the fluids of the mouth. The cells of the superficial layer of the mouth just referred to are flat, large, and very thin, with a nucleus, generally a little to one side of the centre of the cell (Fig. 2279). The cells in the layer beneath this gradually lose their flattened shape, becoming thicker and shorter, the deepest layer having a somewhat oval shape. The epithelial cells of the upper portion of the pharynx differ from those lining the buccal mucous membrane in having cilia on the superficial layer of cells.

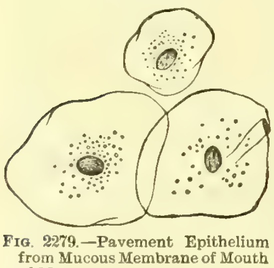


Fig. 2279.—Pavement Epithelium from Mucous Membrane of Mouth of Man.

The saliva is an opaline liquid having a density of about 1.004 to 1.009. Under the microscope are found epithelial elements, salivary corpuscles, and white and red blood-cells, also filaments of *leptothrix buccalis,* bacteria, and micrococci, as well as numerous small rods and spiral filaments. Mixed up with these are numerous air-bubbles.

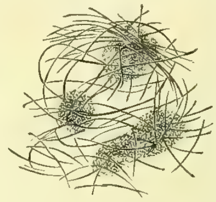


Fig. 2280.—Leptothrix Buccalis and Micrococci. (Bizzozero.)

The salivary corpuscles are larger than the white corpuscles of the blood, and are really lymph-corpuscles swollen by the water of the saliva. Numerous granules, in a constant state of movement (Brownian movement), can be observed in them, and sometimes one or more nuclei. The epithelial elements mixed up with the saliva in the mouth are mostly of the squamous variety. They are the result of the normal desquamation of the superficial layer of the mucous membrane. They are irregularly polygonal in shape, and vary in size from 50 to 80 μ in diameter. Near their oval-shaped nucleus numerous small granules are observed. It is of frequent occurrence to find slight folds in the cell itself. Besides these elements, occasionally thick flattened cells derived from the salivary ducts may be observed; also large granular, spheroidal cells, which are derived from the salivary glands.

Filaments of the *Leptothrix buccalis* are also found in the fluid contents of the mouth. They consist of threads and rods of various lengths; some are very short, others are long, but all are straight. (Fig. 2280.) They may be as much as 100 μ in length. Their diameter varies from 0.5 μ to 1.2 μ. They are quite colorless. They do not branch, but are generally found closely packed in bundles. The slimy covering of the teeth consists to a great extent of threads of leptothrix of various lengths mixed up with micrococci. No matter how vigorously the toothbrush is made use of, they can never be completely got rid of. The "tartar" at the base of the teeth contains them in large numbers.* These threads are found in carious teeth and are supposed by many to be the cause of this diseased condition. This statement, however, admits of considerable doubt. They are found also in the dentine canals, but here they are surrounded by a granular stroma.

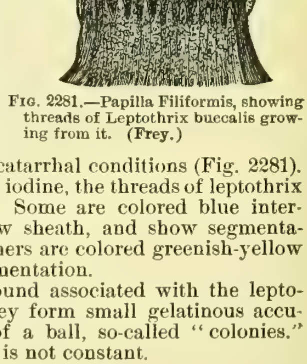


Fig. 2281.—Papilla Filiformis, showing threads of Leptothrix buccalis growing from it. (Frey.)

Besides their association with the teeth, the leptothrix threads are also found mixed up with the epithelial elements in the mouth. On the tongue they are constantly present. They are in great abundance, especially in catarrhal conditions (Fig. 2281). Treated with a solution of iodine, the threads of leptothrix act somewhat diversely. Some are colored blue internally, with a dark-yellow sheath, and show segmentation distinctly; while others are colored greenish-yellow without any trace of segmentation.

Cocci are frequently found associated with the leptothrix. When present they form small gelatinous accumulations in the form of a ball, so-called "colonies." This condition, however, is not constant.

* The "tartar" on the teeth of the Egyptian mummy is found to have the same parasitic growth present.

After the addition of fluid to the leptothrix masses, in their vicinity will be found a spiral form of thread—the *spirochaete buccalis*. This is described by some writers as having its origin in the fragmentation of the leptothrix threads. These become curved and twisted in some localities and then break off, and in this way form *spirilla*, or *vibriones*. These threads are of extreme delicacy and without any cross-markings (Fig. 2282). This spiral form may consist of from three to six or more bendings, which frequently are very irregular. They may be either active, having a serpentine movement, or they may remain quite motionless.

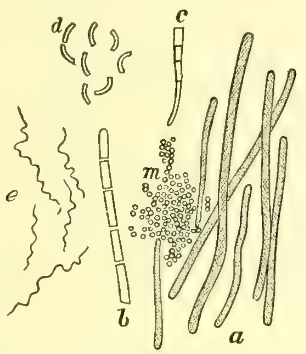


FIG. 2282.—Bacteria, etc., from the Teeth. *a*, Leptothrix buccalis; *b*, a fragment of the same after treatment with alcoholic solution of iodine, showing segmentation (more magnified); *c*, the same without iodine treatment; *d*, Lewis's comma-bacillus; *e*, spirochaete buccalis; *m*, micrococci. (600 diameters.)

According to Dr. Lewis,[15] "comma-like bacilli, identical in size, form, and in their reaction with aniline dyes, with those found in choleraic dejecta, are ordinarily present in the mouth of perfectly healthy persons." They are present in the saliva, and he uses the same procedure exactly to demonstrate their presence in the dejecta that he does in the saliva. His method is as follows: "A little saliva should be placed on a cover-glass (preferably in the morning before the teeth are brushed) and allowed to dry thoroughly, either spontaneously, or aided by a gentle heat. The dry film thus obtained should be floated for a minute or two with one or other of the ordinary solutions of aniline dyes adopted for such purposes, such for example as fuchsin, gentian violet, or methylene blue. The cover should then be gently rinsed with distilled water and the film re-dried thoroughly. The preparation may now be mounted in dammar varnish or Canada balsam dissolved in benzol, and should be examined under a $\frac{1}{12}$ or $\frac{1}{16}$ oil-immersion lens."

It should be stated here that there is some diversity of opinion as to the presence of these comma-bacilli and their similarity to those found in choleraic dejections as described by Koch.

Sarcinæ may be found in the mouth. (For a description see under heading Vomited Matters.) They may be developed in this locality, or have their origin in the lungs and be coughed up.

Particles of *food* may be found under normal conditions in the mouth, and may be present for hours after a meal.

The contents of the mouth may vary from those just described in consequence of local disease affecting either the mouth and its vicinity, or the digestive or respiratory tracts, or as the result of disease affecting the system at large. Some of the more important local conditions that require notice in this connection are the furring of the tongue, catarrhal and croupous inflammation, parasites, etc.

The *fur* of the tongue consists of epithelial cells and detached fragments of the secondary papillæ arising from the papillæ filiformes, mixed up with mucus-cells and parasites. These fragments are very firm and resistant, and adhere closely to one another. In local inflammatory affections, or diseases associated with catarrhal disturbances, the cells increase and are shed more rapidly, and thus afford a more favorable culture-medium for the development of the leptothrix threads and bacilli; consequently these also are greatly increased in number. In certain febrile and other conditions, a brown tongue may be present in some stage of the disease. This is due to the drying and cracking of the surface, fissures being formed from which blood oozes, imparting to it a dark color.

Catarrhal inflammation of the mouth and throat will be recognized by the large number of leucocytes and badly developed pavement-cells, with red blood-globules in variable number, mixed up with granular débris and filaments of leptothrix. Frequently these pavement-cells are found still adherent one to another, showing that they have been exfoliated *en masse*. Cells may also be observed in this catarrhal condition, manifesting the sign of living cells, that is, exhibiting amœboid movements. The application of acetic acid to catarrhal mucus causes a precipitate which has a striated appearance.

Croupous inflammations consist of the formation of a pseudo-membranous deposit which varies slightly in color. Sometimes it is yellowish-white, at other times it has a grayish appearance. It is composed of a network of fibres closely packed, having cells of different kinds imprisoned in the spaces. The cells may be leucocytes, red corpuscles, and epithelial cells. If the membrane on which the fibrinous deposit occurs is one lined with columnar cells, then the imprisoned epithelial cells will be of that variety; if, on the other hand, it is covered with pavement-cells, it will be that variety of cells that will be present in the exudation. It is best to examine the membrane in 0.75 solution of common salt and to tease it with needles. It will be found to be tough and to break up in irregular fragments, which are rather opaque. The addition of acetic acid renders it transparent and causes it to swell up; it also renders the cells in the exudation more transparent, and brings out distinctly their nuclei. Sections may also be made with the ether freezing-microtome and a drop of glycerine slightly colored by methylene violet added, when the fibrinous network and inclosed cells will be well seen. No difference, microscopically, has been made out between croupous and diphtheritic inflammation. On this question investigations are still being constantly made in the hope that a micro-organism, peculiar to diphtheria, may be discovered. Löffler has described and cultivated bacilli, which he says are constantly found in the diphtheritic products in man. Babes[16] has obtained the same bacilli in croupous laryngitis as well as in diphtheria. In all cases the bacilli are accompanied by streptococci with very fine bacilli, or with a staphylococcus, which gives a yellow color to the cultures. By cultivating these bacilli on nutritive media, Babes has succeeded in obtaining large spores, 2 to 3 μ long.

Oidium albicans is a vegetable parasite that is of frequent occurrence during the earlier period of infant life. It forms the white patches known as thrush which are met with in the mouth. Here it is found on the tongue, gums, and soft palate. It has also been observed in the œsophagus and stomach. Adults suffering from exhausting diseases, such as typhoid fever, phthisis, etc., occasionally have this parasite growing in the mouth.

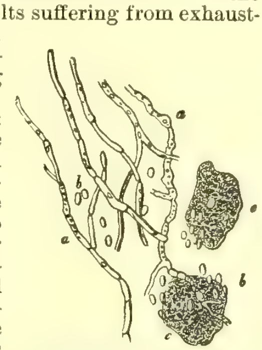


FIG. 2283.—Oidium Albicans, showing: *a*, Hyphæ; *b*, spores; *c*, epithelium from mouth.

Method of examination: Scrape a portion of one of the suspected white patches and place it in a watch-glass containing liquor ammoniæ, one part, and absolute alcohol, two parts; allow it to stand for four or five minutes, and then transfer to a slide on which a small drop of glycerine has been previously placed, and apply the cover-glass. Mounted in this way it can be prepared for permanent use. In infants these white patches generally have closely adherent to them small portions of curdled milk. On microscopical examination these can be readily recognized by the minute drops of fat. On teasing out one of these patches freed from milk, numerous epithelial cells, mucous corpuscles and granules will be observed mixed up with the parasite. As before stated, it is a plant, and consists of hyphæ and spores (Fig. 2283). These hyphæ have a jointed appearance and are composed of long cylindrical cells, averaging about 4 μ in di-

ameter, and being about fifteen or twenty times as long. These long cells are placed in rows, forming bud-colonies. From the end of these, spores shoot off and become separated. These spores by their elongation become converted into hyphæ, with a repetition of the budding process. As the hyphæ increase in length they branch off and ramify one with another. This plant is considered by some observers to be identical with *saccharomyces mycoderma*, the so-called flowers of wine, a fungus which grows on the surface of acid fluids containing but little sugar, and can be easily cultivated in a nutrient fluid containing sugar and ammonic tartrate. It has been proved experimentally that this mycoderma can be grown on the epithelium of the mucous membrane.

Grawitz,[17] who formerly believed in the identity of the two fungi, has recently modified these views as the result of cultivations on nutritive media. He no longer considers them to be the same, but rather separate species.

Concretions from the tonsils are occasionally found in the mouth. They consist of degenerated pavement epithelium mixed up with numerous granules, and also with bacteria and filaments of leptothrix. The mass has a cheesy appearance and generally is very fetid. Sometimes the degeneration has advanced to the calcareous state, when it will present a harder appearance.

The larynx is lined by two varieties of epithelium, which lie on a basement membrane, beneath which is the mucous membrane. Both surfaces of the epiglottis are covered with stratified pavement epithelium. A little below this, in the larynx, it changes to the columnar ciliated epithelium, which is also stratified. At the true vocal cords it again gives way to the stratified pavement epithelium. Below the cords the ciliated columnar epithelium replaces the former and extends down into the bronchi. The lower strata of epithelial cells are ovoid in shape, with one extremity slightly pointed. Opening on the surface of this membrane are numerous ducts of glands, which are scattered throughout almost the entire length of the respiratory tubes, except the very small bronchioles. These ducts and glands are lined with cells which are mostly polygonal in shape.

The mucous membrane of the nose, like that of the larynx, is lined by the two varieties of epithelium just described.

In catarrhal or other diseased conditions, these various cellular elements may be found mixed up with leucocytes. The crusts that are observed in chronic nasal catarrh are simply the mucous cells and epithelial elements which have been dried by evaporation. Most of the elements may be recognized after the crusts have been soaked for a time in water.

SPUTUM.—Microscopic examination of sputum is of great significance in diagnosis. The most important pathological products that may be present are tubercle-bacilli and elastic fibres. Other microscopic disease-products that are found in sputum—some constantly, others but rarely—are pus-cells, leucocytes, lymphoid cells, red blood-cells, epithelial cells, threads and spores of oidium albicans and also of leptothrix buccalis, sarcinæ, actinomycetes, pneumococci, crystals of cholesterin and hæmatoidin, Leyden's "asthma crystals," fat crystals, and bronchial casts.

Sputum, when present to any extent, is the result of a diseased condition of the respiratory mucous membrane, or of that of the pharynx; nevertheless it invariably contains elements which are found under normal conditions in the mouth and throat, and which have already been referred to. Under normal conditions, dust is being continually drawn into the air-tubes; when in sufficient amount it will act as a slight irritant, and stimulate the mucous glands in their walls to secrete more mucus. This dust or foreign matter must be got rid of. The ciliary movement of the epithelia may not be sufficient to help it onward, but an act of coughing may be required. This will cause the separation of some of the epithelia, some of which may have lost their cilia (Fig. 2284); hence, sputum may be to some extent normal, and these bodies may be present in it, as may also other elements found in the mouth.

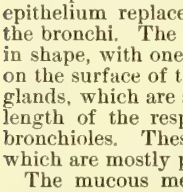


FIG. 2284. — Ciliated Epithelium from Respiratory Passages. Some of the cells have lost their cilia.

Under pathological conditions, the sputum may vary considerably in appearance and in the elements it contains, as well as in the relative proportion of the various morphological elements. Thus, it may be simply mucous in character, as occurs in the early stages of bronchitis; this variety contains but few formed elements; or it may be purulent, as is the case when there are cavities in the lung, when there is empyema opening into a bronchus, or when an abscess of the lung or of some part in the vicinity bursts into a bronchus; or it may be serous, as occurs in the sputum of œdema of the lungs; or again, it may be bloody. This last varies; thus in pneumonia, carcinoma, and in hæmorrhagic infarcts it may be differently colored, according to the amount of blood, from a yellowish-red, up to a dark brown or a prune-juice color.

The morphological elements are very numerous. Those most constantly present and in greatest number are leucocytes. Their number varies according to the character and general appearance of the sputum. In opaque or purulent sputum they are present in great numbers, and their protoplasm usually contains a number of granules and one or more nuclei, which are generally rendered obscure by their presence. The addition of acetic acid clears up the cell by causing the granules to disappear. The cells are sometimes stained by the coloring matter of the blood present in the sputum. Some of these cells may be found to be irregular, and very much out of shape, owing to their having remained a long time either in cavities or in some portion of the respiratory tract.

Epithelioid cells are larger than leucocytes, and contain a single well-defined nucleus with one or more nucleoli. In staining with the basic aniline dyes, their nuclei are less deeply colored than those of the leucocytes. Both leucocytes and these epithelioid cells may contain small black granules as the result of the previous inhalation of lamp-black, or other small, fine particles of dust.

Closely related to these epithelioid cells, if not of the same kind, are other larger cells which are frequently found in sputum, both normal and pathological, and whose origin is supposed by many to be the air-cells of the lung and the finest bronchioles. They are large, round, or ovoid cells, with nucleus and nucleolus. Their protoplasm frequently contains fatty granules, carbonaceous particles or masses of "myelin," either separately in each cell, or all together (Fig. 2285). Sometimes these cells are colored yellowish-brown by the coloring matter of the blood.


FIG. 2285. — Alveolar Epithelial Cells Found in Sputum. Two cells to the left show carbonaceous particles; the two to the right of the figure, above, show fatty matter as well. The other cell, below, contains myelin.

Epithelial cells may be of the flat kind, having their origin either in the cavity of the mouth, on the vocal cords, or from the air-cells of the lung; or they may be of the cylindrical kind, in which case they may come either from the posterior portion of the nose, the upper portion of the pharynx, the larynx, or the bronchi. The cylindrical epithelial cells are not often found in the sputum. Their presence points to an acute catarrh of the mucous membranes of the parts just mentioned. It is only in the earlier stages that they are observed; later on in the inflammatory condition they are very few in number, and ultimately entirely disappear, giving way to leucocytes in great number. Treated with acetic acid, an oval-shaped nucleus and a nucleolus become apparent. Pavement-cells are found constantly in sputum, the most common ones being those illustrated in Fig. 2279.

Red blood-globules when present are easily recognized. They may, however, have lost their coloring matter or be completely destroyed, leaving as traces either pigmentary granules or crystals of hæmatoidine (Fig. 2286). Hæmatoidine appears either in amorphous, yellowish-brown granules, or in rhombic plates, and it is generally in *old* blood extravasations that it is found.

FIG. 2286.—Crystals of Hæmatoidine.

Fibrin, when present in the sputum, is frequently found in the form of very small casts of the alveoli of the lungs or of the bronchi, whose shape indicates their origin (Fig. 2287). Or it may be found in the form of pseudo-membranes, as in croup. In it are enclosed great numbers of leucocytes. Mixing the sputum with water will cause a number of these casts to float, and be visible to the naked eye. The majority will require a lens for their detection. These casts consist of masses of coagulated fibrin composed of very delicate filaments arranged parallel to one another; acetic acid causes their entire disappearance. These casts are the result only of croupous pneumonia or of a fibrinous bronchitis. They are not found in the early stage of pneumonia, but only between the third and seventh days, *i.e.*, during the stage of hepatization. The exudation of croup is much more brittle than that of fibrinous bronchitis or pneumonia. On teasing it with a needle it breaks up easily, but is seen to consist of a net-work of delicate threads.

Elastic fibres may be demonstrated by selecting from the suspected sputum a small, opaque portion of a gray or grayish-white color, placing it on a slide, and adding to it a drop of strong acetic acid. There are two other methods that may be used; both consist in the use of a solution of caustic potash—five to ten per cent. In the one case a drop of the alkali is placed on the slide, a very small portion of the sputum mixed with it, and the cover-glass applied. The other is for use where the fibres are supposed to be very few. A few cubic centimetres of the solution of the alkali are mixed with an equal quantity of sputum, and boiled for a few minutes in a porcelain capsule. This is mixed with about four times as much water, and allowed to stand for twenty-four hours in a conical glass, when, if elastic fibres are present, they can readily be removed with a pipette for examination. According to the first method, the acid acts on the other elements of the sputum, rendering them quite transparent or completely dissolving them, while it has no effect whatever on the elastic fibres. In searching for these fibres one must be careful not to mistake for them fibres of cotton, or needles of fatty acids, both of which resist the action of acetic acid; the latter can be recognized by heating the slide, when they are changed to fatty granules. These fibres may be readily recognized by their wavy appearance or tendency to curl up at the ends, by being colorless, by their bright aspect and well-defined outline (Fig. 2288). Sometimes they are found quite straight, while at other times they are twisted and frequently interlace so as to form a network. Occasionally they are observed to be bifurcated.

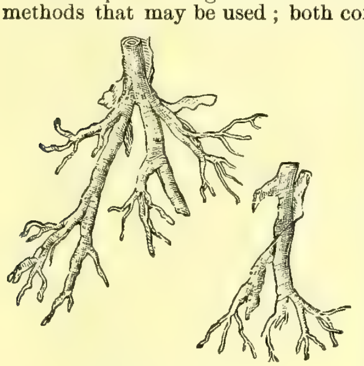


FIG. 2287.—Bronchial Casts.

In estimating the significance of the presence of these fibres in the sputum, we must remember that in the normal lung they form a most important part of the walls of the air-cells and infundibula, as well as entering into the formation of the trachea, bronchi, and bronchioles. Consequently, it is only by some destructive process that these fibres can be separated from their normal position. Such processes we have in ulcerative tuberculosis and in abscess of the lung. Under no circumstances does the presence of these fibres indicate the locality from which they come. They would be present in an ulcerative condition of the bronchioles as well as in one of the walls of the alveoli. In pulmonary gangrene, which may involve large portions of lung-tissue, elastic fibres are rarely seen. Their absence here is supposed to be due to the presence of some ferment generated in this affection, which has the effect of dissolving them.

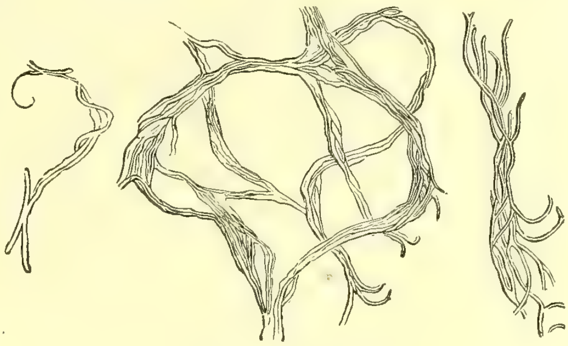


FIG. 2288.—Elastic Fibres.

Crystals of the fatty acids are sometimes present, especially in the sputum of putrid bronchitis, abscess of the lung, and gangrene. They are slender, straight, and colorless needles, which melt into drops on being heated on the slide. Their presence here points to destructive processes, causing death of the parts from which they arise; hence they are frequently found in the sputum in the case of gangrenous cavities or bronchitis, associated with the expectoration of putrid purulent material, which may have remained a long time in the lung. They might be mistaken for fragments of elastic tissue, but this is readily corrected by treating with chloroform or ether, which at

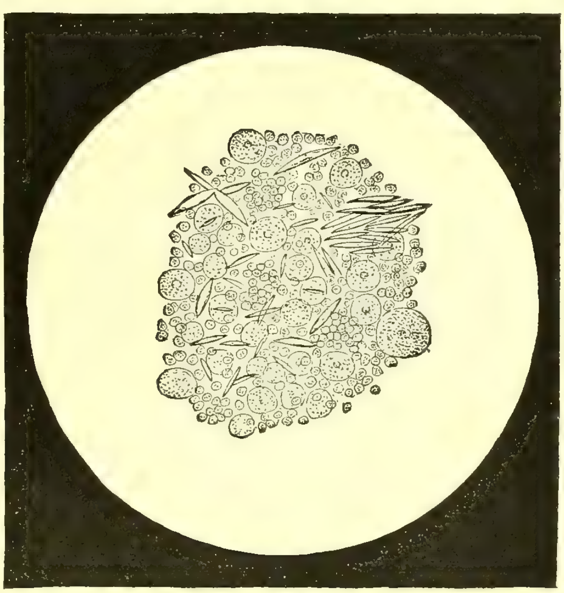


FIG. 2289.—Sputum in Case of Bronchial Asthma, showing Leyden-Charcot's crystals, also round epithelial cells and leucocytes. (Peyer.)

once dissolves the crystals, while it would have no effect on the elastic fibres; heat, as mentioned above, changes the needles into small fat-granules. Other crystals described are those known as "asthma crystals," or Leyden-Charcot's crystals. They are considered identical with some crystals found in the blood in leukæmia, in the marrow of bones, and in semen. Permanent preparations may be made by spreading a thin layer of the sputum on a cover-glass, and, without allowing it to dry, floating it on a five per cent. solution of bichloride of mercury until it hardens, and then floating it on a weak alcoholic solution of fuchsin (in both cases the sputum surface directed downward on the fluid), clearing it up in xylol, and mounting in Canada balsam. Prepared in this way, the crystals are colored a deep red. They are colorless, pointed, octahedral crystals, shaped somewhat like a whetstone (Fig. 2289), soluble in caustic potash, glycerine, boiling water, and in acetic and some other acids, but insoluble in either alcohol or ether. These crystals were supposed by some authors to be pathognomonic of asthma; but as they are found in other bronchial affections, that view has been abandoned. As these crystals are always accompanied by a great number of epithelial cells from the bronchi, their occurrence is supposed to depend, to a very great extent, on the presence of a desquamative bronchial catarrh. Lewey [18] describes another kind of crystal found in the sputum of asthmatic and other patients. They occur as spindle-shaped needles, and triangular and rhombic plates. In the first-named form they might be mistaken for Leyden's crystals. They differ in the fact that, unlike those crystals, they are soluble in glycerine and caustic potash.

Curschmann [19] describes some spiral filaments that are met with frequently in company with Leyden's crystals, generally in asthma during the paroxysm. The sputum in which they are found is very tough and quite transparent. Some of these spiral threads are large enough to be recognized by the naked eye. The smallest are bright, delicate, twisted filaments, occurring singly or with other larger spirals. They are soluble in potash and baryta water; they resist the action of mineral acids. These spirals are mostly covered with epithelium from the alveoli, hence are supposed to have their origin in a desquamative condition of these cells, associated with more or less exudation. Their spiral form is supposed to be due to the fact that the exudation is forced out of the alveolus through its narrow orifice, and that its progress is hindered by the tough secretion covering the bronchi resisting its upward movement, while at the same time it is continually forced onward by the cilia and the act of coughing. According to this theory, they should be regarded as an exudation occurring in a desquamative broncho-pneumonia.

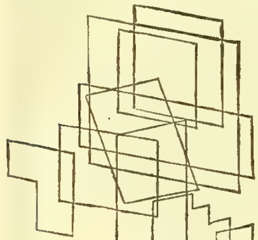


FIG. 2290.—Crystals of Cholesterine.

Crystals of cholesterine are occasionally found in sputum. They may be recognized by the characteristic crystals occurring in the form of plates (Fig. 2290). The angles of the plates may be colored a beautiful blue by the addition of a drop of strong sulphuric acid. This should be added very carefully to the edge of the cover-glass, when it will flow under it.

Crystals of tyrosin and leucin are also occasionally found in the sputum (see Figs. 2327 and 2328).

Hydatids may be present in the sputum, having their origin either in the lung or pleura, and thence rupturing into the bronchial tubes; or it is quite possible for them to have their origin in an hepatic cyst, which has burst into the lungs. They would be recognized by the laminated wall of the cysts, or by the fragments of the hooklets of the echinococci.

Sarcinæ are occasionally met with in the sputum. They are smaller than those of the stomach. They also act differently with the coloring matters.

Since Koch's discovery of the tubercle-bacillus several investigators have been at work on the sputum of pneumonia. Various micro-organisms have been described as being present in the sputum, and, to a certain extent, pathognomonic of the disease. That described by Friedländer is the one that has attracted most attention. He described a coccus possessing an external capsule not so easily colored as the central nucleus, found both in the sputum and the exudation. It is an oval body, sometimes found singly, but usually in groups of two, as a diplococcus (Fig. 2291). Chains of diplococci are often present, but no zooglœa. To demonstrate the capsules Ribbert advises proceeding as follows: The preparation is placed in contact with a liquid composed of water, 100 parts; alcohol, 50 parts; and vinegar, 12½ parts, saturated with dahlia; and is then washed immediately with water. In this way a violet color is obtained which can be preserved in glycerine or in Canada balsam. The cocci are colored dark blue and their envelopes a light blue. In order to effect this the preparation should be submitted to the action of the coloring matter only for a short time. Friedländer's [20] procedure for demonstration of the capsules is as follows: Color in acid gentian solution (concentrated solution of gentian violet in alcohol, 50.0; aq. destil., 100.0; acid. acet., 10.0) for twenty-four hours; then decolorize for one or two minutes in 0.1 per cent. acetic acid; then dehydrate in alcohol, clarify in oil of cloves, and mount in Canada balsam.

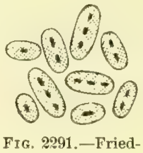


FIG. 2291.—Friedländer's Pneumococcus.

As the whole ground-substance is frequently so deeply colored by this procedure as to render the capsule perceptible only with difficulty, Friedländer modifies the above procedure [21] as follows: The dry preparation is passed three times through the flame of the spirit-lamp, and then for a minute or two placed in one per cent. dilution of acetic acid; this is then removed by blowing over it through a pointed glass tube, and the preparation is quickly dried in the air. The preparation is now stained in a saturated solution of gentian violet in aniline water for a few seconds, washed with water, and examined. In this way the ground-substance is made almost colorless, and the micrococcus with its colored capsule becomes so much the more prominent. Friedländer has modified his views concerning the significance of these organisms to some slight extent. He says that similar organisms are found in other sputa, and they are not always present in pneumonia. Fraenkel,[22] and many others quoted by him, have seen diplococci exactly similar to these in the exudation on the pia mater in cerebro-spinal meningitis. Jaccoud [23] has found exactly the same micro-organisms in vegetations on the mitral valves in infectious endocarditis. Like those in pneumonia, they are found in couples and encapsuled. Germain-Sée denies the existence of these "capsule" cocci, considering the capsule as an artificial product.

Quite recently (November, 1886) a new micrococcus has been described by Manfredi [24] as being present in the sputum of the croupous pneumonia of measles, along with the pneumococci of Friedländer. He describes it as being oblong with rounded or pointed ends, found either singly or united as diplococci. Its size varies from 0.4 μ to 0.6 μ in the isolated form, and in the form of diplococci it varies between 0.6 and 0.8 μ. It stains equally well with solutions of gentian violet, methylene violet, methylene watery blue, and fuchsin, but not so well with the other aniline dyes. Animals inoculated with this micro-organism die with enormous swelling of the parenchymatous organs, especially the spleen and lymph-glands, with a deposit of gray or grayish-yellow nodules in them. The lungs show besides these nodules, the characteristic signs of a more or less intense pneumonia. The nodules belong to the type of *granuloma*, or infectious granulation tumors. They are accumulations of new-formed cells containing the specific micrococci, and are infectious.

Weichselbaum [25] describes several other pathogenic organisms as being present in pneumonia. He describes a streptococcus similar to that of suppuration as being ob-

Microscopy.

served by him in nineteen cases; also a staphylococcus in some other cases.

The discovery by Koch of the *tubercle-bacillus* is one of the most recent important advances in medicine. It has been found in tuberculosis affecting other warm-blooded animals as well as man. The primary anatomical alterations are the same in all these animals, but the results and general appearance of the disease are different. Until within the last few years, the detection of elastic fibres in the sputum was considered one of the best evidences of an active tuberculous condition of the lung. Now their importance, in comparison with that of the tubercle bacilli, is very much diminished. The presence of the tubercle-bacilli in sputum is a certain sign that tubercular disease exists, and that it is in a state of activity. Several methods have been suggested for their recognition. All depend upon the strong affinity these bacilli have for basic aniline dyes. When once so stained the strongest acids will not remove them. The method now generally adopted is a modification of Koch's procedure, as recommended and adopted by Ehrlich, and subsequently by Koch himself. A cover-glass preparation is made in the usual way and then submitted to the staining process. The dye consists of a saturated alcoholic solution of methylene violet or fuchsin, eleven parts; absolute alcohol, ten parts; aniline water, one hundred parts. The cover-glasses containing the films of sputum are left in this for at least twelve hours. They are then passed rapidly through dilute nitric acid (one part of acid to three of water), and subsequently rinsed a few times in sixty per cent. alcohol. By this procedure the tubercle-bacilli alone are stained. They may now be submitted to the contrast stain, which may be a weak solution of either vesuvin or methylene blue—the latter, if fuchsin has been used to stain the bacilli. The specimens are again to be rinsed in sixty per cent. alcohol, and then treated with absolute alcohol, clarified with either turpentine or cedar-oil, and mounted in Canada balsam. Certain precautions are necessary in pursuing the procedures just mentioned; the nitric acid used for decolorizing must be free from nitrous acid fumes; and the balsam used should be dissolved either in turpentine or xylol. The first part of the staining process may be hastened by heating the staining solution until steam arises; twenty to thirty minutes will be sufficient for this treatment.

Rindfleisch has suggested a method which gives very good results and takes less time. Ten drops of a saturated alcoholic solution of fuchsin are added to two drachms of aniline water, and the cover-glass preparation is floated on this in a watch-glass, and heat applied until steam arises. It is then set aside for five minutes, the cover-glass removed, washed in distilled water, and transferred for about fifteen seconds to another watch-glass half-full of alcohol, to which two drops of nitric acid have been added. It is again washed in distilled water, allowed to dry, and mounted in balsam. A contrast stain can be used as in the preceding method.

In examining sputum for tubercle-bacilli by either of these methods, it is advisable to make at least three or four cover-glass preparations before giving a negative decision as to the presence of these micro-organisms. When it is desirable to obtain good cover-glass preparations, and but few bacilli are found by the methods just described, Biedert[26] recommends the following procedure: A teaspoonful of the sputum and two of water are boiled with fifteen drops of liquor sodæ, until the mixture becomes fluid; four more teaspoonfuls of water are added to this, and again boiled. If, after cooling, the mixture does not form a thin fluid, three to six more teaspoonfuls of water are added. It is then placed in a conical test-glass and allowed to remain undisturbed for two or three days. The fluid is now poured off, leaving a layer of 5 to 8 mm. thick at the bottom of the glass. From this the cover-glass preparation can be made.

In examining sections of tuberculous nodules for the bacilli, they will be found scattered throughout the mass, both between and within the cells. In the giant-cells, the bacilli are found in greatest numbers in the homogeneous mass just within the nuclei. It very often happens that the nuclei are all clustered at one side of the cell, in which case the bacilli will be found at the opposite side of the same giant-cell. When the bacilli become more numerous they will be found between the nuclei as well as in the centre of the cell.

The bacilli are motionless. They occur in the form of slender rods, slightly bent. They are met with either singly or in bundles; sometimes in couples. Their length varies from 1.5 μ to 3.5 μ; their breadth is about 0.5 μ. They frequently have a beaded appearance, owing to the formation of spores which are found inside them (Fig. 2292). In cultivation they grow slowly in comparison with most other cultures. The best culture medium is blood serum. Cultures on this are seen with the naked eye, only after from ten to fifteen days. The most favorable temperature for their growth is 37°–38° C. In inoculation experiments two to eight weeks are required before the results are observable. The bacillus possesses a considerable power of resistance to external influences, and in consequence retains its capability of inoculating for quite a long time. It will tolerate a temperature close on to the boiling-point, and will retain its infecting qualities in the desiccated state for at least six months; in decomposing sputum it will be effective for fully six weeks. These facts may possibly account, to a very great extent, for the large proportion (about one-seventh) of the human race who die of tuberculosis, in whom this bacillus is active and virulent, and the most of whom for months previously have been expectorating sputum containing these micro-organisms. Of nine hundred and eighty-two specimens of sputum of tubercular patients examined by Gaffky, the bacilli were found in all but forty-four.

FIG. 2292.—Tubercle-Bacilli, showing spore-formation. × 1200 diameters. (After Flügge.)

Filaments of *aspergillus* (pneumonomycosis aspergillina) are sometimes found in sputum. They are best recognized by treating the sputum with ten per cent. caustic potash.

VOMITED MATTERS.—Although the stomach is lined by cylindrical epithelium, this form of cell is rarely present in the vomit. All the other elements mentioned as being found in the contents of the mouth are likely to be present; so also may blood and bile. The latter will be recognized by its chemical reactions.

On submitting the vomited matters to a microscopical examination the following will be found to be present: (*a*) Particles of food, (*b*) epithelial elements, (*c*) red blood-globules, (*d*) leucocytes, (*e*) parasites, (*f*) disease products.

FIG. 2293.—Vomited Matter, showing muscular fibre, epithelial cells, fat, sarcinæ, torulæ, etc.

With reference to particles of food, those most commonly present are fragments of partly digested meat and starch granules. The former will vary in appearance according to the length of time they may have been in the stomach. If digestion has been going on only a short time the transverse striæ will be visible, the fibres generally being short, and occasionally their nuclei will become apparent. If vomiting has occurred a long time after ingestion of food, the striation is not so well marked. Starch granules (*g*) from bread or other vegetable food are almost certain to be present. They may be recognized by their irregularly rounded or oval shape, with their concentric striæ and hilus a little to one side of the centre. Any doubt as to their nature may be at once removed by treatment with a solution of iodine, which causes a blue coloration. Fat may be present either in the form of drops, large and small, or as crystals arranged as rosettes, or otherwise. As drops they may be recognized by their dark outline and very bright centre (see Fig. 2262). The crystals will be known by

their solubility in alcohol and ether, and by their melting into drops or fat granules on the application of heat.

The epithelial elements are very various, and will consist chiefly of those already mentioned as occurring in the contents of the mouth, besides possibly a few cylindrical cells from the gastric mucous membrane.

Leucocytes will also be present. Some of these are certain to have their origin in the mouth, either from the saliva or from the mucous glands proper of the mouth, or they may arise as the result of inflammatory trouble in the stomach itself. If from the latter locality the gastric juice is likely to have acted on their protoplasm and rendered their nuclei more distinct.

Red blood-globules may be found in the vomited matters. Their absence, however, does not absolutely negative the possibility of blood-corpuscles having been in the stomach, or even of their coloring matter being in the vomit. It may so happen that blood has escaped into the stomach in small quantity and remained there for some time. Under such circumstances the solvent action of the gastric juice will have caused disintegration of the corpuscles; the blood will then be represented in the vomit by brown granules. The presence of these granules is owing to the conversion of the hæmoglobin of the red corpuscle into hæmatin. These brown granules give the vomited matter its peculiar "coffee-ground" appearance, observed in some diseases. The use of the spectroscope will at once determine the presence of blood if prepared as for reduced hæmatin. This can be done by treating an equal quantity of the vomited matter and solution of caustic potash (ten to twenty per cent.) by a reducing agent such as sulphide of ammonium. The solution should be filtered before being placed in the spectroscope cell. When the brown coffee-ground sediment is present, and no red globules can be recognized, it should be treated for the preparation of hæmin crystals. These can be prepared by placing a drop of the sediment on the glass slide, drying it, placing the cover-glass over it, and then adding a drop of glacial acetic acid, and heating gently over a lamp. As soon as bubbles commence to appear it should be removed from the heat, allowed to cool, and then examined. The crystals are developed by this procedure in large numbers, and can be easily demonstrated by adding a drop of glycerine.

Sarcinæ are of frequent occurrence in vomited matters. They have the appearance of small packets grouped

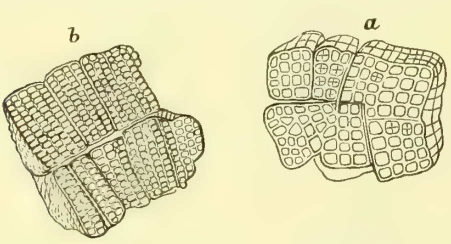


FIG. 2294.—Sarcinæ Ventriculi, treated by iodine, alcohol, and glycerine. From a patient with dilated stomach. *a*, The large-cell, bright variety; *b*, the small-cell, dark form. × 600 diameters.

in fours or multiples of fours. They are cubical in shape, with their corners rounded. The flat surfaces of the cubes are arranged in parallel layers, and they are firmly connected by a tough gelatinous membrane. Their size varies. The largest measure about four micromillimetres. Often apparently two varieties, or at least two sizes, are found in the stomach, the one large and the other small; the first much clearer and brighter than the other (see Fig. 2294). Their contents are sometimes greenish, sometimes yellowish, or of a reddish brown color.

They are found in the stomach under normal conditions, but not so frequently as in disease, being most commonly present in dilatation of this organ; they are also present in catarrhal conditions of the stomach. Sarcinæ are found in other parts of the body, as in the lungs, bladder, and even in the blood.

Torulæ cerevisiæ are also met with in the vomit. They may be readily recognized by their oval shape, by their bright appearance, and the appearance of a vacuole, and by many of them having buds of various sizes arising from them; indeed, it is by this process that they grow (see Fig. 2293, *f*). The vacuole is easily demonstrated by staining with some of the aniline dyes; fuchsin is possibly the best. They do not, however, stain alike. The older ones may resist the stain for a much longer time than the young cells.

In vomiting, associated with functional dyspepsia, these torulæ, as well as sarcinæ, may be found in great abundance in the vomited matters. Their presence is of no pathological importance. They have never been found in the substance of any living tissue. They can only be introduced from without, and as there is almost certain to be some saccharine matter in the stomach, they may set up fermentation there. The gastric juice seems to have no effect in arresting this process.

Various intestinal parasites, such as ascarides, etc., may have crept up into the stomach and then have been vomited.

The FÆCES very frequently furnish important data on microscopic examination. To be able to recognize the different elements present means the possession of a knowledge of the microscopic appearances of nearly all the tissues of the body, as well as of those vegetable substances which furnish the common constituents of our food. Many of these have been already referred to in treating of vomited matters.

Method of Examination.—In the first place, it is advisable to add to the material to be examined a few drops of carbolic acid, or of an alcoholic solution of thymol. If fluid, the excreta should be allowed to stand in a conical test-glass for fifteen or twenty minutes, thus permitting the more solid particles to be deposited. Several preparations, taken from different layers of the fluid by means of a pipette, should be made from this. If solid, the fæces should be examined in a .75 per cent. solution of common salt, or in glycerine to which thymol has been added.

The elements found in normal fæces are very numerous. Those most frequently present are: Débris of food, both animal and vegetable; fat, epithelial cells, crystals, and parasites. The débris of animal food present is represented chiefly by striated muscular tissue, which occurs mostly in small fragments, the result of previous mastication. These fragments are very often colored yellow by the bile, and have their corners rounded off. Sometimes larger masses are found that have escaped mastication, in the centre of which fibres may be observed with striation well marked. Others may show their nuclei only. Pieces of tendon, cartilage, or bone may also be present.

Fat, found in the form of drops of various sizes, is always present. It may also exist as needle-shaped crystals. In the latter form it may be scattered over the field of the microscope as single, isolated, needle-shaped rods, or as clusters forming rosettes. In children or persons using milk extensively as an article of food, the fat may be found compressed into cheesy-looking masses. Vegetable débris may exist as spiral fibres, or as a network of cells and cell-spaces; or, where fruit has been taken, it may have the form of concretions. Epithelial cells are constantly present, and may be of either the cylindrical or pavement variety; in the one case having their origin in the intestinal mucuous membrane, and in the other in the anus. Like the muscular débris, these are frequently colored yellow by the bile. Crystals are always found in the fæces. Those most frequently present are the triple phosphates. The only parasites present in the normal condition of the body are of a vegetable nature, and, according to Bienstock,[27] belong to the group *bacillus*. Of these he describes five species. What some writers have described as micrococci, he says, are short, thick rods. These five varieties he has made out principally by culture experiments. The first is a large bacillus, about the size of the Bacillus subtilis of Cohen. The second is a bacillus which is of such rapid growth that in ten to twelve hours it covers the surface of the culture

tube. Both these forms are constantly present in the fæces. The third form he describes as taking a week or more to grow half a millimetre from the inoculation puncture, and is a remarkably small bacillus. The other two bacilli he considers of great importance in connection with digestion in the intestines. Both of these are constant elements of the fæces from the time the child abandons a purely milk diet; that is to say, from the commencement of a mixed diet. They both show great similarity in their development, but act differently. The one causes splitting up of the albumen, the other of the carbo-hydrates. The first is never present in the fæces of infants which have not yet taken anything but milk.

Besides the rod-shaped bacilli, Lewis [28] states that a spirillum exactly like that found in the mouth is present in normal fæces. Bienstock, without reference to him, says that this form is not met with, and regards its non-appearance there as evidence of its not having spores. He thinks that spores would have escaped the destructive action of the gastric juice, while the spirilla themselves would be destroyed.

Diplococci, similar to those described by Friedländer as met with in the lungs, are also mentioned by some observers [29] as being found in normal fæces.

Sarcinæ similar to those met with in the stomach are also occasionally present.

The *pathological elements* present in fæces may, in many cases, be recognized by the naked eye, while in other cases the microscope will be required for their recognition. Some of them are simply those existing under normal conditions, which have undergone changes as the result of disease. Epithelial cells may thus be so swollen and out of shape as to be recognized with difficulty; or they may have undergone some change such as fatty or hyaline degeneration. Their number varies with the disease and with the stage of the disease in which they are examined; if early, the cells will be numerous, whereas if the disease has existed a long time, there are likely to be but few present, as these cells are reproduced but slowly. This is the case in dysentery and cholera; in simple intestinal catarrh the epithelial cells may not be quite so numerous at first as in the more acute disease, but they are likely to be present throughout this pathological state.

Leucocytes are constantly present in catarrhal affections, and in ulcerative conditions of the intestines. In the latter case, they are more numerous than in the former.

Blood escaping from any part of the intestinal tract may be found in the fæces. The blood-corpuscle may be present unchanged in appearance, or its hæmoglobin may escape from the corpuscle, undergoing changes which give to the stools a brown color. This is generally the case when the blood comes from the stomach. The retention of blood for any considerable time in any part of the intestine favors these changes in the corpuscles; they become so altered that they can no longer be recognized by their shape. By means of spectroscopic examination the presence or absence of blood could be determined, but, of course, its source could not be so discovered, as it may have been introduced with the food. Preparations made with glacial acetic acid, as already described, may show, by the formation of hæmic crystals, that the color is due to blood. If the source of the blood should be near the anus, the corpuscles are then likely to have undergone but little, if any, change, and the blood may at once be recognized by its color as well as by the presence of the red corpuscles.

Mucus is almost certain to be present to a greater or less extent in most diseased conditions of the bowels, and consequently in the fæces. It may be in either a liquid or a coagulated state. In the former condition it is likely to be intimately mixed up with the other contents of the bowel, or it may be found as a covering of scybalous masses. The coagulated state is a rare one; in this condition it occasionally forms round or tubular masses, which may be mistaken for worms, but may easily be recognized by their homogeneous appearance, as seen under the microscope.

Crystals of ammoniaco-magnesian phosphate are found in great numbers in diarrhœa, and also in typhoid fever. Leyden-Charcot's crystals are also numerous in various affections, such as phthisis, enteritis, dysentery, etc. Starch may be present, either as cells or in granular masses. Treatment with iodine will identify it. Starch is not found in the fæces under normal conditions.

Rarer pathological products found in the fæces are portions of gangrenous intestine, tumors, or contents of cysts which may have opened into the intestine.

Animal parasites are of frequent occurrence in the intestine. Very often the microscope is the only means of determining their presence. This is especially the case when the symptoms suggest the probability of their presence and when they are not found in the fæces; but microscopical examination may reveal the presence of ova. These vary in appearance. The ovum of the Ascaris lumbricoides or round-worm, when mature, is oval in shape, about 90 μ in length, and about 50 μ in diameter (Fig. 2295). It is composed of two membranes enclosing granular contents. A small germinal vesicle is sometimes observed within this granular substance. An albuminous material of a greenish-brown color surrounds the ovum. This albuminous covering is irregular in shape, having at either end wedge-shaped projections. These ova are very tenacious of life. Neither drying nor freezing destroys them. The ovum of the Oxyuris vermicularis or pin-worm is irregularly oval, one side flat and the other rounded. (Fig. 2296.) It is about 55 μ in length and 25 to 30 μ in width. It also has two, sometimes three, membranes, all of which are very thin. Its contents are granular. Sometimes an embryo may be present in the ovum. Drying has no injurious effect on this ovum. The ovum of the Trichocephalus dispar, or whip worm, is easily distinguished from those of other worms. (Fig. 2297.) It is lemon-shaped and measures from 50 to 60 μ in length and 25 μ in transverse diameter. It is yellowish-brown in color. At each end of its capsule is an opening through which its internal membrane projects in the form of a papilla of a bright color.

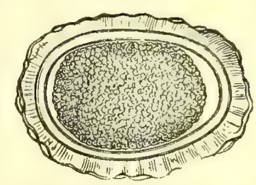


FIG. 2295.—Ovum of the Ascaris Lumbricoides.

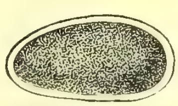


FIG. 2296.—Ovum of the Oxyuris Vermicularis.

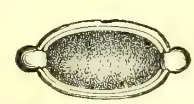


FIG. 2297.—Ovum of the Trichocephalus Dispar.

The anguillula intestinalis is a rare form of parasite in this part of the world. It is occasionally found in the stools of persons suffering from diarrhœa in Cochin China. This parasite is about 2.2 mm. long, with a rounded head and posterior portion finely pointed. What is supposed to be the same parasite, modified in appearance, is described by some under the name of anguillula intestinalis, but the probability is that these are two forms of the same worm in different stages of development. These parasites are frequently mistaken for the one next to be described, but may readily be recognized by the difference in size.

The ankylostomum duodenale is found both in the duodenum and jejunum. It varies from 10 to 18 mm. in length. When this parasite is present its ova are found in great numbers in the stools. In this respect it differs from the species of anguillula just mentioned, as the ova of the latter are rarely seen in the stools. The larvæ, however, are often present, but not so in the case of the ankylostomum. The ova are oval-shaped; average about 60 μ long and 40 μ wide. They have a thick membrane with double contour, in the interior of which is found the vitellus. This may be simple, but more frequently it is in a state of segmentation consisting of two, four, or eight dark granular segments with a nucleus. (Fig. 2298.) They develop rap-

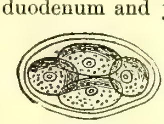


FIG. 2298.—Ovum of the Ankylostomum Duodenale.

idly after being discharged with the stools. These ova are formed by larvæ which multiply in the duodenum, and are now considered by many authorities to be a frequent cause of pernicious anæmia. A high degree of anæmia always exists with the presence of the parasite, an increase in the white corpuscles being associated with the decrease of the red. It may remain a long time in the intestine. Cases are reported in which it has been known to be present as long as two years, during which time but few ova were found in the stools. It generally makes in the intestine a long wound, the surface of which is covered with bloody mucus.

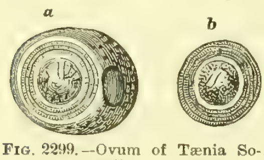


Fig. 2299.—Ovum of Tænia Solium.

The ovum of the tænia solium is spherical or oval-shaped. Its capsule is opaque and marked with radiating striæ (Fig. 2299, *b*). A second covering, composed of albuminous matter with a number of granules, is frequently found outside this, as seen in Fig. 2299, *a*. A very thin membrane—the primitive vitelline membrane—encloses it. Its contents are a six-hooked embryo in a granular state. The hooks are easily recognized under the microscope. These ova are about 35 μ long, and differ but little from those of the tænia medio-canellata. The mature segments of the tænia solium are longer than they are wide. They are about 10 mm. long and 6 to 7 mm. wide. Their corners are rounded off. The uterus is divided into from seven to ten thick lateral branches and is filled with eggs. The genital organs open into a papilla on the side (Fig. 2300, B), a little behind the middle.

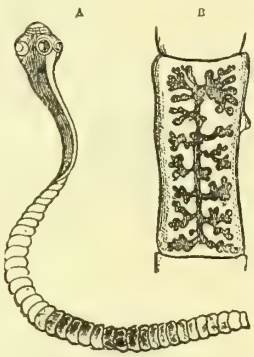


Fig. 2300.—Tænia Solium. A, head and body of the worm; B, a single segment magnified.

The head is about the size of a small pin-head, and for an inch or so is followed by a threadlike neck (Fig. 2300, A). It is globular in shape, and its upper portion is surrounded by a circlet of about twenty-six hooklets. Below these will be found four suckers.

The ovum of the T. saginata (T. medio-canellata) is brown and striated like the former variety, but is more decidedly oval and very slightly larger. The ripe segments are longer than they are wide, and on compressing them between two pieces of thin glass a papilla, furnished with an opening, can be seen at one side, a little below the middle. This communicates with the uterus, which is composed of from seventeen to twenty lateral divisions (Fig. 2301, C). The head has four large sucking disks, but no hooklets (Fig. 2301, B).

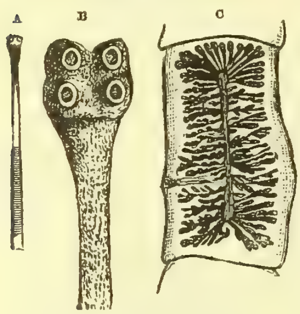


Fig. 2301.—Head and Magnified Segment of Tænia Saginata.

The ovum of the bothriocephalus latus is of a light brown color, oval-shaped, and provided with a lid at one end which permits of the escape of the embryo (Fig. 2302).

The ova are about 80 μ long and about 45 to 55 μ in width. The embryo is round or oval-shaped, and like that of the tæniæ it has three pairs of spicules. It is, in addition, surrounded by a capsule furnished with cilia, by means of which it swims about in water. The segments of the B. latus (Fig. 2303) are wider than they are long. The largest is about 3.5 mm. long and 10 to 12 mm. broad. The uterus is brownish, and rosette-shaped. The opening of the genital organs is on the flat surface and is indicated by a central thickening. The head is club-shaped, and about 2.5 mm. long and 1 mm. broad. Several cases of pernicious anæmia have been recently reported in which this parasite was found and was considered to be the cause of the anæmia.

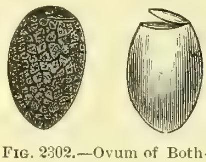


Fig. 2302.—Ovum of Bothriocephalus Latus.

The ova of the distoma lanceolatum, or of the D. hepaticum, which are sometimes present in man, may be found in the stools. They may be recognized by the presence of a cover on one end, by their oval shape, and also by their color, which may be either yellow or brownish yellow. The ovum of the D. hepaticum is about 140 μ long and about 80 μ wide (Fig. 2304). That of the D. lanceolatum is only about one-fourth that size.


Fig. 2303.—A Segment of the Bothriocephalus Latus.

Infusoria are sometimes found in the stools, especially in cases of chronic diarrhœa. They are supposed to have entered by the mouth, and to have met with conditions in the intestines favorable to their development. A large amount of mucus is generally found associated with them. The varieties most commonly present are the paramœcium coli and cercomonas intestinalis. The former may be recognized by the cilia around the mouth, and the presence of a nucleus and one or two contractile vesicles. They are oval in shape, measuring about 100 μ in length. The cercomonas intestinalis is pyriform in shape, and has anteriorly a single, long cilium, not always easily recognized, which it uses for locomotion. It is only about one-tenth the size of the paramœcium. Both these infusoria, when present, seem, as far as their number is concerned, to bear a direct relation to the intensity of the intestinal catarrh, disappearing with the subsidence of the diseased condition of the bowel.

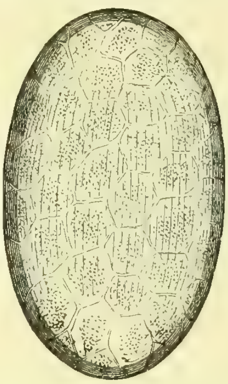


Fig. 2304.—Ovum of Distoma Hepaticum.

Amœbæ have been found in the large intestine of man in catarrhal conditions of the bowel. Those that have been observed vary in size from 0.02 mm. to 0.035 mm., and possess very active movements. Besides vacuoles, they contain highly refracting granular matter (Fig. 2305) as well as a nucleus and nucleolus. As accidental contents there may be present in them micrococci, vibrios, bacteria, disintegrating epithelium, red and white blood-corpuscles, besides various medicaments found in the intestine.


Fig. 2305.—Amœbæ Coli. (Eulenburg's Real-Encycl.)

Meconium differs from fæces in the entire absence of alimentary débris. It contains a large amount of mucus, with intestinal epithelial cells, fat, cholesterine, and a great number of granules, some of which are albuminous, the rest being derived from the coloring matter of the bile; the albuminous granules, are colored blue by the addition of nitric acid. In the infant that has lived twelve hours or so and nursed, the meconium will be more of a gray

color, due to the presence of some milk with the epithelium detached from the œsophagus and pharynx.

The URINE is a rich field for microscopical investigation. Before being examined, it should be allowed to stand for a few hours in a tall, conical test-glass. This permits the deposit of any morphological elements that may be present. A pipette with a fine aperture should be taken, and its

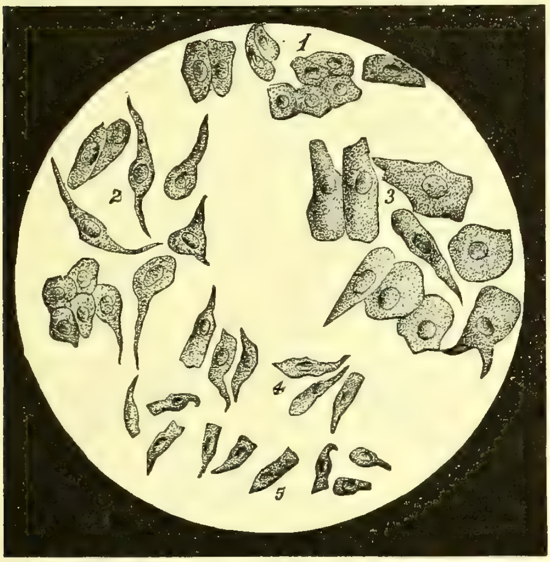


FIG. 2306.—Epithelium Present in Urine. 1, From the tubes of the kidney; 2, from pelvis of kidney and ureters; 3, from bladder; 4, from the prostate; 5, from Cowper's glands. (Hofmann.)

upper end closed with the finger and introduced to the bottom of the conical glass. On lifting the finger, the bottom layer of fluid with its contents will be forced into the pipette. It can now be transferred to a slide and covered with a cover-glass. Sometimes it is desirable to "fix" the elements, so as to preserve them unaltered for future comparison. This can easily be done with the cellular elements by the addition of a drop of a one per cent. solution of osmic acid to the specimen on the slide; or by placing the cover-glass or slide, on which the specimen is placed, over the mouth of the bottle containing the acid and thus exposing it to its vapor. They may be subsequently stained, if desired, either with picrocarmine or methylene violet. If it is not desired to make a permanent preparation, it can be temporarily sealed with the mixture of vaseline and paraffine referred to previously.

In normal urine there may be found epithelial elements from any part of the urinary tract, and, in the case of the female, some large, squamous cells from the vagina as well. Besides these, long striated masses of mucus may be present, and sometimes may be mistaken for casts.

The other morphological elements present in normal urine and found in the sediment, vary according to the length of time that has elapsed after the urine has been passed; thus, as soon as it cools, salts of various kinds may be deposited, and various organisms may make their appearance as the result of fermentation. Bacteria are present very soon after urine is exposed to the atmosphere. When alkaline fermentation occurs, the character of the deposit is quite different. It will be found to consist of the triple phosphates of ammonia and magnesia, or of urate of ammonia, with a few granules of phosphate of lime. Small globular elements of a vegetable nature are also present.

Micro-organisms may be present in the normal urine in the case of females. They are always present in the mucus of the vagina, and during micturition may be carried away with the urine.

The pathological elements that may be present in urine are very varied; they may consist of cells, precipitated chemical bodies, or parasites.

The epithelial elements vary in appearance, according to the part of the urinary system from which they come. Rounded and spheroidal cells with well-defined nucleus come either from the convoluted tubules of the kidney, from the loops of Henle, or from the deep layers of the mucous membrane of the pelvis of the kidney. The cells from the convoluted tubules are granular and have a distinctly fibrillated appearance. In the looped tubules of Henle the cells are clear and flattened, and have a small flattened nucleus. These cells are much smaller than those from the bladder, ureter, or vagina. Their shape is different from that of the deeper layer of bladder epithelium; from the urethral epithelium they may be distinguished by the cylindrical shape of the latter. Urethral epithelium (Fig. 2307) may sometimes resemble that from the kidney. If any doubt exists as to the origin of similarly shaped cells, the presence of albumen in the urine will be quite sufficient to show that they come from the kidney. Disease may materially alter the shape and appearance of these cells, so that when seen separately it may be difficult to determine their origin. When, on the other hand, although so changed, they are clustered together in the form of tubules or cylinders, their origin from the kidney is at once recognized. The cells may be so filled with fatty particles as to completely obscure the nucleus and alter the shape of the cell. Sometimes the flat cells from Henle's loop are spherical in shape, from being swollen by the urine, or their protoplasm may become opaque. These round cells may be easily distinguished from pus-cells by being much larger, and having only one well-marked nucleus. Some of them, however, may be altered in appearance by the division of their nucleus, giving the appearance of pus-cells which have been treated with acetic acid. The fact of two or more nuclei being visible without the acid is

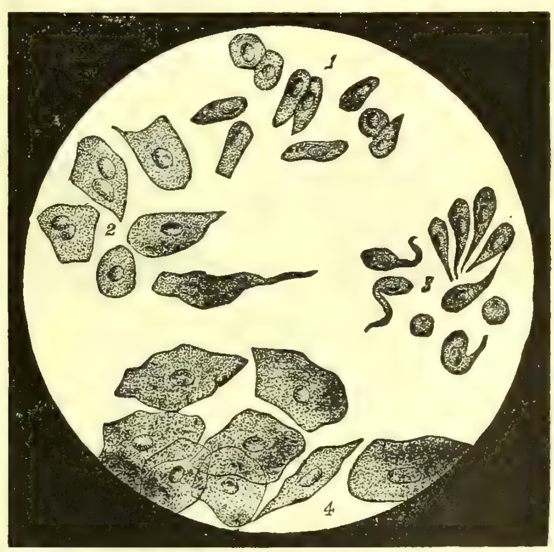


FIG. 2307.—Epithelium Present in Urine. 1, From male urethra; 2, from female urethra; 3, from Littré's glands; 4, from vagina. (Hofmann.)

quite sufficient to distinguish them from pus-cells; furthermore, the pus-cells are always granular in appearance.

Columnar epithelium may be found in the urine, in which case it will have had its origin either from the pelvis of the kidney, the ureter, or the urethra. The cells are conical in shape; many of them are more or less caudate in form and mostly irregularly shaped, some being somewhat triangular, others spindle-shaped. They are generally about twice as long as they are broad. The caudate cells have a prolongation at one end. These

cells may be from the pelvis of the kidney or from the ureter, in which case they must be from the deeper layers; the mucous lining of this portion of the tract consists of stratified epithelium, and the cells of the superficial layers are considerably flattened, while the deeper layers consist of the cells above described. The origin of these cells can be learned only from a study of the clinical symptoms. If these symptoms point to kidney trouble, then the cells most likely have their origin in the pelvis of the kidney or in the ureter. Sometimes these cells are imbedded in small cylindrical masses of mucus. In the absence of clinical symptoms pointing to the kidney, it may be presumed that their source is the prostatic portion of the urethra. Should gonorrhœa be present, pus-cells will be found present with them in great numbers, and the existence of the gonorrhœa would, of course, point to the urethra as the source.

Pavement epithelial cells may also be present as the result of disease. These may be either from the vagina, in the female (Fig. 2307, 4), or from the bladder. Those from the vagina more closely resemble the squamous cells of the mouth, are larger and thinner than the bladder epithelium, and have a warped appearance. Both varieties are considerably larger than the renal epithelium.

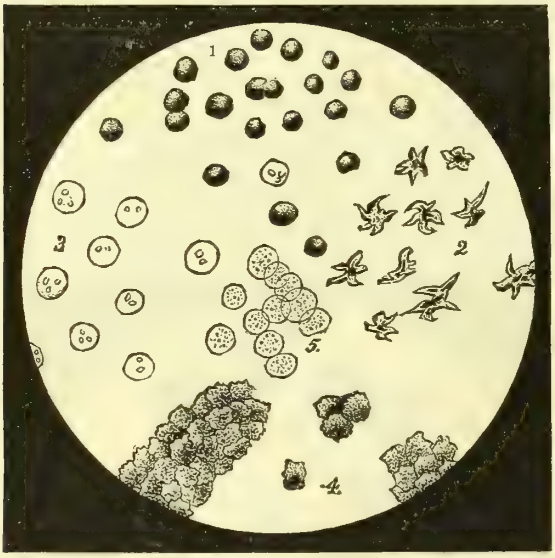


FIG. 2308.—Pus corpuscles in Urine. 1, Unaltered; 2, showing amœboid movements; 3, treated with acetic acid, showing nuclei; 4, result of pyelitis; 5, action of carbonate of ammonium. (Hofmann.)

The presence of these cells alone does not indicate any abnormal condition. It is only when they are numerous and are associated with a great number of leucocytes that they are to be considered as indicative of any abnormal state, and then they point to a catarrhal condition of some of the tracts named. If the urine is alkaline the probability is that the source of these cells is the bladder; if acid their origin is higher up the tract.

Leucocytes and mucous corpuscles are grayish-white globular bodies, a little larger than the white blood-cell. They are generally found imbedded in some stringy mucus. These cells are indistinguishable from pus-cells, except that the latter generally contain more than one nucleus, while the mucus-cell has but one. In certain conditions of the urine the cells may be rendered so opaque that it is impossible to make out the presence of a nucleus without the aid of acetic acid. Sometimes simply diluting the urine will render the nucleus visible. The nucleus may sometimes be obscured by the presence of a large number of granules. Occasionally amœboid movements may be observed in these cells, especially if the urine is neutral or feebly alkaline, as sometimes occurs in vesical catarrh (Fig. 2308). The leucocytes may be so few in number as to require the microscope to make them out, or they may be so numerous as to form a deep layer at the bottom of the vessel. They may proceed from the kidney; from some portion of the urinary tract; or from an abscess opening into it. If casts are present this fact will point strongly to the kidney as the origin of the leucocytes; but in the absence of data such as these, we can form an opinion only from the clinical history. The leucocytes themselves may form part of cylinders, either simply with hyaline material or mixed with red blood cells, the latter occurrence pointing to a more acute pathological condition of the kidney. It is well to remember that when purulent urine is also alkaline at the time of emission, or very shortly after, it will be quite possible, if the urine is not examined until some hours have passed, that very few leucocytes may be observed. The alkaline urine speedily undergoes fermentation, and in this condition acts rapidly on the purulent deposit, causing the corpuscles to swell up and ultimately to become disintegrated, changing the entire mass into one of a distinctly gelatinous appearance, which closely resembles mucus.

Red blood-globules, so long as they retain their normal shape, are readily recognized. The degree of concentration of the urine, and of its acidity or alkalinity, will considerably modify their appearance, and also the length of time during which they may be recognized under the microscope (Fig. 2309). They are rarely found adhering in the form of rouleaux. Their normal shape remains unchanged for a considerably longer time in acid urine. In urine of low specific gravity, they swell up and become spherical, and their hæmoglobin becomes dissolved in the urine, though for some time they may still be recognized by the absence of a nucleus and by their homogeneous, transparent appearance, as well as by their outline, which may be either quite regular or slightly notched or wavy. In alkaline urine the corpuscles rapidly lose their coloring matter. If the red corpuscles are agglutinated and formed into cylinders by fibrinous exudations around them, more especially if they have the form and shape of urinary tubules, it will be possible at once to fix upon these tubules as their source. Speaking generally, the blood comes from the kidney when the urine is of a brownish-red or smoky color, or when the blood is equally mixed in it and small in amount; in such cases the blood-corpuscles are deposited very slowly. Of course, in such exceptional cases as injuries to the organ involving the vessels, the blood may be profuse; so may it be at times in malignant disease of the kidney. The presence of the epithelial cells characteristic of the urinary passages, together with blood in the urine, points to these passages as being the source of the blood. If blood is passed only at the end of micturition, or if it is noticed that the last portion of the urine is more highly colored, and that the urine itself is of a clear red, then the blood must come from some part of the urinary passages. In such cases clots may be passed, some of which may have been a few hours in forming, and may thus have retained the mould of the parts from which they come. The clinical history will help in forming a certain diagnosis. When the presence of blood is due to congestive conditions, it will be more abundant in the earlier stages of the affection. The more severe the inflammatory affection, the larger the amount of blood-corpuscles present; this is especially the case in acute nephritis, when it is not at all an unusual thing for the urine to be highly colored by the blood. Growths in the bladder, both benign and malignant, may give rise to the presence of blood. Calculi, by mechanically irritating or tearing the bladder, may also cause slight hæmorrhages.

FIG. 2309.—Blood-corpuscles in the Urine.

Casts are a frequent result of diseased conditions of the kidney. Some are easily seen under the microscope; others, such as the hyaline, require careful illumination to bring them into view. Where the Abbé condensor is used, a diaphragm with small aperture should be inserted beneath it. With other methods of illumination, as small

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an aperture as it is possible to have with good light, should be used, as much better definition is obtained in this way. To obtain the casts for permanent mounting, they may be prepared as recommended by Cornil and Ranvier: one cubic centimetre of urine is mixed with an equal quantity of one per cent. osmic acid solution in a small test-tube, and allowed to stand for twenty-four hours; then a small quantity of distilled water is added, the mixture is agitated very gently, and is allowed to stand in a conical test-glass. The cylinders, which will now have assumed a brownish or black color, will fall to the bottom and may readily be separated with a pipette and transferred to a slide. A drop of glycerine may then be added and the preparation sealed.

Casts have been variously classified; the principal varieties are hyaline, epithelial, granular, and bloody; to these may be added fatty casts.

Hyaline casts are quite transparent, and consequently somewhat difficult of recognition. Treated by the osmic acid method, they are easily seen, or they may be treated with an aqueous solution of iodine in iodide of potassium, which colors them yellow. Prepared in this way they may be examined at once. A two per cent. solution of methylene violet is also a very useful stain. They are of

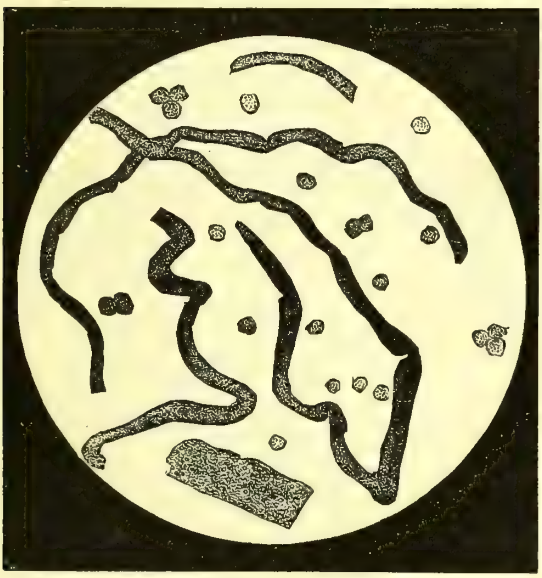

Fig. 2310.—Hyaline Casts. (Peyer.)

various lengths and widths; they vary between 10 μ and 50 μ in width; usually they are narrow, retaining pretty much the same width for their entire length. Some are quite straight, others are curved (Fig. 2310). Their ends may be either rounded or abruptly broken off. Not infrequently they gradually diminish slightly in width toward one end or toward both ends. The cylinders sometimes contain granular matter, which is occasionally spread equally throughout the cylinder, or may be collected at either end. Small fatty granules may also be found in those cylinders; so, also, may red blood-globules, leucocytes, and epithelial cells. These bodies are fixed in the hyaline substance as in a cement. This hyaline substance, it is now generally conceded, is simply an exudation of albumen, which, when escaping without other elements, constitutes the simple hyaline cast. All casts have more or less of this hyaline matter.

This exudation may saturate the epithelial cells, which are diseased and easily loosened. These it brings with it, and when the cells are present in great numbers, we find the epithelial casts, to which we will now refer (Fig. 2311). These last-mentioned casts consist simply of epithelial cells washed out of the urinary tubules by the urine and the exuded albumen. They are readily recognized by the character of the cells. They are cloudy and seldom show a well-defined border. They are always more or less considerably swollen by fluid, and are in a state of degeneration. When this degenerated epithelium preponderates in the cast, consisting as it

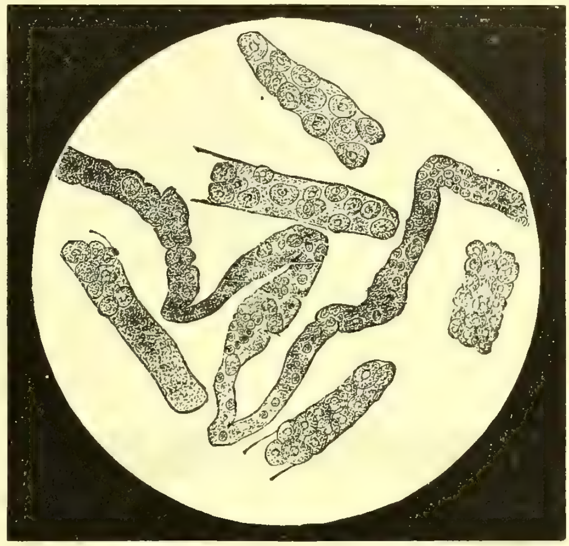

Fig. 2311.—Epithelial Casts. (Peyer.)

does then of granular matter, it forms the granular cast (Fig. 2312). The broken-down fragments of the degenerated epithelium, together with cells filled with small granules, constitute the granular matter of this cast. Fatty matter is frequently mixed with these cells. Under the microscope, the casts appear as a solid plug, sometimes shaped at one end like the neck of a bottle, at other times of the same calibre throughout, with their ends rounded off.

Blood-casts are always found to contain hyaline matter

Fig. 2312.—Granular Casts. (Peyer.)

as well, and are frequently mixed up with epithelial cells.

Waxy casts are found principally in amyloid degeneration of the kidneys. They may sometimes be found in chronic nephritis, and are then of grave import. The cylinders are very hard and refract light powerfully.

They have a peculiar glistening appearance and are quite homogeneous. They are very brittle, have a well-defined contour, and generally present a somewhat waxy appearance (Fig. 2313).

Uric acid cylinders are sometimes found in the case of infants at the breast. Infarcts of uric acid exist at the same time in the kidney. The cylinders are reddish brown, and have a coarsely granulated appearance.

Bacteria and micrococci sometimes form cylinders in suppurative nephritis.

The parasites found in the urine may be either animal or vegetable. The animal parasite most frequently present is the tænia echinococcus. Complete vesicles may be found in the urine, or only characteristic parts of the hydatid, as the hooklets, or possibly some portion of its cysts. When present there are almost certainly blood-cells and leucocytes as well. The presence of these is due to the rupture of the cyst of either the kidney or of some neighboring part into the pelvis of the kidney or ureter, and there exciting inflammation with its figurative results, viz., blood-cells, leucocytes, etc.

Ova of the distoma hæmatobium, some of which may be partially developed, may also be found in the urine. Hæmaturia is occasionally present with this condition.

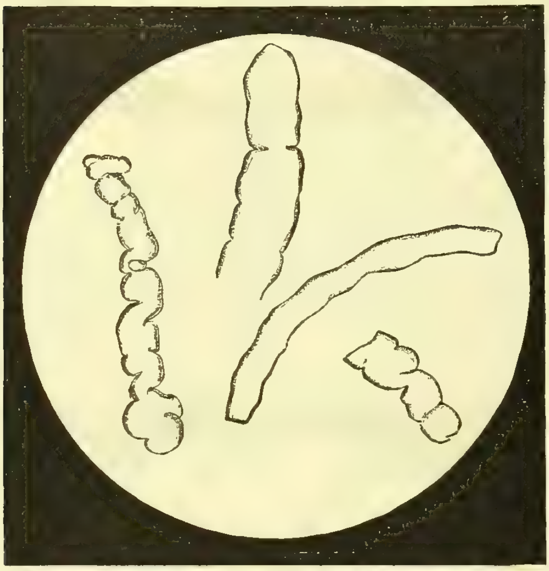

FIG. 2313.—Waxy Casts. (Peyer.)

The ova are oval-shaped bodies with a more or less pointed extremity, which represents a rudimentary anchor.

Embryos of filaria sanguinis hominis may be present in chylous urine. They are small serpentine bodies with very active movements. They are about as thick as a red corpuscle and about one-tenth of a millimetre in length (see Blood, Pathology of the).

Micro-organisms are found in freshly passed urine in various infective diseases, such as diphtheria, recurrent fever, etc., also in cystitis and pyelo-nephritis. Tubercle-bacilli are found in uro-genital tuberculosis, and gonococci in gonorrhœa.

Normal urine is free from bacteria when first passed, but, when exposed to the air for some time, is crowded with them. They are developed from those floating in the air and deposited in the urine. Certain diseased conditions which favor an alkaline fermentation of the urine within the bladder are found to be accompanied by the presence of bacteria. This may be due in some cases to the introduction of these micro-organisms within the bladder by means of the catheter. In some specimens of diseased urines, such as diabetic, yeast cells (torulæ cerevisiæ) may be observed. They may be recognized by their oval shape, with small buds frequently seen at either end and a vacuole in their interior. These cells vary in size, but average about that of a blood-corpuscle, for which they might possibly be mistaken. This may be avoided by observing that they contain no granules, and by their smooth and bright exterior. They may be observed in the left of the field in Fig. 2314, as well as in other parts of the same figure. Sarcinæ, such as previously described, are also frequently present, and are supposed to have been formed in the urine previous to micturition. They are very similar in shape to those found in vomited matter in diseases of the stomach, but are somewhat smaller. They are found both in acid and alkaline urine. More or less pain in the back is usually complained of at the same time that these organisms are found in the urine. Sediment of urine containing sarcinæ will most likely also have triple phosphates as well as calcium salts.

Tubercle-bacilli have been observed in some cases of tubercular diseases of the kidney or of the urinary passages. They have been observed as short rods within epithelia in the deposit at the bottom of the vessel.

Penicilium glaucum, or mould fungus, is often met with in the urine, forming a network or mycelium, as seen in Fig. 2314. It is frequently met with in albu-

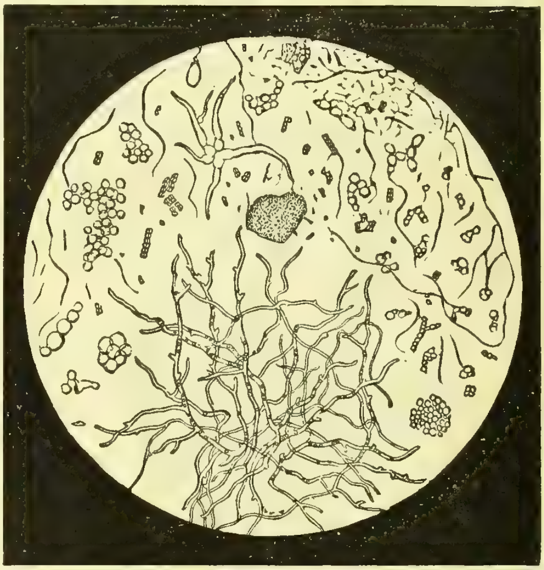

FIG. 2314.—Fungi in Urine. This figure shows penicilium glaucum, sarcinæ, torulæ, leptothrix filaments, etc. (Peyer.)

minous urine, or in urine containing a large amount of mucus, but dies as soon as the urine becomes alkaline. The sporules are of an elongated oval shape and vary greatly in size, and are frequently observed in a budding condition as seen in the upper part of Figure 2314, where they assume somewhat of a star-shaped appearance. From these long spores elongated cellular shoots give off branched tufts of sporules on the surface of the urine.

Oidium lactis is sometimes found in diabetic urine.

Filaments of leptothrix are of occasional occurrence in the urine. In Fig. 2314 they may be recognized as very fine threads seen in various parts of the field.

The gonococcus is a micrococcus discovered by Neisser, which, he says, is the cause of the infectious nature of gonorrhœa. Besides being present in the purulent discharge from the urethra, it is also found in the discharge of gonorrhœal ophthalmia. M. Gabriel Roux (of Lyons)[30] says that by the following procedure the gonococci can be diagnosed with certainty. The cover-glass preparation, made in the usual way, is colored either by methylene blue or gentian violet, and is then treated with Gram's solution of iodine for two or three minutes. This fixes the aniline colors on the micro-organisms ex-

clusively, and not on the anatomical elements. If now examined, it will be found that the micro-organisms are in this way colored either blue or violet, according to the dye used. Should any doubt exist as to their true nature, the preparation should be treated with alcohol, and recolored with eosine. If the micro-organisms are of a blennorrhagic nature they will be decolorized, and recognized only with great difficulty; whereas, if they are cocci from other sources, they will retain their blue or violet color on a rose-colored ground. They are round micro-organisms, rather large, about 0.8 μ in diameter. They are rarely found as zooglœa, but usually in couples in a state of semi-division, arranged in a figure-of-8 form. They generally adhere to the surface of the pus-cells (Fig. 2315), or are placed superficially within the cells. To a less extent others are found between the cells, in which case they are frequently separated from one another by a hyaline, jelly-like substance.

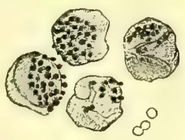

FIG. 2315.—Gonococcus. (Neisser.)

This form of coccus does not exist in other inflammations of the urethral mucous membrane. The bacteria of other suppurative conditions will not cause the specific disease.

Spermatozoa are occasionally found in the urine in cases of spermatorrhœa; especially in the urine passed the first thing in the morning. As a rule, the urine is cloudy in such cases, the spermatozoa being found in a mass of granular-looking flakes. Spermatozoa may also

FIG. 2316.—Spermatozoa in Urine. (Peyer.)

be found in urine passed after coition, from some of the semen having remained behind in the urethra.

Cancer-cells are sometimes, but rarely, found in urine. In such cases they are likely to have their origin in a growth involving the wall of the bladder.

Fragments of villous growths which have sloughed off may sometimes be found in the urine. Crystals of hæmatoidine may be seen in these fragments. Treating the specimen with glycerine renders them more distinctly visible.

The crystals that may be present in the urine are very numerous. The presence of some of these will indicate a diseased condition of some portion of the urinary apparatus, while others are of no clinical import.

Uric acid crystals may exist in normal urine, but if they are found immediately after the urine is passed, the condition is a pathological one, as it points to the probability of a calculus being formed in the kidney. Some care is required in searching for them, as they may be completely obscured by the presence of amorphous urates. In such a case it is necessary to heat the urine to 50° C., thus dissolving the urates, and filtering rapidly. The urates pass through, leaving the insoluble uric acid crystals on the filter. Crystals of uric acid vary both in size and shape; some are so large as almost to be visible to the naked eye; others require high magnifying powers in order to be seen. They are reddish-brown in color, sometimes with a slight orange tint. These colors give the deposit the appearance of cayenne pepper. They are never colorless, while all other crystalline deposits may be. They are very often found occurring as rosettes made up of oval-shaped plates (Fig. 2317); or plates may occur singly either as rhomboids or oval-shaped, with sharp angles. Some of the rhombic plates have blunt, rounded corners, and resemble a whetstone. Sometimes they are hexagonal, sometimes rectangular, or they may be barrel-shaped. Rows of these crystals are occasionally found having the appearance of long cylinders, from the fact of their being deposited on accidental impurities, as hairs or threads. If there is any doubt as to the nature of these crystals, it can readily be removed by the addition of an alkali—soda or potash—when it will be found that the crystals are dissolved, having been changed into the soluble urates. They can then be precipitated in the form of hexagonal plates by a drop of acetic or of hydrochloric acid.

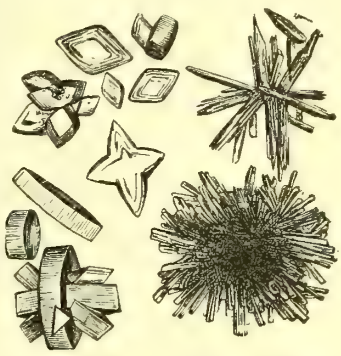

FIG. 2317.—Uric Acid in the "Whetstone" form and arranged as rosettes.

FIG. 2318.—Uric Acid in its "Dumb-bell" and other Shapes.

The urates are the most common precipitates found in the urine. They occur as small granules irregularly grouped. They are the least important, and yet the most common, of all the urinary deposits. The urine containing excess of urates is perfectly clear when passed, but as it cools the salts are deposited, causing it to become cloudy and muddy-looking, sometimes with a deposit of brick-colored sediment. Occasionally, especially in the case of children, it has a "milky" aspect. This cloudiness is due to the deposit of amor-

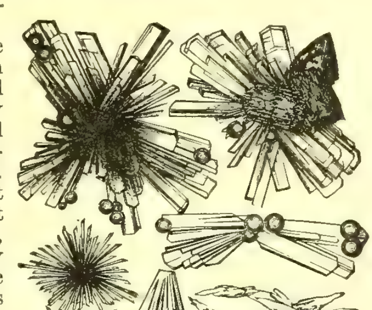

FIG. 2319.—Urate of Soda.

Microscopy.

phous granules of urate of soda (Fig. 2319). Sometimes, however, this salt forms definite round bodies with spikes projecting from them. It is found in great abundance in febrile conditions; also frequently after excesses in diet, etc. The urate of ammonia (Fig. 2320) forms brown-colored spheres, which are occasionally double. It resembles the urate of soda, only the bodies from which the spikes project are more globular. This deposit is rare, and, when present, it is generally found in alkaline urine, accompanied by earthy phosphates. Phosphates are present in the urine only when it is alkaline or very feebly acid. They are also deposited during alkaline fermentation. Three earthy salts are found as the result of combination with phosphoric acid, viz., calcium phosphate, magnesium phosphate, and the ammoniaco-magnesian phosphate. The calcium phosphate occurs most commonly as amorphous granules; it sometimes, but very rarely, occurs as club-shaped crystals with broad oblique bases, or as acicular or star-shaped crystals (Fig. 2321). This salt is insoluble in water, but is speedily dissolved by the addition of an acid. This serves to distinguish it from uric acid, for which it might be mistaken, the acid having no effect on the latter; furthermore, uric-acid crystals are colored, which is not the case with crystals of the calcium salt. It is only when the urine is alkaline that this salt is present as a deposit. On heating urine containing it a precipitate resembling albumen is produced, which readily disappears on the addition of a drop of acid. Phosphate of magnesia is of rare occurrence. When present, it is in an amorphous form.

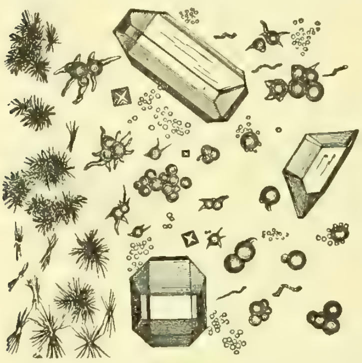
Fig. 2320.—Precipitate Formed of Urate of Ammonia, Earthy Phosphates, and Oxalate of Lime.

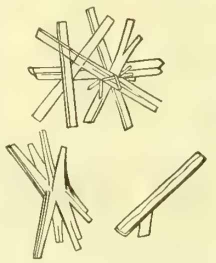
Fig. 2321.—Star-shaped Crystals of Calcium Phosphate.

The ammoniaco-magnesian phosphate, called also triple phosphate, is the more common of the phosphates in the urine. It is present only when the urine is alkaline or feebly acid. It usually occurs with phosphate of lime. It consists of right rhombic prisms, which refract light well and have smooth surfaces and sharp edges (Fig. 2322; other shapes of crystals are seen in Fig. 2323). Sometimes it is found in the form of feathery crystals (Fig. 2324), which disappear completely on the addition of acetic acid. This fact serves to distinguish them from calcium oxalate, which is not acted on by the acid. The presence of these salts in the urine immediately after it has been passed is very significant, as pointing to the presence of an intravesical fermentation, due probably to an inflammatory condition of the bladder.

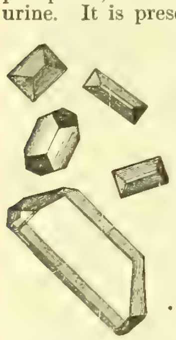
Fig. 2322.—Triple Phosphate (ammoniaco-magnesian phosphate); most frequent shapes.

Oxalate of lime occurs in the urine in two forms, that of colorless, quadrilateral, octahedral crystals which refract light strongly (Fig. 2325), and also of colorless dumb-bells; sometimes they occur as rectangular plates, with diagonal lines running from the angles, resembling an envelope in shape. These crystals are all insoluble in water and acetic acid, but soluble in strong mineral acids. Their insolubility in acetic acid, as mentioned before, distinguishes them from phosphates, as does also their insolubility in alkalies distinguish them from uric acid. The free use of certain vegetables, as rhubarb, or of fruit, such as oranges, has a tendency to cause their presence in the urine. These crystals are frequently found in catarrhal jaundice, and in diabetes mellitus; they are also frequently observed in the urine of patients recovering from acute febrile diseases. The so-called "oxalic-acid diathesis" is associated with this deposit in the urine, as well as with a dyspeptic and hypochondriacal condition. Cystin is very rarely met with in the urine. When present, it is generally in urine slightly acid and yellowish green in color. It is composed of hexagonal flat plates, which overlap

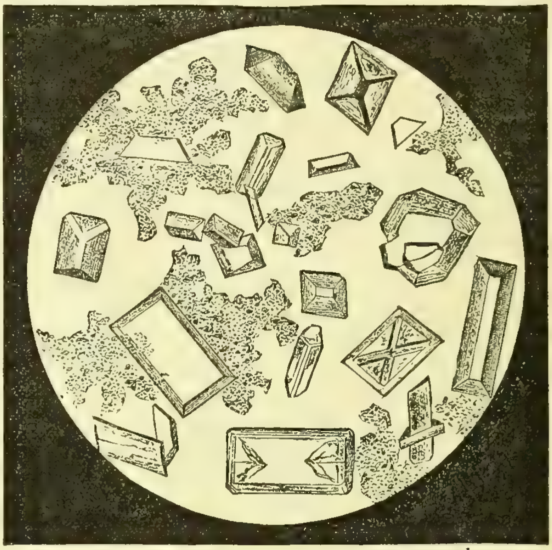
Fig. 2323.—Ammoniaco-magnesian Phosphate. (Peyer.)


Fig. 2324.—Ammoniaco-magnesian Phosphate. (Peyer.)


Fig. 2325.—Oxalate of Lime.

Microscopy.

one another by their flat surfaces, thus forming laminated groups (Fig. 2326). They have a pale lemon color, which turns slightly greenish on exposure to the air and light. Urine containing cystin has usually a peculiar odor, resembling decayed cabbage. By some the odor is supposed to more closely resemble that of sweetbrier. Cystin might be mistaken for uric acid crystals, but may be readily recognized by the fact that it does not give the murexide reaction, and also by its ready solubility in hydrochloric acid and oxalic acid. A better distinguishing characteristic is to allow a drop of aqua ammoniæ to run under the cover-glass. This dissolves the cystin, but has no effect on uric acid, unless heat is applied. In the course of a few minutes the cystin will again appear as hexagonal plates, owing to the evaporation of the ammonia. If there is any delay, adding a drop of acetic acid will hasten the re-precipitation. Cystin might also be mistaken for the earthy phosphates. A drop of acetic acid will remove all doubt, as it has no effect on the cystin, but dissolves the phosphates.

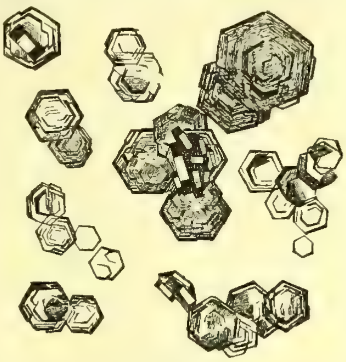

Fig. 2326.—Cystin.

Tyrosin and leucin are met with only in extremely rare cases. They are occasionally found in acute yellow atrophy of the liver and acute phosphorus poisoning, and in certain diseases in which there is rapid wasting. Indeed, their presence denotes extensive as well as rapid destruction of the hepatic cells. When present in excess in the urine, all that is necessary is to evaporate a drop of the urine on a glass slide and place it under the microscope, when they will be readily seen. Leucin, when present in the urine, occurs as round, oily-looking drops, having the appearance of fat, but unlike fat in that they are insoluble in ether. Sometimes they occur as small,

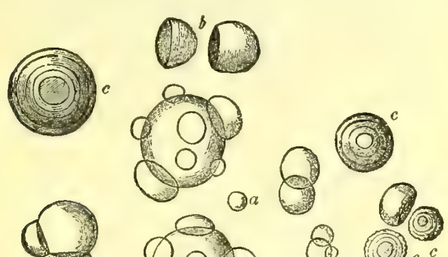

Fig. 2327.—Various Forms of Leucin.

smooth spheres, as seen in *a*, Fig. 2327, or as hemispheres, *b;* others may have a stratified appearance, somewhat resembling starch granules, as seen at *c*. Tyrosin crystallizes as fine needles, which have a tendency to run together, forming sheaves and rosettes and variously shaped clusters, as seen in *b*, Fig. 2328. They may also be present as isolated needles with a silky lustre, as shown at *a*.

Hæmatoidine has been occasionally found in the urine in the form of small rhombic tablets. The cases in which it has been observed have been pyelo-nephritis, villous tumors of the bladder, and various acute affections of the kidney.

The Skin.—The perfectly healthy skin is seldom free from micro-organisms. This is especially the case in parts which are plentifully supplied with sweat-glands so as to retain a certain amount of humidity on the surface. In the drier portions of the skin these organisms are rarely found.

Bizzozero, who has paid especial attention to this subject, describes at least three forms as being met with in the healthy skin. He employs the following methods for demonstrating these organisms: The fat is first removed from the epidermis by washing with alcohol and ether. The epidermic scales are then submitted to either one of the three following methods: a drop of a fifty per cent. solution of acetic acid or of a ten per cent. solution of caustic potash is added to the scrapings of the epidermis placed on a glass slide, and a cover-glass is placed on this and then examined; or the scrapings are examined in glycerine slightly colored with methylene blue; or a cover-glass preparation is made after allowing them to soak for about fifteen minutes in a fifty per cent. solution of acetic acid and teasing them out. The acid is then driven off by gentle heat, the cover-glass passed through the flame of a spirit-lamp, and some nuclear stain, such as methylene blue, allowed to act on the preparation; after which it is washed in distilled water, allowed to dry, and then mounted in Canada balsam. The micro-organisms may also be seen by rubbing a cover-glass over the skin and then passing it through the flame

Fig. 2328.—Tyrosin.

of a spirit-lamp or Bunsen burner three times, as for tubercle-bacilli, coloring with gentian violet or fuchsin, and mounting in Canada balsam. It is advisable to wash the cover-glass with chloroform to remove any fat that may adhere to it. In some places, especially where there is much furfuraceous deposit, the organisms are large. The three varieties described are: 1. Spherical cells with a thick membrane and homogeneous contents, averaging 3.5 to 4.5 μ in diameter. On some part of their contour a bud of homogeneous appearance may be observed. Nothing like threads is present. This fact, and the process of budding, led Bizzozero to give this parasite the name saccharomyces sphérique. 2. Other cells, smaller and paler than the above, but with a more uniform diameter, their length being about 3.5 μ and their transverse measurements 2.3 to 2.6 μ. Their membrane is more delicate than the first named, the granules being more brilliant. These bodies also have a bud in some part of their contour, generally at either pole. 3. The third form embraces the micrococci and bacteria which are present in sweat. The micrococci are generally found in couples and are remarkable for their large size, their diameter averaging about 1 μ

A very large number of bacillary bodies are found mixed up with the epithelial elements disengaged by the

sweat of the feet. This is especially so with reference to the interdigital epidermis. These bacilli vary in size

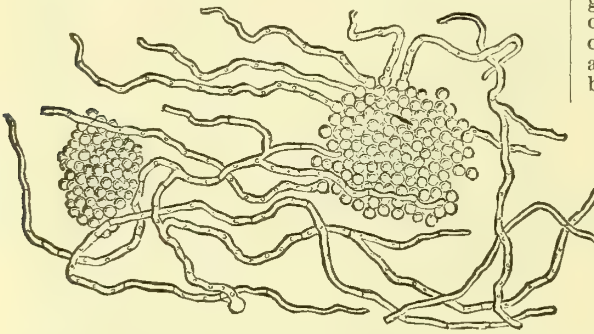

FIG. 2329.—Groups of Conidia, with Tubular Filaments, in Pityriasis Versicolor. (Neumann.)

from 2.5 to 4.5 μ in length. Very delicate filaments, measuring about 0.4 to 0.9 μ in diameter, are also found mixed up with the epithelial elements. Bizzozero considers them to belong to the same botanical order as the leptothrix, hence has named them L. epidermis. He has sometimes found a similar vegetation between the scrotum and thigh.

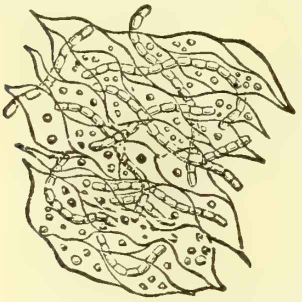

FIG. 2330.—Herpes Tonsurans, showing Disjointed and Isolated Conidia between the Epidermic Cells. (Neumann.)

Cocci have been described as being the cause of alopecia areata, but exactly the same cocci have been found on healthy skin.[31]

Parasitic Diseases of the Skin.—Method of examination: Scrape, with a perfectly clean knife, enough epidermis to include the suspected part; place on a glass slide and then add a drop of a twenty to forty per cent. solution of caustic potash or soda, and put on the cover-glass.

Hair containing fungi may readily be distinguished from normal hairs, by the naked eye, by treating them with chloroform. Placing the hair for two or three minutes in the chloroform, and then allowing it to dry, causes the diseased part to assume a chalky-white appearance. In herpes tonsurans, for instance, the bulb of the hair is free from the fungus, and is unaffected by chloroform, and consequently retains its normal color, whereas in favus the bulb becomes white through the chloroform treatment; in the latter affection the bulb of the hair is invaded by the fungus.

FIG. 2331.—Fragment of Hair from a Case of Herpes Tonsurans, showing Jointed Conidia and Chains of Spores. (Neumann.)

The commonest of the parasitic skin diseases is pityriasis versicolor. It consists of brownish-yellow spots, easily removed with the finger-nail, sometimes barely as large as a pin's head, and sometimes covering large portions of the trunk. It is never seen in children nor in old people. The fungus consists of threads or hyphæ of various widths surrounding spores arranged in groups, as conidia (Fig. 2329). These spores are generally round, of variable size, but usually somewhat smaller than a red blood-cell. They measure from 4 to 6 μ in diameter, although they are sometimes as large as 8 μ. They have a large, round, yellow nucleus, surrounded by protoplasm of a bright and transparent character. The nucleus occupies nearly the whole cell, and gives it somewhat the appearance of a non-nucleated cell, having a wall with double contour. The hyphæ have long articulations. They very rarely branch, but spread themselves in every direction between the epithelial elements.

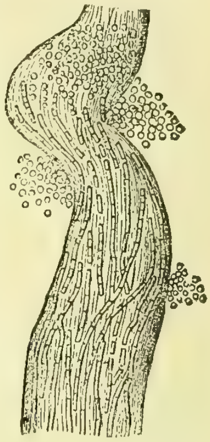

FIG. 2332.—Hair in Sycosis, showing Conidia in Groups and Chains on and between the Fibrillæ. (Neumann.)

The tricophyton tonsurans (tinea tonsurans, herpes tonsurans) is the parasite present in ring-worm of the scalp. It may be readily observed by softening the integument invaded by the parasite with a solution of caustic potash, then scraping and transferring to a slide, and examining without any further preparation; or it may be examined in glycerine. It consists of a mycelium and spores. The threads of the mycelium are wavy and branching, forming a network (Fig. 2330). The filaments are from 2 to 3 μ in diameter and of variable length, and contain some bright granules. The spores have a mean diameter of 6 μ, and are round or oval in shape. They may form conidia chains in the hair-follicles or in the hairs themselves (Fig. 2331). These subsequently develop into tubes. This causes the hairs to become brittle and rigid, and in consequence of breaking off irregularly they have a ragged appearance.

In over 85 per cent. of the cases of parasitic sycosis the disease is preceded by herpes tonsurans, in which case the same parasite will be found, that is, the tricophyton, in the form of spores, either as conidia or in chain-like form in the hairs, with or without mycelium (Fig. 2332).

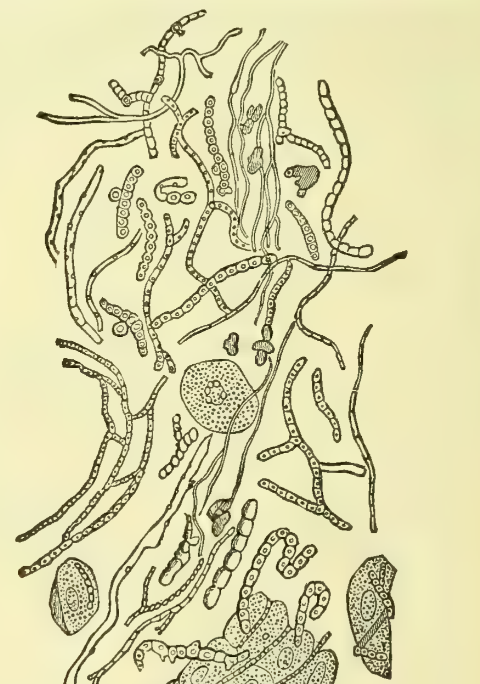

FIG. 2333.—Favus, showing Spores and Mycelium, also Epithelial Débris.

Microscopy.

Favus is a parasitic disease due to the presence of a fungus (achorion Schönleinii) with spores and mycelium. When examined microscopically, it is seen to consist of some flattened scales from the upper layer of the epidermis, mixed with threads of mycelium of varying thickness. These threads are seen to branch dichotomously and to have mixed up with them numerous spores, either singly or arranged as conidia. Fat-cells, fragments of disintegrated tissue, and finely granular elements are mingled with the mass (Fig. 2333). The spore-bearing tubes seldom contain more than five or six spores, whose diameter is 6 or 7 μ. The spore enters alongside the root of the hair, and the mycelium penetrates into the hair itself. Both spores and mycelium invade the surrounding epithelium, setting up inflammation, loosening the cement-substance of the cells, and giving rise to the formation of scales and crusts on the surface of the skin.

The animal parasites found on the surface of the skin are very few. The acarus scabiei is found on the surface

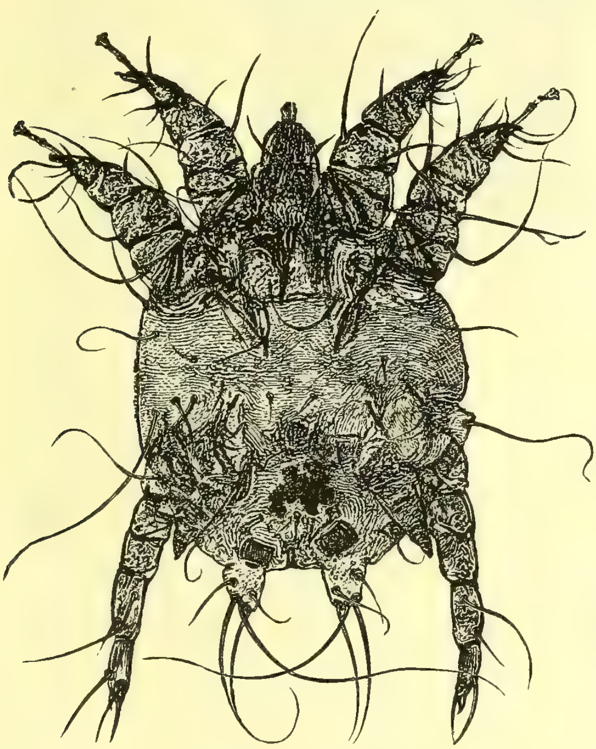

Fig. 2334.—Acarus Scabiei.

of the skin, especially on the flexor side of the wrist-joint, on the contiguous surfaces of the fingers and interdigital folds, in the axilla, and elsewhere. The parasites may be recognized by the characteristic grooves made by them. These are tortuous, and vary in length from one to ten millimetres. They gradually deepen and terminate in a vesicle, in which the parasite is found. The course of the groove may be observed by the naked eye; on examining with a lens, small white points intermingled with a dark, granular-looking substance may be observed. The white points are the ova of the animal, the dark matter being, most likely, dust, or excrementitious matter. These grooves frequently contain as many as forty or fifty ova each, in various stages of development. About the fourteenth day the newly growing animal is observed to move about in the ovum, from which it escapes, and working its way along the crevices in the skin, perforates it. It is this that causes the intense itching. This is very much increased by warmth. It is the female only that burrows. The parasite resembles a tortoise in shape. It has eight legs, four placed anteriorly, with the head between them, the other four behind. The former have suckers, and the latter hairs (Fig. 2334). The female is larger than the male. It may be lifted out of the furrow by means of a needle or fine lancet.

Fig. 2335.—Acarus Folliculorum.

The acarus folliculorum is occasionally found in normal as well as in diseased conditions, in the sebaceous glands of the nose and other parts, such as the face and ears, especially in fat persons. It measures from about 85 to 125 μ, and is about 20 μ broad. It has a proboscis on its head which is fitted closely to the thorax. Its abdomen is about three times the length of the thorax, and has no feet attached, the eight that the parasite has being connected with the thorax.

The Cysts and their contents that most frequently come under the observation of the clinical microscopist are: Hydatid cysts, ovarian cysts, dermoid, colloid, and serous cysts. In the hydatid cysts, the parts that may be recognized under the microscope are the wall of the cyst, the head of the echinococcus, or the hooklets. The cyst varies in size, and may be even as large as the fœtal head. The wall is formed partly from the organ in which it lies, and is partly of parasitic origin. It presents a stratified appearance, and frequently has growing from it a bud-like projection, which becomes converted into a so-called "brood-capsule," filled with larval worms (scolices) (Fig. 2336). A brood-capsule may contain as many as twenty scolices, which are easily detached and then float about. These scolices may be recognized by the head supplied with a double crown of hooks, numbering about forty-four (Fig. 2337). The pedicle by which the scolex was attached to the internal surface of the cyst is seen at its posterior part.

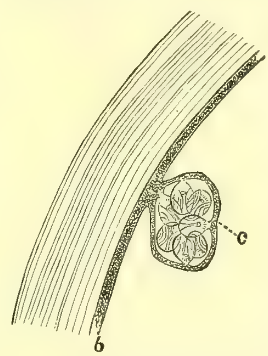

Fig. 2336.—A Portion of Echinococcus-capsule with its Brood-capsule attached. At c the capsule filled with scolices is seen growing from the parenchymatous layer b.

These cysts are most common in the liver. They are found also in various other organs. Tumors of the lung, pleura, or even of the liver may burst into the bronchi, and then their contents appear in the sputum. In such cases the only evidences of

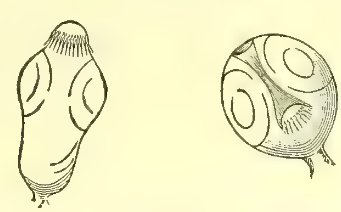

Fig. 2337.—Heads of Echinococci Removed from the Brood-capsule.

their presence may be the separated hooklets as seen in Fig. 2338.

Several cases are reported of a cyst of the brain bursting into the ventricles.

Fig. 2338.—Separated Hooklets.

Ovarian cysts contain leucocytes, fatty granules, red blood-cells, crystals of cholesterine, and pigmentary matter. These bodies are held in suspension in a liquid which may be of a low specific gravity, or it may be as high as 1.025. Sometimes it contains albumen; sometimes there is none, or very little, present.' Unlike ascitic fluid, it does not coagulate on boiling. The most important elements which may be found in the fluid are ciliated, cylindrical epithelial cells, which have their origin in the wall of the

cyst, and the discovery of which at once removes all doubt as to the nature of the cyst. Colloid concretions are sometimes present in these cysts. The fluid of the cyst varies in color; it may be quite clear, or lemon-colored, or of a reddish-brown or chocolate color.

The TRICHINA SPIRALIS belongs to the group Nematodes, or thread-worms. It is imported into the human system through the ingestion of pork. The female, eight or ten days after entering the system, gives birth to a great number of young, which, after perforating the intestinal wall, wander through the muscles (see Fig. 2339). They soon penetrate the fibres, and by their presence cause a swelling of the sarcolemma. Here they surround themselves with a sort of capsule formed chiefly of the thickened sarcolemma. Any of the striated muscles, except the heart, may be invaded by the parasite. Its favor-

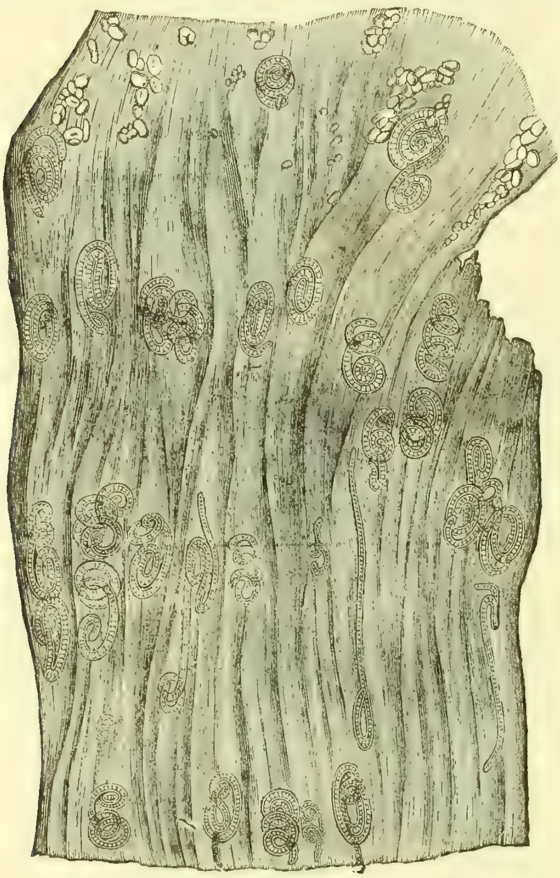

FIG. 2339.—Trichina Spiralis; showing the parasites free in muscle, near the tendinous portion. (Schmidt-Mülheim.)

ite seats, however, are the diaphragm, and the muscles of the neck and jaw. For the purpose of examining them under the microscope, sections should be made in the direction of the muscle-fibres, moistened with acidulated water and teased out. If trichinæ are present, they may be easily recognized with a low power as seen in Fig. 2339. Some trichinæ are rolled up in various manners; others are seen in their capsules. If they remain within the capsules for a considerable length of time calcification may set in, and the worms may die. Fig. 2340 shows a portion of muscle in this state. Permanent preparations may be made by taking a thin section, clearing it up as much as possible with caustic potash, washing it well in water, and then mounting it in glycerine.

MILK may sometimes need to be examined microscopically. For this purpose, all that is necessary is to place a drop of milk on the slide and examine it at once. Good milk consists of a thin, clear fluid, holding in suspension a number of fat-globules of various sizes, surrounded by a thin film of caseous material which forms a sort of capsule. Mixing with either benzine or ether, and shaking up for a considerable time, will dissolve out the fat and leave the capsule. This latter, treated with a watery solution of iodine, takes a yellow color.

FIG. 2340.—Trichina Spiralis; showing capsules which have undergone calcification. (Schmidt-Mülheim.)

Diseased milk may be recognized by the presence of pus- and mucus-cells, as seen in Fig. 2342. It is not simply the milk of diseased cows that is unsuited for nourishment, but also that of healthy animals for the first few days of its secretion. It is then called colostrum, and contains a very great number of gland-cells in a state of fatty degeneration, and unsuited as yet for nourishment (see Fig. 2341).

TYPHOID BACILLUS.—As far back as 1871, v. Recklinghausen described special forms of colonies of micrococci as being present in typhoid. Gaffky,[32] Koch's assistant, who has paid particular attention to this subject, describes a micro-organism of a different form, which he considers to be quite characteristic. It is an endospore bacillus, which, he says, is constantly present in several of the internal organs (Fig. 2343). It is found in the solitary glands and Peyer's patches; in the mesenteric glands, spleen, liver, and kidneys. In the kidneys the bacilli are present only in the capillaries, never in the urinary tubules. The single rods are $2.5\,\mu$ long and about one-third of that in breadth. They are found in the greatest number in the initial stage of the disease. After death these micro-organisms never increase in number, and when cultivated in gelatine they never become the cause of putrefaction. This latter fact shows that the bacilli are not those of putrefaction. To demonstrate the presence of the typhoid bacilli, Gaffky hardens the organs in alcohol and colors the sections in methylene blue; then washes them, dehydrates them in alcohol, and clarifies them in turpentine.

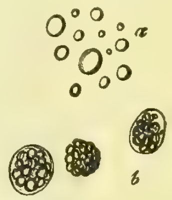

FIG. 2341.—a, Ordinary milk globules; b, colostrum corpuscles.

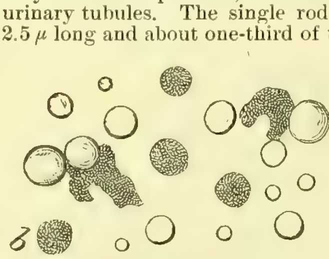

FIG. 2342.—Diseased Milk; showing pus-cells at b.

Artaud[33] proceeds somewhat differently. He examines the fresh specimens immediately after death. These he freezes by chloride of methylene, and, after making his sections, follows the same method of procedure as that used by Gaffky. His results differ from those obtained by Gaffky.

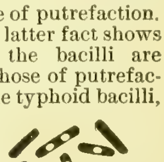

FIG. 2343.—Typhoid Bacillus (highly magnified).

Fränkel uses the following method for demonstrating the bacillus of typhoid: Distilled water is rendered slightly alkaline by the addition of caustic potash; to this a concentrated solution of methylene blue is added until the fluid becomes intensely blue; after standing twenty-four hours it is filtered, and, if necessary, some more blue is added. Immersion of a section for a few minutes in this solution colors the bacilli fairly well. In order to make permanent preparations, the sections are permitted to remain in the solution several hours, or even a day. The sections are then decolorized in water slightly acidulated with acetic acid, and then in absolute alcohol. They should be kept in the latter until only the nuclei and bacteria remain colored. They are then mounted in the usual way.

Experiments with the bacillus as to the action of the gastric juice showed that their vitality was destroyed, the disinfectant action being supposed to be due to the acid present.

Vilchur has quite recently been engaged in studying the bacteriology of typhoid fever, and attaches importance to the appearance of the colonies, which are larger than in those of a non-typhoid character. For staining the spores from cultivations he uses a solution of rubin in aniline water.

Syphilis Bacillus.—Lustgarten[34] describes a specific bacillus, met with in certain syphilitic products, which he regards as the carrier of the infecton. Cover-glass preparations are made in the usual way. These are better prepared as a moderately thick film. They are first colored with Ehrlich-Weigert's solution of gentian violet for from twelve to twenty-four hours, or for two hours at 40° C.; then washed with water. They are then decolorized by treating first for about ten seconds in a 1.5 per cent. watery solution of permanganate of potash, and immediately transferred for a short time to a watery solution of pure sulphurous acid (prepared by treating metallic copper with sulphuric acid). The preparation is now washed in distilled water and again transferred to the solution of permanganate of potash, in which it should remain not longer than three or four seconds. From this it is again transferred to the sulphurous acid, and so on until it is completely decolorized, which generally is effected after three or four repetitions of the process. The preparations are now permitted to dry, and are mounted in Canada balsam.

Prepared according to this method, the bacilli closely resemble tubercle-bacilli. They are about 4 μ long, are more or less curved, and, at times, have some resemblance in shape to a figure-of-8. The bacilli frequently have from two to four points corresponding to the spores of bacilli. These spore-like bodies are clear and bright, and are oval in shape. The bacilli are never found free in the tissues, but always inside of cells, which are somewhat larger than lymph-cells, occasionally even double their size; sometimes singly, sometimes in groups of two to eight.

Trachoma.—According to Professor Zehender (of Rostock), trachoma is supposed to be due to a diplococcus, which differs but little in appearance from the gonococcus, except that its dimensions are much smaller. It can be cultivated in different liquids, while the gonococcus thrives only in blood-serum. The diplococci are found in the interior of the follicles, but outside of the cells. The gonococci are found chiefly within the cells. The former can be inoculated in man, but not in the rabbit; the latter produces more or less marked effects in all animals. *George Wilkins.*

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MICTURITION; MODIFICATIONS OF THE ACT IN DISEASE. In all branches of medicine careful observation is necessary to exact diagnosis. Different pathological conditions modify the act of urination in ways more or less characteristic, and this article is intended to assist in the study of such modifications. Accurate diagnosis may be impossible without recourse to other sources of information than those discussed here, but the neglect of the symptoms here mentioned often leads to avoidable errors. Disorders of micturition in women are only incidentally alluded to; nor is any attempt made to render the article complete as regards the male. Such a result could be gained only by repeating much that has been said in other places.

The information contained in the article is drawn from very various sources, which it is not always possible to acknowledge, especially as much of it is common to all observers.

The numerous modifications of micturition brought about by disease may be considered under various heads: Changes in frequency; changes in the stream; painful micturition; difficult micturition; impossible micturition; involuntary micturition; and the passage of abnormal substances.

Impossible micturition, including retention and anuria, is not treated here, as it is very fully discussed in other articles.

Frequent Micturition.—It is not easy to determine exactly the normal frequency of micturition. It varies somewhat with different individuals, and in health is subject to changes from numerous causes, depending in great measure upon the amount of urine secreted, as influenced by the amount of fluid taken and by the cutaneous transudation.

In disease an increased frequency of micturition is one of the most common of urinary symptoms. It may be due to nervous influence, to increase in the quantity of fluid secreted, to changes in the quality of the secretion, and to lesions of the retaining and evacuating apparatus.

A temporary increase from nervous influence is very common, and must have fallen within the experience of everyone. In times of great anxiety and excitement there is an irresistible call to urinate at very short intervals. That desire is felt by amateur boat-crews when waiting to enter their boats for a race, and by most men before any specially trying ordeal. It is also a phenomenon attendant on the passage of a renal calculus, when the calls to urinate are not only frequent, but irresistible, and may be accompanied by similar sensations in the rectum. Irritation of the lower end of the bowel may have a similar effect, though retention is perhaps more frequent from such a cause. These are but temporary disturbances, of which the nature is fairly well understood by patients themselves. Profound nervous lesions are not without effect upon urination. In the majority of cases of disease of the cord, disturbances of the bladder occur very early in the disease. In the shape of incontinence, it may be the only prodromal symptom for a long period.

Usually there is a frequent desire to micturate, with more or less dribbling; sometimes there is retention alternating with involuntary discharge. Frequent micturition is not confined to the initial period, but may persist when the disease is far advanced.

An excessive secretion and consequent frequent micturition are the result of several distinct morbid conditions. Frequent micturition may be the most prominent symptom of diabetes, saccharine or insipid. It may result from renal disease, either chronic interstitial nephritis or amyloid degeneration; or it may be due simply to a chronic irritation of the vesical mucous membrane.

It would be improper here to more than allude to these renal troubles. Surgeons who have to do with patients with long-continued suppuration, as from hip or other joint disease, should be careful to heed any complaint of frequent micturition, that amyloid degeneration of the kidneys may not escape their notice.

An increase in secretion is present, as an additional cause of frequent micturition, in many cases in which chronic irritation of the bladder and frequent calls to evacuate it already exist. As an irritation of the excretory ducts stimulates the activity of the corresponding secreting glands, so the chronic irritation of the bladder in patients with stone, prostatic obstruction, stricture, or tuberculous cystitis, excites an excessive flow of urine. The most common cause of this reflex polyuria is obstructive hypertrophy of the prostate, with chronic partial retention of stagnating, and perhaps decomposing, urine. This diuresis is in some cases very profuse, especially at night.[1]

An abnormal condition of the urine, in consequence of which this fluid irritates the bladder and causes undue frequency in the evacuation of its contents, may occur in certain constitutional diseases, or as a symptom of renal inflammation. The urine in these cases of constitutional disease contains an excess of certain ingredients which impart to it an irritating quality. Lithæmia or gout, and certain forms of dyspepsia, may be the causes of a vesical irritation which is sometimes sufficiently severe to be mistaken for cystitis or renal disease.

The renal inflammations which communicate to the urine a quality rendering it irritating to the bladder, thus occasioning undue frequency in micturition, are chiefly acute parenchymatous nephritis and pyelitis; the first of which is often attended, during the first day or two of its duration, by excessively frequent calls to urinate, so urgent and so distressing as to simulate an attack of acute cystitis.

Pyelitis, of whatever origin, is commonly accompanied by undue frequency of micturition. The irritating properties of the pus in the urine stimulate the bladder to repeated contractions, and "many a case of pyelitis has been treated as chronic cystitis, powerful injections being thrown into the bladder in the vain hope of controlling the formation of pus which is supposed to have its origin there."[2] The recognition of pyelitis is often difficult, the diagnosis being based in many cases only upon presumptions more or less strong. As expressed by Curtis, the first step toward a correct interpretation of the symptoms, in any given case, consists in suspecting the possible existence of pyelitis.[3]

Frequency of micturition is a very common symptom of renal calculus. In some cases the irritation at the neck of the bladder is so excessive that the thought of a calculus in the kidney or ureter does not arise; but catheters and sounds are again and again resorted to, on the supposition that the seat of disease is the urethra or bladder. If the frequency of micturition be associated with pus in the urine, cystitis is, perhaps, said to exist; while in reality the pus is coming from the higher urinary passages, and any cystitis which is present is the result of the so-called "exhaustive examinations" of the bladder with instruments.[4]

An inability to entirely empty the bladder, either from an impairment of the expulsive force, or from some permanent obstruction to the exit of the urine, results in the condition sometimes described as chronic partial retention; when the bladder is constantly partly filled its capacity is reduced, and, consequently, an invariable accompaniment of that condition is a frequently recurring desire to evacuate the urinary reservoir. The most frequent cause of partial retention is obstructive hypertrophy of the prostate. A most characteristic feature of these cases is a relatively more frequent urination by night than by day. When a man who has passed the age of fifty years complains of urinating frequently at night, although his days are less disturbed and exercise seems rather to decrease than increase the frequency, it is almost certain that the case is one of prostatic hypertrophy. But age and nocturnal frequency are not alone sufficient to justify a positive diagnosis of enlarged prostate. A notable case of error came under my observation, in the person of a clergyman who had led a laborious life as a Methodist circuit-rider in the Southwest. He was over sixty, and suffered severely from chills and frequent micturition, most troublesome at night He was losing flesh and was considered "worn out." He had been informed, on the evidence of symptoms alone without examination, that he had an enlarged prostate; had been presented with a flexible catheter, and told to use it at night; but he had found it impossible to introduce it, and had borne his troubles very philosophically so long as he was able to persevere in his work. His stream was very small, and expelled only with effort, but entirely without *the slobbering* of the enlarged prostate. Examination of the urethra disclosed a stricture within two inches of the meatus, and in answer to questions he told me that, years before, he had been injured by being thrown against the pommel of his saddle. Blood had flowed from the meatus quite freely, and some trouble had remained for a few days; but his religious duties had engrossed his attention, and he had forgotten the circumstance until my questions brought it to his mind.

As the partial retention becomes greater and the capacity of the bladder less, the frequency will be more impartially distributed, though the greater frequency will still be nocturnal.

The patients with vesical calculus present the opposite characteristic of greater frequency in the daytime, a frequency which is markedly increased by exercise or by jolting or jarring. In these cases the influence of repose in lessening frequency is not less manifest than that of movement in increasing it. Frequency of micturition, increased by exercise or jarring, occurs also in vesical tuberculosis and cystitis, but repose has no beneficial effect in the first, and in the second it has a much less marked and immediate effect than in calculus. Even the most absolute repose does not afford complete relief in tuberculosis. Of course, a diagnosis would not be made from the frequency alone, without the concurrence of other symptoms; and the simultaneous existence of two forms of disease masks the distinctive characteristics of the frequency.

As a symptom of stricture, frequency indicates, generally, considerable narrowing, and, according to Mr. Bryant, a contraction which has been so gradual in its progress as to escape notice until this irritability of the bladder has enforced more accurate observation.

Modifications in the appearance of the stream attract the attention of patients, who are apt to enter into very minute and careful descriptions of their peculiarities. In reality, the conditions that modify the jet are so very complex that it is impossible to always distribute to each factor its share in the alteration. The degree of compression exercised by the contraction of the bladder, the quantity of liquid upon which the pressure is exerted, as shown by the difference between the full stream and the expulsion of the last portion, the state of the neck of the bladder, the condition of the urethra, the form and narrowness of the meatus, and the character of the prepuce may, one or all, have an influence upon the character of the stream. Fortunately, the different modifications have no importance unless they are pronounced and constant. Some of the peculiarities that attract the most attention on the part of patients are due to changes at the meatus—as an adherent prepuce, the agglutination of the lips by the scanty remains of a decreasing gonorrhœa, the

œdema of an acute clap, or some more transient and less important change. The twisted stream alone seems to be of little practical significance. The division into two or more distinct streams, when it is habitual, furnishes strong presumptive evidence of a stricture, but the presumption needs to be confirmed by subsequent examination.

Diminution in volume, when constant, is of much more importance. It is seen in the strictured, and allows one to judge approximately of the diminution in the size of the urethra. The knowledge gained as to the urethral calibre by watching, during micturition, the patient who alleges difficulty, is so valuable that it should always precede the exploration of the canal.

Diminution in projection, when constant through the whole of micturition, deserves great consideration. It occurs alike in stricture and enlarged prostate, but more commonly in the latter condition. It may affect only part of the jet, a good portion of the urine being projected to a proper distance, while the remainder falls in drops upon the ground between the patient's feet; or this part of the jet may take the form of a secondary but imperfect stream, directed to the right or left. This bifid appearance is more common in stricture.

The total disappearance of the projection, so that the stream falls directly downward, most often occurs in enlarged prostate, but often also in stricture. A narrow preputial opening, which it is difficult to bring into direct apposition with the meatus, may send the stream in any direction.

The extreme cases of loss of projection in the *prostatiques*, as the French call the old men with enlarged prostates, can hardly be mistaken for anything else. Gouley gives a graphic picture of these cases as follows: "In prostatic hypertrophy and contracture of the vesico-urethral orifice the patient urinates in a small, weak, and perpendicular stream, suddenly interrupted and soon followed by a succession of drops, perhaps twenty or thirty, to begin again and to be again followed by dribbling, and even slobbering, until two or three ounces of urine may be collected in a vessel, without which the patient surely soils his garments or wets his shoes." [5]

DIFFICULT MICTURITION may be due to some failure of the evacuating apparatus, or to a hindrance to the escape of the urine. The contractility of the bladder may be diminished, the flexibility of the vesical neck, or that of the urethra itself, may be modified; the calibre of the canal may be more or less diminished at some portion; or a mechanical obstruction, due to the presence of a foreign body, may more or less completely bar the escape of the urine.

The difficulty may be more or less marked at the beginning of the act or at its close, or it may be uniform during the entire period. When the difficulty occurs at the beginning the stream is retarded. When there is a marked impediment the difficulty in starting the flow may be very great, but the effort will be not much greater than that required to continue it. But there is one class of cases in which the retardation of the stream is specially marked. The desire to pass water is felt, the attempt is made, but it is some time before the first drops appear at the meatus. The difficulty may be present with every micturition, but it is more frequently nocturnal, and is even more marked at the first urination after awakening in the morning. Not only does the patient wait for the arrival of the urine, but he may be obliged to make great efforts to induce it to come, by pulling upon his prepuce, by frictions, and by walking up and down. If for any reason he fails to obey the first call to urinate, the difficulty increases, but ordinarily, after the bladder has been emptied in the morning, the retardation is over for the day. These patients are the victims of prostatic enlargement, and it is the congestion due to the prone position which augments the difficulty of urination, and retards it as well as increases its frequency.

In these cases of retarded flow the most painful effort is made at the beginning. The effort is continuous in many cases of stricture and impacted calculus, and in cases of disease of the cord, or in those in which vesical contractility is weakened so that the act must be completed by the abdominal muscles. The effort is confined to the close of the act in cases of cystitis, and of calculus and other foreign bodies, in which cases it is spasmodic and involuntary, and is continued after the bladder is entirely evacuated.

The effort required is, in some cases, so severe and long-continued as to cause marked congestion of the face, abundant transudation of sweat, the passage of gas or fæces from the rectum, or even the protrusion of the bowel. The latter symptom is of common occurrence in children with vesical calculus, and is occasionally so prominent a symptom as to direct attention away from the bladder trouble.

Contrary to what one might at first thought expect, the effort required is not always in direct relation to the narrowness of a stricture. It seems to be rather proportioned to the extent of the strictured portion, so that a man who has multiple strictures may be obliged to make greater exertions to pass his water than another who has a single annular stricture of half the calibre.

SUDDEN STOPPAGE.—The sudden stoppage of the urine when flowing in full stream is very properly regarded as a valuable sign of stone in the bladder, but the symptom has acquired an exaggerated importance, as the suspicion of stone is often dismissed in its absence. In point of fact its occurrence is infrequent. To produce it, it is necessary that the stone and the bladder-exit shall be so related that the former may play the part of a ball-valve. In general, the stone must be small and spherical, the bladder-walls perfectly regular, and the orifice normally situated and perfectly supple. An enlarged prostate will ordinarily prevent the occurrence of the symptom from this cause, as the stone will either fall behind the prostate or fail to accurately fit the orifice. The symptom is then much more likely to occur in young subjects, and is rare in patients over fifty. A similar interruption of the jet occurs in other conditions. Spasmodic and insufficient contraction of the bladder, the resistance of an enlarged prostate, and the fatigue of the vesical muscle in overcoming the resistance, are causes which may explain interruptions.

A small pediculated tumor, properly situated, might close the orifice equally as well as a calculus.

A sudden stoppage in which the stream is not, and cannot be, resumed indicates the impaction of a stone in the urethra. Such impaction is, in some cases, the first indication of the existence of a stone, and the first hint is given in this way not very rarely in young children.

The *position* during micturition is of great consequence to many individuals, especially when any hindrance to micturition exists which requires an effort to be overcome.

Even in health, most men think it impossible to pass their water unless upright or seated, and when any accident confines them to a prone position find some difficulty in forcing the bladder to empty itself. A patient with enlarged prostate sometimes finds that, when kneeling or in the prone position, he is able to pass water after it has ceased to flow in the upright posture. In some rare instances, according to Sir Henry Thompson, the outgrowth from the median portion of the prostate may be pyriform, with a narrow pedicle, and so movable as to fall forward upon the vesico-urethral orifice like a valve when the patient is in the upright position, so that the patient finds by experience that he can pass urine more freely when on his side or his back than in any other position.[6] Prostatic patients are apt to choose a place where they can stand and lean forward, resting the head against the wall; in this way they acquire a fixed point of resistance above to increase the power of the accessory muscles. This position also brings the weight of the abdominal contents against the urinary reservoir. The same forward inclination of the body is utilized in the sitting posture, and this is the position said to be commonly chosen by patients with myelitis.

Occasionally a patient with a stone is subject to repeated sudden stoppages, which occur so frequently as

to be a source of great annoyance, and is obliged to accustom himself to pass water while lying on the side.

Curious positions are often assumed by females with abdominal tumors that press upon the neck of the bladder or the urethra itself. These changes in position cause a displacement of the tumor, which relieves for the moment the compression. Patients find the most favorable position only by chance, and physicians should favor the adoption of any position that obviates the necessity of using the catheter. Cases occasionally arise in which the patient, whose water is shut off by the superincumbent weight of a tumor, is obliged to displace the tumor by the use of her hands on the abdomen, when the water will flow again freely.

The *incontinence* of children need not be discussed here. True incontinence, not the result of overflow, sometimes occurs in prostatic hypertrophy. It is not very common, and when it occurs is puzzling to practitioners, who have learned that it is an "axiom, the importance of which it is impossible to overrate, that *an involuntary flow of urine indicates retention, not incontinence.*" The incontinence is due to an unusual form of growth in the prostate, which opens the internal urethral orifice instead of closing it, as usually occurs.

Incontinence may also follow lithotomy in the male, when it is due either to too free an incision of the prostate or to some damage to the neck of the bladder in the extraction of the stone. The neck is also injured sometimes in lithotrity, with the same effect, an effect which is seldom if ever permanent. True incontinence occurs in tuberculous disease of the bladder, the neck of the bladder being injured or destroyed by ulcerations more or less profound.

In females incontinence is a very frequent result of the various accidents of childbed. It is an occasional result of the pressure of abdominal tumors, though a less common result from such cause than retention.

Incontinence is also occasionally an early symptom of nervous disease. But it is never to be forgotten that an involuntary dribbling of urine in an adult is usually the overflow from a full bladder. The sensations of the patients with chronic retention are not at all to be trusted in such a matter. A man with a bladder mounting to the umbilicus, with its outline perfectly visible through the abdominal walls, will persist in asserting the impossibility of a retention.

PAIN connected with micturition is often distressing in the extreme. It is important to note its relation to urination in point of time, whether it occurs before, during, or after the act. When the pain is confined to the time of micturition, and is evidently located in the urethra, there is either a urethral lesion, like gonorrhœa, or a modification in the character of the urine. Among the latter cases belong the individuals who perspire very freely and reduce the secretion from their kidneys to a small amount of highly concentrated urine. The burning of fever-urine is known to most people; the same sensation is produced by alkaline urine, and by urine modified in various other ways.

Pain accompanying micturition may be only the prolongation of a more accentuated pain before micturition. There is a large class of individuals, whom Guyon[7] calls the *impressionables*, who not only pass water frequently, but in whom the desire is painful and demands instant gratification. Micturition relieves the pain entirely. Among these cases may be found individuals who suffered from incontinence in childhood. When they are submitted to instrumental examination, there is found extreme sensibility of the urinary passages, especially at the sphincter, but no lesion properly so called. The normal sensibility of the parts is exalted. Such abnormally exalted sensibility is found in a higher degree in patients afflicted with disease of the spine.

In certain cases of prostatic hypertrophy the initial pain is very great; in some of these cases, though the patient hastens to prepare himself, for fear he shall wet his clothes, many seconds and even minutes elapse before he can, with great efforts, force the first drops through. In others the expulsion follows immediately the painful sensation which gives notice of the desire. In the first case retention is threatened, a congestive attack being superadded to the hypertrophy. In the second case a subacute cystitis is present in addition to, and as a consequence of, the hypertrophy.

Prostatitis, acute or chronic, may exaggerate the sufferings of the patient by adding to the vesical irritation usually experienced a ceaseless and painful tenesmus, which is unrelieved by micturition. Such a ceaseless call occurs in malignant disease of the prostate, and may be accompanied by a similar rectal tenesmus. Emptying the bladder completely with the catheter brings no relief to these cases.

A tabetic patient under my observation is tormented by a constant desire to pass water, which bears no relation to the amount in the bladder. She cannot appreciate the passage of the urine, and, as she feels no relief, is not always willing to believe that she has really passed any.

Pain after micturition, limited to or most intense at that time, is usually—probably always—symptomatic of an intravesical trouble. It is one of the very common symptoms of a stone in the bladder, when it is caused by the grasping of the stone by the vesical muscle in its efforts to empty the viscus, and the symptom varies in intensity with the condition of the bladder and the character of the stone. When the stone is smooth and the bladder-wall in a normal condition the sensation may be slight compared to that produced when an acutely inflamed bladder grasps a rough calculus. In general, excepting in certain extreme cases in adults, the pain seems to be more sharply defined in children, who squirm and twist their legs, protrude their rectum, and if boys, pull at the prepuce, in the hope of easing their sufferings. Their fingers sometimes acquire a sodden appearance from the prolonged contact with urine.

One little patient, whose sufferings were very great, used to hold his water for an incredible space of time, to avoid the pain that followed micturition. Pain after micturition is equally symptomatic of a lesion of the neck of the bladder, and is caused by the energetic contraction of the viscus in its attempts to expel the last drops of urine; it is familiar enough in the cystitis which so often complicates urethritis. It is only when gonorrhœal cystitis has grown chronic, and some obscurity in its history makes its origin doubtful, that its character can be questioned; then pain as a symptom is not sufficiently characteristic to allow its differentiation from other inflammatory or organic changes of the neck. But there are certain marked points of distinction between calculus, on the one hand, and the inflammatory or organic changes, on the other. To quote Guyon once more: "If the final pain shows itself only in micturition in the erect position; if it disappears or diminishes notably when the patient takes care to urinate when lying down; if violent exercise, or even simply walking, provokes crises that repose absolutely puts an end to; if, in one word, the influence of motion is nearly always provocative; if the days are evil, though the nights are calm, you have a right to suspect the existence of a foreign body, and it is a duty without delay to search for it."

The pain in these cases is felt at the meatus, or more commonly on the under surface of the glans. Authors connect the pain at this spot with calculus. It would be more exact to say that it indicates a lively irritation of the neck of the bladder. It is often very intense in gonorrhœal cystitis. A similar pain may also present itself with a narrow meatus. Guyon has seen such a pain disappear after meatotomy.

Speaking in a general way, when the neck of the bladder is diseased, there are radiations of pain toward the rectum, the penis, the thighs, and even the heel, as occurred in a case of Guyon's; but these last phenomena are too variable in their seat and intensity to furnish useful indications.

Pain at the end of micturition is also symptomatic of an infrequent condition not yet mentioned, viz., fissure or crack at the neck of the bladder, which is thus described by Mr. Reginald Harrison.[8]

"The symptoms are very similar to those observed when fissure exists at other orifices. There is frequent micturition, with a sensation often described as resembling alternating dilatation and contraction at the close of the act. Sometimes a few drops of blood escape after the urine has been expelled, followed by a sharp, stinging pain referred to the neck of the bladder. The pain varies in degree in the same patient, being usually intense when the urine is highly acid, diminishing in severity as neutrality is approached. Examination of the prostate in the male, and of the neck of the bladder in the female, invariably produces on pressure a sharp lancinating as if a knife were being inserted, which is very characteristic of the affection. Similarly, the passage of an instrument into the bladder is attended with much distress."

HÆMATURIA.—Urination may be modified by the passage of blood. The admixture of blood and urine may be perfect, or the blood may be nearly clear. It is hardly to be supposed that blood, apparently pure when passed from the meatus, can come from the kidneys; but otherwise the coloration gives little indication of its source. That the brownish coloration, sometimes said to be characteristic of blood of renal origin, should be produced, it is simply necessary that a comparatively small quantity of blood remain for some time in contact with the urine in the bladder.

It seems hardly necessary to caution anyone against attributing to the urinary apparatus the blood passed by the female during menstruation.

Blood is occasionally passed by the male from some sore beneath a tight prepuce, but in such case its presence at the meatus is usually noticeable at other times than during the passage of urine.

The source of the blood may be any point of the urinary apparatus, and the provoking causes of the flow may be mechanical, congestive or inflammatory, organic or constitutional. Any consideration of constitutional causes would be out of place here, and among mechanical causes those which may be called surgical, as the action of a lithotrite in the bladder, may be disregarded.

It may be stated at once that the hæmaturia following an injury to the loin, or the front of the ilio-costal area of the abdomen, is not necessarily symptomatic of ruptured or lacerated kidney; and, on the other hand, that hæmaturia is not always a symptom when the kidney is severely lacerated or completely ruptured. Hæmaturia may denote simply contusion of the kidney.[4] On the other hand, complete rupture of the kidney may take place and blood be completely absent from the urine.

Among traumatisms must be included jolting, such as one receives in a vehicle or on horseback, the effects of enforced pedestrianism, or of other prolonged effort. Unusual efforts, especially in walking or riding horseback, are very apt to give rise to the first hæmaturia in an individual who, up to the time of its appearance, has had no indication of a stone lying in the bladder. As, for example, an elderly gentleman walking on the beach with some ladies, found they were more active than himself. Having some pride in showing equal endurance, he continued the walk without protest, but at the cost of some effort, and with a desire to pass water, which he was obliged to restrain. At the end of his walk he was surprised to find his urine bloody. The hæmaturia ceased on rest, but it was the first in a long train of symptoms which culminated in the removal of a stone from the bladder.

Hæmaturia from renal calculus presents the same peculiarity of recurring with exercise and ceasing with rest, so that a case may present the peculiarity of bloody urine at bedtime and clear urine on rising. The converse may show itself in malignant disease of the kidney, as the supine position appears to favor the accumulation of blood in renal growths, whence they are more apt to bleed in the night than in the day.[9] The tendency to hæmorrhage in renal calculus differs somewhat with the character of the stone. Concretions coated with phosphates, "associated, as they necessarily are, with local inflammation, are usually surrounded with thickened and altered mucous membrane, which is more apt to yield pus than blood."[9]

The pain which calculous individuals suffer from the jarring of a vehicle is well known; it varies with the character of the vehicle, a ride in a springless cart being absolutely unendurable. Both pain and hæmorrhage are provoked to a much less degree by a ride in a railway carriage, or in a horse-car over a well-laid track, than in other conveyances.

Unfortunately for diagnostic purposes, motions similar to those mentioned may give rise to hæmaturia in the case of neoplasms or inflammations. The effect upon the bleeding of subsequent repose has some diagnostic value. Some hours of rest cause the blood to disappear from the urine in calculus; it would be very exceptional to see it continue after twenty-four hours unless an inflammatory condition was also present. In inflammatory conditions rest is not without influence, but its influence is much less marked and immediate. An acute cystitis may even be developed and become hæmorrhagic while the patient is constantly in a prone position, as in a patient confined to bed by an acute disease, in whom it was necessary on a single occasion to use a catheter, probably because of the large amount of opium administered. This single use of the catheter, perhaps imperfectly cleansed, was followed by an urethritis and a cystitis in which each micturition was for some time characterized by a final hæmorrhage. The idea of calculus is hardly to be entertained if the hæmaturia recurs repeatedly, as well after rest as after exertion. Such hæmaturias occurring without provocation, and not limited even by absolute repose, are frequent in tubercular and cancerous disease. They occur in the various forms of cystitis.

Repeated, though slight hæmaturias, apparently from the bladder, have occurred in cases of stricture, but have disappeared on the removal of the obstacle to the flow of the urine.

Guyon believes that the duration of the separate attacks of hæmaturia and the frequency of their recurrence have a value in diagnosis as to the renal or vesical origin of the blood, the separate attacks being longer when the origin is vesical, and relatively short when the lesion is renal. In cases which he cites, the hæmaturias of renal origin lasted only three, four, or five days; while the attacks of vesical origin lasted as many weeks. In one exceptional case in which the separate attacks, which proved to be of renal origin, were greatly prolonged, the intervals between the attacks were of many weeks' and even months' duration. These long periods of repose are less common in hæmaturia due to organic lesion of the bladder than in lesions of the kidney.

Blood in the urine may be equally diffused through the whole amount passed, or it may be more abundant in, or even be confined to, the first or last portions. The appearance of blood in the first portion of the urine passed, except when it comes from the anterior urethra, is certainly not very frequent; it indicates very clearly the seat of the lesion in the prostatic portion of the urethra, without indicating its character.

Blood present at the beginning of urination, and followed by clear urine, is apt to reappear at the close of micturition.

When the blood appears only at the end of micturition, or when urine tinged with blood is followed by a few drops of clear blood at the close, it may be assumed that it comes from the neck or its immediate vicinity, though the character of the lesion seated there may vary.

The final hæmorrhage is very frequent in gonorrhœal cystitis. It is so rarely wanting that one might say that gonorrhœal cystitis was essentially hæmorrhagic. In certain cases the blood is expelled in great quantity, and appears mixed with almost the entire quantity of the urine, but the last drops are always most charged. That happens because the inflamed mucous coat of the neck is always strongly compressed by the contact of the bladder walls which accompanies the effort to expel the last drops.

The final hæmorrhage of a long-standing gonorrhœal cystitis differs in one important point in its history from a similar hæmorrhage in a tubercular cystitis. The first

hæmorrhages do not take place in the same manner. There occur almost always in tubercular cystitis premonitory hæmaturias, abundant, coming on without appreciable cause, and analogous to the hæmoptyses at the beginning of pulmonary tuberculosis. These hæmorrhages surprise the patient at a time when he has neither pain nor frequency of micturition, nor other sign of urinary derangement. Later in the history of tubercular cystitis hæmaturia occurs at the end of micturition, being due to the same mechanical cause as in gonorrhœa.[10]

Pus in the urine is an almost constant symptom in maladies of the urinary organs, but is entitled to but brief consideration here. It is to be remembered that it may come from the external organs, as from a subpreputial sore. Abscesses in the vicinity may discharge into the bladder. Such an accident is very frequent in females, but though less frequent, it occurs also in males—as in a young man with hip disease, who passed a small spiculum of bone after a severe attack of cystitis. He had previously discharged several bits through abscesses in the thigh. The sudden or very rapid appearance of pus in the urine, above all if there have been no pre-existent vesical phenomena, should arouse the suspicion of an abscess of the vicinity.

The amount of pus passed at different times during urination is shown by receiving the urine in two or more glasses. Suppuration in the anterior urethra demonstrates itself by discharge from the meatus, but the urine in such a case will show a deposit of pus washed from the anterior urethra. It is often important to make certain whether the pus is, or is not, equally disseminated through all the urine—as was shown in the case of a patient convalescing from gonorrhœal cystitis. His urine had been loaded with pus, it still contained pus, but the discharge from the meatus had returned, and his vesical symptoms had practically ceased. The experiment of the two glasses showed that the pus was wholly contained in the first jet of urine that washed the urethra. On the strength of that test alone, it became possible to sanction a journey which would have been unadvisable if the bladder still showed signs of inflammation.

Sir Henry Thompson, to whom we owe this very practical manœuvre, has known more than one patient, treated for months for a pyelitis, whose urine, after the urethra was washed into the first glass, was perfectly clear.

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MIDDLE PARK HOT SULPHUR SPRINGS. *Location* and *Post-office*, Hot Sulphur Springs, Grand County, Col.

ACCESS.—From Denver by Colorado Central Railway to Georgetown, thence by tri-weekly stages or carriage to springs, forty miles over a graded wagon-road through Brentwood Pass, in the Rocky Mountains, 11,350 feet above sea-level.

ANALYSIS (Professor E. J. Mallett, Jr.).—In 100,000 parts of spring water are contained :*

Carbonate of soda	38.44
Carbonate of lithia	trace
Carbonate of lime	11.02
Carbonate of iron	2.34
Sulphate of potassa	2.90
Sulphate of soda	43.06
Chloride of sodium	22 48
Ammonia	trace
Total	120.24

Carbonic acid gas. Temperature, 117° F.

* Grains in an imperial gallon are about three-fifths of the above.

We have received the following description of these springs from Dr. Charles Dennison, of Denver, who is notably familiar with the climatology and health-resorts of the Far West :

These springs are six in number, all closely resembling each other in mineral constituents, and located on the right bank of the Grand River, in the heart of Middle Park, in Grand County, Col. The peculiar features of this elevated *park* (about 8,000 feet above sea-level) need to be described as unlike any of the others in Colorado—South Park and San Louis Valley, for instance. Instead of being, like those, an elevated plane surrounded by precipitous mountains, it is composed of many valleys converging toward the Grand River and covering a considerable territory. There is probably not five per cent. of this large enclosure that is level ground, while the ridges or hills which break up the park into separate divisions are covered to some extent with timber, and are high enough to be considered mountains almost anywhere outside of the broad "backbone of the American Continent." The scenery is thus delightful in its variety, and many pleasant places for "camping out" in summer time are afforded. Aside from these grassy valleys and wooded hills, the other interesting features of the Park are the beautiful Grand Lake, the source of the river of the same name, shut in by picturesque and lofty mountains; the cañons which this river has worn out in its southwestward journey toward the Pacific Ocean, and the Hot Sulphur Springs, after which the only town of any importance in the park is named.

These springs, of which there are several within a space a hundred feet square, rise along the line of contact between a heavy body of the slate and a stratum of sandstone, both of which have been lifted up and stand inclined to the west at an angle of sixty degrees above the horizon. The mineralized water appears to have percolated through the slate, until it reaches the sandstone, which does not admit of its passage, and so it is forced to the surface in the sandstone. Most of these springs are about forty feet higher than the river, and two hundred and fifty feet distant; several of them unite in a common stream and flow over a ledge of sandstone into a natural basin, over which the bath-house, with anterooms adjoining, is built. Into this steaming caldron the bather ventures, at first with a sensation as of being scalded, for the temperature of this waterfall, half the size of an ordinary-sized man's body, is 110° to 117° F. When one gets used to this great heat the sensation is very pleasant, but the effect is very relaxing and very weakening if one remain long in the bath. The density of the water is perceptibly greater than ordinary river water, for one can there float with ease when elsewhere he would do it with difficulty. The little waterways which convey this water to the bath are lined with a soft, yellowish-white deposit, smelling of sulphur; and the sulphurous fumes emitted, and the sulphuretted hydrogen taste of the water as it bubbles up from the rocks, show the correctness of the name given to the springs. There are six analyses made of the six principal springs, but they are so similar in composition that the one given will suffice, which is that of the largest and hottest—the "Bath Springs." *George B. Fowler.*

MIDDLETOWN SPRINGS. *Location and Post-office*, Middletown Springs, Rutland County, Vt.

ACCESS.—By carriage from Poultney, a station on the Rutland & Washington Division of the Delaware & Hudson Canal Co. Railroad, seven miles from the hotel.

ANALYSIS (Peter Collier).—One pint contains :

	Grains.
Carbonate of soda	0.402
Carbonate of magnesia	0.158
Carbonate of lime	0.418
Carbonate of iron	0.167
Carbonate of manganese	0.147
Chloride of potassium	0.163
Chloride of sodium	0.027
Sulphate of lime	0.018
Alumina	0.010
Total	1.510

Therapeutic Properties.—The mild constitution of these waters, together with the healthful locality of the springs, renders them very useful in all forms of chronic debility (see Minequa Springs).

The springs, four in number, are situated on the north bank of the Poultney River, and every provision is made for the comfort and entertainment of the guests. The hotel, "The Monvert," has accommodations for three hundred and fifty guests. It has lately been refurnished, and possesses all the improvements of a first-class house. From its piazza there is a fine view of the peaks of Killington, Pico, Little Pico, and several other eminences of the Green Mountain Range. The village, nestled at the foot of the mountains, at an altitude of three thousand feet, contains churches of all denominations.

George B. Fowler.

MIDLAND WELL. *Location and Post-office,* Midland, Midland County, Mich.

Access.—From Detroit by the Flint & Père Marquette Railroad.

Analysis (S. P. Duffield, M.D.).—One pint contains (47° F.):

	Grains.
Chloride of sodium	3.405
Chloride of magnesium	0.228
Chloride of calcium	0.647
Sulphate of potassa	8.559
Sulphate of soda	2.298
Sulphate of lime	0.464
Phosphate of alumina	0.180
Silica	0.308
Organic matter	0.257
Loss	0.334
Total	16.680

Therapeutic Properties.—The peculiarity of this water is its purgative constituent, sulphate of potassa, an old-fashioned remedy, once known as polychrestus salt.

G. B. F.

MIGRAINE. Etiology.—Migraine is an hereditary neurosis *par excellence.* This feature of the disease is so patent that it is even recognized by the laity, and patients often refer to the malady as the family headache. In a very large proportion of cases the hereditary influence is transmitted by the mother, and generally to the daughters alone. The influence of heredity in this disease is generally direct, *i.e.*, the parent has also suffered from migraine. It is also a peculiar fact that special features of the disease are often transmitted. For example, if hemianopsia happens to be a symptom of the disease in the parent, it is apt to constitute a feature of the attack in the children. And this is true of other peculiarities of paroxysms of migraine. But in not a few cases various members of the family suffer from other neuroses, such as epilepsy, insanity, trigeminal neuralgia, etc. In families in which insanity is prevalent it sometimes appears, as is also true of certain cases of trigeminal neuralgia, that migraine may take the place of more serious affections of the brain. On the other hand, it has been shown that migraine, when it develops in middle life, is often the forerunner of progressive general paralysis of the insane, or of other organic cerebral diseases.

Oppenheim's investigations point to close relations between migraine and locomotor ataxia. Among 85 cases of the latter affection, this writer observed 12 (10 in females and 2 in males) who either were suffering or had suffered at an earlier period from typical attacks of migraine. The latter generally ceased with the development of tabetic symptoms. In some cases the head symptoms alone subsided, while the vomiting became more obstinate (transformation into gastric crises). In rarer cases the migraine continued after the development of the locomotor ataxia.

The predisposition to the disease may also be acquired by individuals in whose families no neuropathic tendency can be discovered. This may result from prolonged worry or mental strain; for example, "cramming" for examinations in school, the loss of sleep and grief incident to nursing, or sexual excesses committed soon after puberty. The development of migraine is also favored by general anæmia, or by the condition of debility left over after protracted and exhausting diseases, such as typhoid fever, malaria, etc. In some cases the disease is distinctly associated with the gouty diathesis, and a number of cases have been reported in which the gouty paroxysms were replaced by attacks of migraine. The female sex exhibits a decidedly greater predisposition to the disease than does the male sex. This increased susceptibility of females is manifested even in those cases in which no hereditary influence can be discovered.

Migraine develops most frequently between the period of puberty and the twenty-fifth year. It very seldom begins after the latter period, and then, as we have previously intimated, is often a prodrome of some more serious disease, such as insanity, locomotor ataxia, or general paresis. In not a few cases, however, the onset of the disease dates back to the sixth or seventh year, and Bohn has reported the following case of congenital migraine: A girl, aged eleven years; the attacks have occurred at intervals of four to six weeks from birth until the present time. They begin with redness of the face, and, since the child has been able to describe her symptoms, with pain of gradually increasing severity in the anterior portion of the left side of the head. Later the eyelid can be raised only slightly; vision impaired during the paroxysm, and pulse unusually slow and hard. The pain ceases at intervals; constant nausea; vomiting produces relief. During infancy the patient suffered from attacks (every four to six weeks) of sudden restlessness, which lasted one to two days, and were attended by diminution of appetite, vomiting, and inflammatory irritation of the left eye. When the child learned to talk, she complained of her head during these attacks, and later of the left side of the head.

The individual paroxysms of migraine may be the result of manifold exciting causes. On account of the frequent presence of nausea and vomiting during the seizure, undue stress has been placed upon gastric disturbances, dietetic errors, etc., as causes of the disease. Many patients, it is true, tell us that their attacks are brought on in the manner indicated, but careful investigation will generally show that the gastric symptoms constitute a part of the seizure of migraine, and do not precede it. In some undisputed cases, however, there is no doubt that gastro-intestinal disturbances, sometimes in themselves of a trifling nature, will produce violent attacks of migraine.

Among other exciting causes may be mentioned menstruation and mental excitement of all kinds. Some women suffer from migraine only during the menstrual flow, even though the latter appears to be entirely normal. In one of my patients the attacks occur at the menstrual period alone, but only if there has been an unusual degree of excitement at that time.

Unusually profound impressions upon the special senses will also incite a paroxysm in predisposed individuals. This is true of the odor of various substances, whether offensive or pleasant; of bright and glaring lights, loud sounds, such as sudden bursts of music, etc.

In some cases the disease is said to be the result of nasal affections, especially of hyperplasia of the mucous membrane of the inferior turbinated bone. Schaeffer reported six cases due to nasal polypi and chronic hyperplastic rhinitis; five of these cases were cured by treatment of the nasal affection. The disease has also been attributed in many cases to ocular affections, but we have rarely found it due to such causes.

In not a small proportion of cases of migraine, as in other functional neuroses, the most careful and patient investigation fails to reveal the existence of any etiological factor.

Clinical History.—The disease consists chiefly of paroxysms of headache of a peculiar character, with interparoxysmal periods, during which no symptoms are noticeable. The attacks of pain are sometimes preceded by prodromes, which may last from a few hours to a day or two. They consist of a feeling of mental depression (rarely of increased mental vigor), a sensation of

pressure in the head, ringing in the ears, occasional flashes of light before the eyes, a bad taste in the mouth, etc.

The headache itself generally lasts from six to ten hours, sometimes twenty-four hours, and, in very severe cases, even two or three days. In many instances the paroxysms last about the same length of time in the same patient, although this often varies according to the time of day at which the headache begins. Many tell us that if the pain is experienced on rising in the morning it will subside in the evening, and, after a good night's rest, they awake the next morning feeling perfectly well. But if the pain begins later in the day it often continues during the night, interferes with sleep, and gradually subsides on the following morning.

The pain usually increases gradually in severity, but soon attains its greatest intensity. In very many, perhaps in the majority, of cases it is not confined, as the term hemicrania indicates, to one side of the head, but attacks both sides, although generally more severe on one side than on the other. In a few cases it first attacks one side, then subsides there, and passes to the other side. The pain is variously described as boring, burning, tearing, or throbbing, and often is so atrocious as to rob the patients of all self-control. Some individuals are compelled to lie down during the entire attack, others are forced to sit in a chair because the recumbent posture makes the pain still more intolerable. The room is generally kept darkened and the eyes closed in order to avoid a bright light. Absolute silence is generally insisted on by the patients, and even the rustling of a newspaper or the ticking of a watch may cause untold torments.

The pain is generally distributed over the entire side of the head, but is usually most severe in the temple or at the junction of the parietal and temporal regions. It is also apt to be very severe in both foreheads and in one or both eyeballs.

Nausea and vomiting are also very common symptoms, though by no means so constant as the headache. Many patients suffer from nausea from the beginning to the end of the attack. This sensation is generally intensified by the mere thought or sight of food. Vomiting is also observed in many cases. Sometimes it takes place repeatedly during the paroxysm, sometimes it is the terminal symptom.

Another, but less frequent, phenomenon during the seizure is drowsiness or stupor. The patients sometimes lie in a semi-unconscious condition, but dimly cognizant of what is going on around them, and can only be partly roused by questions.

Vertigo is also often observed, and sometimes forms one of the most disagreeable features of the paroxysm. When associated with nausea and vomiting, it may produce a condition which is exactly similar to seasickness.

During the seizure the pulse is usually small, and its rapidity is often materially diminished.

The attack may terminate in various ways. Sometimes the headache, and with it the other symptoms, gradually subside until they finally disappear, or they terminate abruptly after copious vomiting, or the patient falls into a refreshing sleep, from which he awakes free from pain.

This affection also presents, in many cases, various other important and interesting phenomena, which will be referred to later. We will now describe the two varieties of the disease to which attention has been directed, chiefly by the German writers. The classification in question is based on the occurrence of circulatory and pupillary disturbances in some cases.

In so-called spastic or sympathico-tonic hemicrania, the symptoms of irritation of the cervical sympathetic are noticeable. The face and ear on the painful side are pale and feel cool to the touch, the temporal artery is hard and tense, the pupil dilated. In some of these cases it is said that the pain is intensified by pressure upon the carotid on the same side, and diminished by pressure upon the carotid on the opposite side. Toward the end of the attack the symptoms sometimes change to those of paralysis of the cervical sympathetic—redness of the face and ear, increased heat of the integument, sometimes diminution in the size of the dilated pupil, etc.

In the angio-paralytic form of hemicrania the face and ear are hot, red, and perspiring, the pupil is contracted, the palpebral fissure is narrowed, the temporal artery full, and the pain is diminished by pressure on the carotid of the same side.

No typical cases of this kind have come under our own observation. While we have noticed that the face is sometimes pale, and the temporal artery apparently contracted, we have not seen any pupillary symptoms in such cases, nor have we observed them when the face was hot and congested.

From our acquaintance with the literature of the subject, we are inclined to believe that the clinical history of the spastic and paralytic forms of hemicrania has, in great part, been merely handed down on faith from one author to another. This opinion is strengthened by the fact that German writers, who lay such stress on the sympathetic features of the disease, maintain almost complete silence concerning certain very interesting, and at the same time very important, symptoms to which we will now call attention.

Prominent among them are visual disturbances of varying kinds. In addition to the flashes of light before the eyes, which constitute quite a constant symptom, there may be other peculiar visual sensations, viz., obscuration of the field of vision and luminous spectra. These phenomena often, though not always, appear at the beginning of a paroxysm. The following history will serve to illustrate several points in symptomatology: Veronica T., aged seventeen years; a sister suffers from epilepsy, and two brothers had convulsions while teething. The patient has had headaches for the past three years; first menstruated two years ago. The headaches have occurred about once a month (though not connected with the menses), except during the past month, when they came on every other day. The patient awakes in the morning feeling the pain and sickness, and has a coated tongue. The pain is confined to the right parietal and frontal region, and disappears slowly about 3 P.M. During some of the attacks she would begin to feel dizzy about 10 A.M., and then the visual symptoms would appear and last about twenty minutes. On one occasion she lost sight entirely in the right eye; at other times there was temporal hemianopsia of the right eye. There appeared to be a dark cloud in front of the eye, in which were glittering moving worms. On placing a handkerchief before the right eye, she could see distinctly with the left eye, but on covering the latter, right temporal hemianopsia was noticed.

This case is especially interesting from the fact that it seems to prove that the hemianopsia may be monocular, an occurrence which is denied by Liveing. The features characteristic of this case, viz., the partial blindness and the visual hallucinations, are subject to numerous variations. According to Galezowski, who has paid special attention to ocular migraine, "the hemiopia is either monocular or binocular; the former is sometimes lateral and, at other times, occupies the upper half of the visual field. Sometimes the hemiopia passes into complete blindness, or it is followed by slight indistinctness of vision for the remainder of the day. Central scotoma is more rarely the chief symptom of the malady which retains this form, but this symptom is sometimes transformed into hemiopia."

The visual hallucinations are sometimes more complicated than in the case described above, and may consist of zigzag, rapidly moving lines of light, sometimes arranged in the shape of fortifications, and perhaps of brilliant changing colors. In still other cases the patients perceive different colors, but without any definite shape, and usually on a dark background. Cases have been reported in which the attacks of migraine consisted solely of the visual disturbances.

In addition, there may be other symptoms of an evidently cerebral character, such as numbness and tingling on one side of the body, hemiparesis, aphasia, and confusion of ideas. The following history, reported by

Abercrombie, is illustrative of these cerebral symptoms: "Some time ago I was consulted by a lady who describes her attacks in the following manner: She is first affected with blindness of the right eye, which comes on gradually as if a cloud passed slowly over the eye; about a quarter of an hour after this she feels a numbness of the little finger of the right hand, and extending very gradually over the whole hand and arm, producing a complete loss of sensibility of the parts, but without any loss of the power of motion. The feeling of numbness then extends to the right side of the head, and from this it seems to spread downward to the stomach. When it reaches the side of the head, she becomes oppressed and partially confused, answers questions slowly and confusedly, and her speech is considerably affected. When it reaches the stomach she sometimes vomits. The feeling of numbness then begins to subside, and as it goes off she is seized with a violent headache, which continues for several hours."

Lebert, who suffered from ordinary migraine, also experienced three attacks, which "began with some incoherence of ideas, a difficulty in finding words, and a numbness in the tongue and in the last fingers of the right hand; an hour later acute pain was felt over the right brow, followed by vomiting and cessation of the attack."

A case has come under my own observation, similar to that quoted from Abercrombie, except that the symptoms were not so well marked.

Hughlings Jackson divides migraine into three varieties, viz., the typical, subtypical, and supratypical. The first includes three stages: *a*, visual projections, usually beginning on one side, frequently with zigzag or "fortification" outlines, these conditions sometimes preceded by darkness of parts of the visual field; *b*, headache, usually one-sided; *c*, vomiting, usually ending the attack. Subtypical migraine includes two stages: *a*, visual projections alone; *b*, headache alone. Supratypical migraine: in some cases, in addition to visual projections, there are one-sided numbness, tingling, coldness, etc., and sometimes aphasia.

Saundby has reported two cases of migraine associated with temporary paralysis of the third nerve. Horner has described, in migraine, a form of ptosis which he attributed to paralysis of Mueller's muscle.

Attacks of hemicrania recur with varying frequency, sometimes at intervals of many months; while in severe cases there may be periods during which the patient is free from suffering only for a few days at a time. After middle life the attacks generally diminish in frequency and severity. In exceptional cases the disease disappears, but only to give place to some more serious neurosis. The general health is not often affected by hemicrania, although it occurs very often in feeble, debilitated individuals.

PATHOLOGY.—The pathology of migraine is extremely obscure, chiefly for the reason that, as in other functional neuroses, no help is afforded us by pathological anatomy.

Even the site of the pain is not known with certainty. The probabilities are, however, that it is situated in the distribution of the branches of the fifth nerve, which supply the dura mater and pia mater; perhaps, also, in the substance of the brain itself.

In the consideration of the pathology of this disease, we must constantly bear in mind that it is closely related to other functional neuroses. Not alone does it occur in families in which epilepsy, insanity, neuralgia, asthma, and other neuroses are also manifested, but in the same individual we sometimes find that the disease is replaced by one or the other of the affections mentioned. Furthermore, attacks of migraine sometimes pass by insensible stages into epileptiform seizures, and it may be extremely difficult to determine where the one disease ends and the other begins.

Perhaps the most widely accepted theory at the present time is that of the origin of the disease in the cervical sympathetic, or in the corresponding cilio-spinal region in the cord. In the spastic form of hemicrania the condition is supposed to be one of irritation of the parts in question; in the angio-paralytic form, of inhibition or paralysis of these parts.

Now, apart from the fact that the circulatory and oculo-pupillary phenomena in migraine are comparatively infrequent, and are not an essential feature of the disease, the sympathetic theory utterly fails to explain the visual phenomena, the unilateral numbness, aphasia, etc., which are observed from time to time in this malady.

Liveing, one of the ablest writers on the subject, thinks that migraine is the result of a "nerve-storm," *i.e.*, an explosive discharge of nerve-force, which traverses the optic thalamus and sometimes other sensory centres. He bases this view chiefly on the analogy and interchangeability of migraine with other paroxysmal neuroses.

The theory advocated by Hughlings-Jackson is very similar to that offered earlier by Liveing. According to the former writer "migraines, certainly when there are ocular phenomena with one-sided disorders of sensation, are epilepsies, *i.e.*, local excessive cerebral discharges. The ocular phenomena and the unilateral disorder of sensation are parts of the paroxysm, but the headache and vomiting are post-paroxysmal symptoms." He believes that the discharging lesion takes place in some part of the cortex of the posterior lobe, and that the visual symptoms are probably accounted for by a discharge of nervous elements in Ferrier's visual centre.

The phenomena of spastic and angio-paralytic hemicrania are readily explained by the assumption of a discharge from the cortex to the medulla oblongata and the cilio-spinal centre in the cord.

This theory appears to us to offer the most satisfactory explanation of all the facts of migraine, and at the same time of its relationship to other paroxysmal neuroses.

Sydney Ringer has somewhat modified this theory. According to him, migraine and other explosive neuroses are due to loss of resistance in certain parts of the nervous system, whereby impressions upon these parts spread beyond their normal area. In the common form of migraine (supra-orbital headache, with nausea and vomiting) the evolution of nerve-force occurs first in that part of the nucleus of the fifth nerve which is connected with the supra-orbital branch; the discharge then travels backward and involves the centre for vomiting.

Although the theory of the neuralgic character of migraine is almost entirely discarded at the present time, it is still held by a few able writers. This opinion seems to us to be opposed to the weight of evidence. The character of the pain is entirely unlike that of neuralgia, and this circumstance is referred to by patients who may happen to have suffered from both affections. In addition, the pain of facial neuralgia is strictly unilateral, is situated more superficially, and is more apt to be associated with trophic changes in visible parts; while the pain of migraine, in part at least, is situated deeply, and is often combined with disturbances of cerebral functions.

The theories of the bilious or gastric origin of migraine are interesting merely from an historical point of view. At the present time they are entertained only by the laity.

DIAGNOSIS.—As a rule, there is very little difficulty in making a diagnosis. The attacks are readily distinguished from neuralgia by the absence of the lancinating pains of the latter disease, the deeper situation of the pains, the nausea and vomiting which occur so frequently, the eagerness on the part of the patient to avoid all sources of sensory irritation and to assume a recumbent position, in some cases the peculiar visual phenomena and the other cerebral phenomena mentioned above, the evidences of sympathetic irritation or paralysis in certain cases, and the lesser amenability to treatment.

The osteocopic pains of syphilis are distinguished by the nocturnal exacerbations of pain, the periosteal swellings which are so often noticed, the presence of other evidences of syphilis, and the happy results obtained by the administration of iodide of potassium.

In rare cases it may be difficult to differentiate the disease from mild epilepsy (petit mal), and at times the disease seems to shade off gradually even into severer forms of epilepsy.

Careful examination must be made in doubtful cases, in order to determine whether the patient experiences any loss of consciousness, however fleeting, during the paroxysms.

PROGNOSIS.—The disease rarely produces serious detriment to the general health of the patient, but if the attacks return at brief intervals it interferes very materially with his comfort and well-being. In rare cases, particularly when it develops in middle life, it is a forerunner of organic affections of the nervous system.

Complete recovery from the disease, *i.e.*, the prevention of relapses, is secured in only a small proportion of cases.

In like manner, little can be done in the majority of cases to alleviate materially the sufferings of the patient during individual attacks, though, on the other hand, extremely happy effects are sometimes obtained. Fortunately the disease generally grows spontaneously milder, and the attacks become less frequent with advancing years. When the hereditary neuropathic taint is well marked, the prognosis is less favorable.

TREATMENT.—The most important feature in treatment is to increase the stability of the nervous system, *i.e.*, to raise its tone. As the disease is so often hereditary, and so often begins in childhood, medical supervision should begin at an early age. No forcing in education, no pampering of the sentimental side of the child's character—above all sufficient sleep and good, nutritious food. It is advisable to order a course of cod-liver oil every winter. Adult patients should chiefly avoid mental worry and excitement, particularly immoderate attendance at the theatre, opera, receptions, etc.

A search should be made for exciting causes of the paroxysms in the various organs, such as eye-strain, nasal affections, gastro-intestinal disturbances, uterine diseases, etc., and appropriate treatment adopted for the latter. In such cases our efforts often meet with success when the disease is the result of acquired predisposition, and not of strong hereditary tendencies.

The best medicinal agent in our hands has been arsenic, in the form of Fowler's solution or arsenious acid (preferably in tablet triturates). This remedy may be given continuously for several months at a time. We have often found that the intervals between the attacks were greatly lengthened by its use, but it seems to have little effect on the severity of the attacks when they do occur.

Another valuable agent is cannabis indica, which must be given, like the arsenic, steadily and for a long time. The preparations of this drug are remarkably variable, so that the doses requisite to produce its physiological effects vary between very wide limits. General tonics may also be useful (iron, strychnia, etc.).

The appropriate remedies for the individual attacks are generally found only after experimentation with various drugs.

Sometimes the simple expedient of tightly binding the head, or the application of hot or cold water, will prove extremely soothing to the patient. In other cases a mixture of bromide of potassium and chloral hydrate (say thirty grains of the former and fifteen grains of the latter) will induce sleep, from which the patient awakes relieved and sometimes entirely well. If necessary the dose may be repeated in a couple of hours.

Guarana, caffeine, bromo-caffeine, given in repeated doses at short intervals, are also useful in some cases. At times we are compelled to resort to the use of morphine (preferably by hypodermatic injection), but this remedy has generally failed us. If the attacks are very frequent we must constantly bear in mind the possibility of the formation of the morphine habit. I have obtained good results in some cases from the administration of aconitia, but this remedy is by no means so valuable in this affection as it is in trigeminal neuralgia.

A mild galvanic current passed transversely through the mastoid processes, galvanization of the neck, nitrate of amyl (by inhalations), nitro-glycerine, croton-chloral hydrate, valerianate of zinc, and a host of other narcotics, have been recommended.

In a considerable proportion of cases the patients recognize the uselessness of all attempts to moderate their sufferings, after an attack has developed. *L. Putzel.*

MILFORD SPRINGS. *Location and Post-office,* Milford, Hillsborough County, N. H.

ACCESS.—By Milford Branch of the Boston & Albany Railroad; or by Boston & Lowell Railroad, Southern Division, to Milford or to Amherst station, thence two miles to the Springs by stage.

ANALYSIS.—One gallon contains:

	Ponemah Spring, I. M. Ordway.	Iron Spring, G. E. Sewell.	Magnesia Spring, G. E. Sewell.	Medical Spring, G. E. Sewell.
	Grains.	Grains.	Grains.	Grains.
Carbonate of soda	0.2392	....	....	....
Carbonate of lime	0.3416	....	2.00	....
Carbonate of magnesia	....	0.40	....	....
Chloride of sodium	0.1955	....	1.00	0.90
Sulphate of magnesia	......	....	2.00	....
Sulphate of potassa	0.0677	....	...	1.80
Sulphate of soda	0.3740	0.40	....	0.60
Sulphate of lime	......	....	1.04	....
Sulphate of iron	......	1.04	trace	1.00
Oxide of iron	0.0860	....	....	....
Phosphate of soda	......	....	...	....
Phosphate of lime	......	....	....	....
Magnesia	trace	....	....	....
Silica	1.2400	....	trace	1.01
Sodium alumina	......	1.04	....	....
Water, etc	0.4800	....	....	....
Total	3 0240	2.88	6.04	5.31

THERAPEUTIC PROPERTIES.—The analysis shows this to be one of the purest of spring waters. Its value depends upon this fact, and, being naturally charged with carbonic acid gas, the water is extensively used as a substitute for the drinking-water of large cities or populous districts.

Exclusive use of this water, together with a sojourn at the healthful locality, is conducive to the cure of ailments depending upon disorders of digestion.

Milford Springs are situated in the southern part of New Hampshire, fifty miles northwest from Boston, on elevated ground affording a beautiful view of the surrounding country. There are charming drives in all directions, and the grounds of the hotel are carefully arranged. The "Hotel Ponemah," built in 1883, contains all the modern improvements for the comfort and entertainment of its guests. The waters of these springs are bottled and shipped throughout the country.

G. B. F.

END OF VOLUME IV.